RECONNOISSANCE SOIL SURVEY OF SOUTH-CENTRAL PENNSYLVANIA.

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GENERAL DESCRIPTION OF THE AREA.

The area mapped embraces 16 counties of South-Central Pennsylvania, with a combined area of 10,908 square miles, or 6,981,120 acres. It includes the counties of Clearfield, Cambria, Somerset, Bedford,

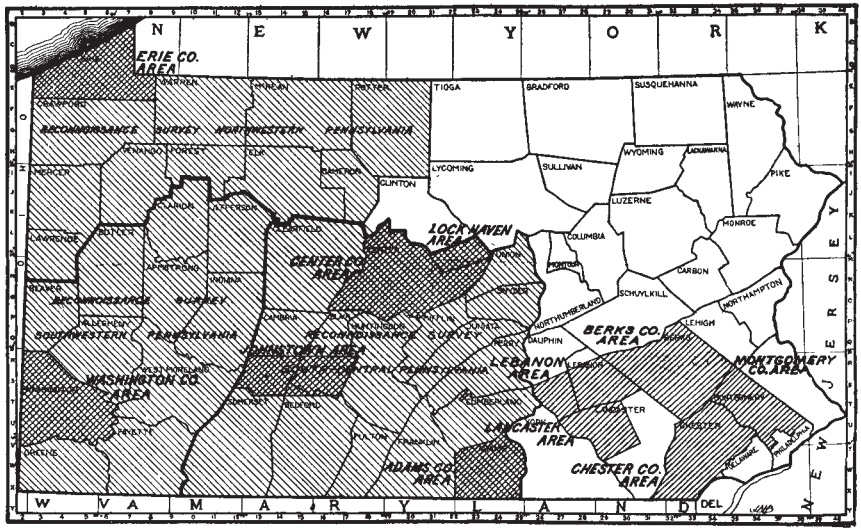

FIG. 4.—Sketch map showing reconnoissance survey of south-central Pennsylvania.

Blair, Center, Huntingdon, Fulton, Franklin, Adams, Cumberland, Perry, Mifflin, Juniata, Union, and Snyder. Of these, Center, Adams, and parts of Bedford, Blair, and Cambria were reduced from the detailed maps of those areas, and parts of Somerset and Clearfield Counties were mapped during the field season of 1909. The other counties were mapped during the present season.

On the west the area joins that of the Reconnoissance Survey of Southwest Pennsylvania made in 1909, the boundary being the eastern line of Fayette, Westmoreland, Indiana, and Jefferson Counties. On the north the area is bounded by Clinton and Lycoming

Counties, on the east by the Susquehanna River and York County, and on the south by the State of Maryland.

This region embraces three great physiographic divisions of the State—the Allegheny Plateau, the Appalachian Mountains and Valleys, and the Piedmont Plateau. The three western counties, Clearfield, Cambria, and Somerset, occupy the rolling to mountainous top of the Allegheny Plateau, while the eastern boundaries of the two southern (Somerset and Cambria) follow the line of the Allegheny escarpment. Adams County, on the southeast, is partly in the Piedmont Plateau, while the rest of the counties lie in the Appalachian Mountain and Valley province, which consists of the narrow, more or less parallel mountain ridges and intervening narrow valleys, together with the broad limestone valleys in Center and Blair Counties, and that part of the Great Valley known as the Cumberland Valley in Cumberland and Franklin Counties. These latter valleys are so distinct in character that they are classed as a separate division of the region known as the limestone valleys.

These differences in the character of the topography of the different sections of the area have produced marked differences in soil and agricultural development, as will be shown in a later chapter.

DRAINAGE.

The waters of this section find their way to the sea by three great river systems. Most of Somerset, two-thirds of Cambria, and a small area of Clearfield drain into the Ohio through the Youghiogheny, Conemaugh, and smaller streams. The southern portion of Bedford, Fulton, Franklin, and Adams drain into the Potomac through Wills and Toms Creeks, Licking Creek, Conococheague Creek, and other smaller streams and their tributaries. The remainder of the area is drained by the Susquehanna through its West Branch, Penns Creek, the Juniata River, and other tributaries.

The West Branch of the Susquehanna heads in southern Clearfield County, flowing northeast into Clinton County, receiving the drainage of Clearfield and Center Counties through its many tributaries. Of these Clearfield Creek, in the county of that name, and Bald Eagle Creek and its tributary, Spring Creek, in Center County, are the largest. The river swings to the east and south through Clinton and Lycoming Counties and takes a general southerly course near the northeast corner of the area, joining the East Branch at Northumberland, opposite the Union-Snyder county line, to form the Susquehanna River proper. Along this eastern side of the area the river receives the drainage of Union and Center Counties through Buffalo and Penns Creeks and of Snyder County through Middle Creek. The other counties are drained through the Juniata River and the

Conodoguinet and Yellow Breeches Creeks and their tributaries. These streams proved very important in the settlement and development of the country, as they afforded ways whereby the settlers could get into the interior valleys and routes for the transportation of their products to the markets in the southeastern part of the State.

TRANSPORTATION.

At the present time the area as a whole has excellent transportation facilities, being crossed by the main line of the Pennsylvania Railroad, with its many branch lines to the north and south. Along the east side the Northern Central Railway affords rapid transportation. The New York Central has a line into Center and Clearfield Counties, and the southern counties are served by the Reading, Western Maryland, Baltimore & Ohio, and Cumberland Valley (Pennsylvania control). There are, besides these large systems, several smaller roads—the Bellefonte Central and the Central of Pennsylvania in Center County, Huntingdon & Broad Top Mountain and the East Broad Top in Huntingdon County, Tuscarora Valley and Shermans Valley in Juniata and Perry Counties. There are also numerous electric traction lines in some parts of the area. In spite of this, there are many sections remote from the railroads, shut off by mountain ranges, through which it is too expensive to carry transportation lines. Fulton County has no railroads at all, the Baltimore & Ohio at Hancock, Md., 3 miles from the county line, the East Broad Top in Huntingdon County, the Huntingdon & Broad Top Mountain in Bedford County, and the Cumberland Valley in Franklin County being the nearest railway points. Because of the markets and connections, Mercersburg, on the Cumberland Valley Railroad, is one of the important shipping points for Fulton County.

Public roads are generally rather rough, except in the limestone valleys, where crushed limestone has served to make a very good surfacing material. Except in the mountains, where the roads are stony, they are generally good in summer, but become very muddy and at times almost impassable in spring and fall.

There are several very well-kept toll roads and turnpikes, one of the most important being the old Pittsburgh-Philadelphia pike, which crosses the southern tier of counties. The State has constructed a number of macadam roads throughout the region, usually from 2 to 8 miles in length from a city or central shipping point out into the country. The general tendency toward improvement in public roads, partly due no doubt to the establishment of rural free-delivery routes over most of the section, is doing much to improve conditions and to reduce the cost of marketing farm products.

In Fulton County the traction engine, hauling two to four wagons, is being used to some extent in hauling lumber, tan bark, etc., over the mountains to the nearest railway station, and hauling fertilizer, lime, etc., back to the farms.

POPULATION.

The population of this area in 1910 was about 815,430, made up of four general classes—the mine workers in the coal regions of the three western counties, the railway employees, the farmers, or rural population, and the merchants, traders, and professional people of the towns.

The coal miners and workers about the furnaces are largely foreigners—Hungarians, Italians, and other nationalities from the south of Europe. They make up a considerable proportion of the population of Clearfield, Cambria, and Somerset Counties. They are usually illiterate and unprogressive and live under rather poor conditions in the mine and mill tenements and often in mere shacks.

The rural population is varied, but people of German descent predominate. The descendants of the Scotch-Irish, who were the first settlers in these regions, have drifted away from the farm and are now found in large numbers engaged in railroading or business.

There are no very large cities in the area. Altoona, with 52,127, and Johnstown, with 35,482, being the largest. These, with Harrisburg, 64,186, and Sunbury, 13,770, just east of the area, and Carlisle, Dubois, Chambersburg, Huntingdon, Tyrone, Waynesboro, Clearfield, Lewistown, Bellefonte, and 10 or 12 smaller towns of from 1,000 to 5,000 inhabitants within the area, make up the urban population.

There are a great number of small towns of from 100 to 500 population in the limestone districts, especially, largely inhabited by retired farmers. About one-fourth the population live in towns of more than 1,000 inhabitants.

HISTORY AND SETTLEMENT.

The first white settlers in the area were the Scotch-Irish pioneers who cleared land and built their cabins on the Conodoguinet Creek, in Cumberland County, about 1725. Others moved on to the west and about 1728 a settlement was established on the Conococheague in Franklin County. Between 1730 and 1740 settlements were made in Big Cove and on the Aughwick Creek in Fulton County and at Burnt Cabins in Fulton County. By 1751 the pioneers had pushed across the mountains to Raystown, now Bedford, in Bedford County. Blair County was settled at Frankstown in 1756, Somerset in 1760, and Cambria in 1774.

Another stream of settlers proceeded to the north and west along the Susquehanna and its tributaries. These men and their families established homes in Juniata County about 1749, and in Union, near Lewisburg, in 1754. Mifflin County was settled by Arthur Buchanan in 1755, when he built a cabin near where Lewistown now stands. Fort Granville, in Mifflin County, and Fort Shirley, in Huntingdon County, were built in 1756. Between 1760 and 1770 settlements had been established in Center and Clearfield Counties, and the whole area was opened.

The first settlements were necessarily almost self-supporting, and such necessities as could not be grown or made by the family were obtained by bartering furs, skins, etc., with the traders from the East. The establishment of gristmills, where corn and wheat could be ground, increased the production of these crops, while the manufacture and sale of whisky aided the settlers in marketing their corn and rye.

As the eastern settlements at Philadelphia, Baltimore, and other points on the coast and rivers grew in population, the demand for agricultural products increased and the settlers obtained better markets.

At first the only means of transport was the pack train, or on the rivers the canoe and flatboat. The opening of the great "pikes" across the State was an important step. One of these roads, still in excellent condition and much used by automobiles, the Philadelphia-Pittsburgh Pike, crosses the southern part of the State, passing through Somerset, Bedford, Fulton, Franklin, and Adams Counties. The second of these roads followed the Susquehanna and Juniata Rivers into the center of the State, opening the counties of Center, Huntingdon, Mifflin, and Blair. Further development of these roads served to open up the whole area of the country.

The development of the Pittsburgh district, with its wealth of coal, made demands for better transportation to the sea. By 1834 a continuous line from Pittsburgh to Philadelphia was open. This consisted of the old Columbia Railroad, 82 miles long, from Philadelphia to Columbia; the eastern division of the canal, from Columbia along the Susquehanna and Juniata to Hollidaysburg, 172 miles; the Portage Railroad to Johnstown, 36 miles, and canal from there to Pittsburgh, 104 miles.

The canal system, with its heavy expense for loading and reloading from boat to cars, never proved a success. The rates were too high and the transportation very slow.

The Pennsylvania Railroad was started in 1847. In 1849 it was opened to trade as far as Lewistown, and in December, 1852, the first cars were run from Philadelphia to Pittsburgh.

The Cumberland Valley Railroad was built between 1835 and 1845, opening the rich Cumberland Valley. The Huntingdon & Broad Top Mountain was built in 1853 and 1855, and the building of other roads served rapidly to open up the entire country.

With the opening of these railroads came the extensive development of mining and manufactures and the resultant demand for food products. The markets for agricultural products increased with the growth of population, and the rapid development of the rural sections followed.

As has been stated, the early agriculture of the region was limited practically to supplying home needs, furs, skins, whisky, and some grain being the chief articles of barter. With the opening of the roads stock raising became more general, and when the railroads were built grain and stock became the important products.

During the earlier years corn, oats, wheat, rye, barley, and grass were grown, together with small areas of potatoes, sweet potatoes, and sorghum. In the mountain and plateau section agriculture was of secondary importance to the lumber industry.

The whole region was forested, and as the country developed the lumbering industry grew in importance. The timber was cut and logs floated down the rivers to the mills and markets. Tanbark from hemlock, oak, and other trees was a product of importance, and many tanneries were established over the whole area. At the present time practically all the timber land has been cut over, much of it cut twice, and the lumbering industry has nearly disappeared. Many of the tanneries are still in operation, especially in the more mountainous and remote sections.

There are large areas in the part of the State covered by this survey that, because of their rocky soil or rough topography, are adapted only to the growth of forests. This is true of large areas on the Allegheny Plateau in Clearfield, Cambria, Somerset, Blair, and Center Counties, and on many of the mountain ridges east of the Allegheny escarpment.

Forest fires, occurring with distressing frequency, are destroying the young growth and retarding reforestation. Great areas of the mountain sides and the plateau are covered with scrub oak, which makes a dense growth 3 to 5 feet high and affords excellent fuel for the next fire.

The State has acquired some large forest reserves in this region, and with approved methods is setting about the task of reforesting the waste places and protecting the trees that now exist. On lands not owned by the State the destruction of the forests is proceeding rapidly. The true lumberman is being followed by those who are

cutting pulp wood for the paper mills, taking everything down to 2 or 3 inches in diameter. In other regions this small stuff is being cut for mine ties, props, and timbers. The removal of this growth is exposing the soils on the steeper slopes to active erosion. The soil is washed from the rock surfaces, and on many mountain slopes gullies are being formed.

The removal of the forest cover has had a marked effect on the drainage of the region. When the forests covered the area the deep bed of leaf mold, protected from evaporation by the shade, served as a great sponge to hold the rain water and allow it to seep gradually away to the springs and streams. With the removal of the forest this "sponge" has been destroyed by fire or by the slower process of decay, and the rain waters quickly flow to the stream channels. As a result heavy floods are occurring each spring and during the long dry summer the rivers go nearly dry. This condition is causing considerable loss to the power companies that depend on water to develop their electric current.

Another natural product that has had a marked effect on the agricultural development of a part of the area is coal. The Allegheny Plateau is largely made up of the Coal Measures, and soft coal is extensively mined in Somerset, Cambria, and Clearfield Counties. In western Center County and on the Broad Top Mountain in Huntingdon, Bedford, and Fulton Counties, coal is also mined. In the western counties the presence of coal has materially affected land values, increasing the selling price to very high figures. When the coal is removed, if it lies near the surface, cave-ins and sinks may occur, and frequently the water supply fails. In these regions too, the farmers all have a speculative interest in the coal industry and do not give their best efforts to agriculture. On the other hand, the presence of the coal has brought the railroads, built up towns, and developed excellent markets for farm products. The farmers of Somerset, Cambria, and Clearfield Counties can dispose advantageously of their farm products, corn, oats, and hay for the animals at the mines, and wheat, potatoes, cabbage, turnips, beets, onions, tomatoes, etc., to the miners and their families. The Broad Top coal field affords a market that has meant much to the farmers in northwestern Fulton, northeastern Bedford, and southern Huntingdon Counties, and the labor troubles of 1909–10 in that field caused serious losses to the farmers of the region mentioned.

Three other natural products have had considerable effect on the development of parts of the region. Brick-clay beds have been extensively developed in the western and central parts of the area, the workers making a market for the products of the farm. Glass

sand is being extensively mined along the Juniata and limestone quarries have been opened and operated over the area wherever that rock has been found. The most extensive quarries occur near Bellefonte, Tyrone, Hollidaysburg, Birmingham, Lewistown, and in Cumberland County, near Harrisburg. The limestone is quarried for burning, for building purposes, road material, and railroad ballast. The importance of these deposits of limestone to the agriculture of the region can not be too highly estimated. Most of the land needs the application of lime and the presence of many small kilns scattered over the whole area makes it easy to obtain the burned lime.

The natural resources of the area are, as a whole, well developed, and manufacturing industries are general. Fulton County, aside from farming, has no industries except tanning and lumbering.

CLIMATE.

Climatic conditions of the area vary greatly, as is to be expected with a wide range in latitude and elevations running from 400 to over 3,000 feet. The climate in Cumberland and Adams Counties is markedly different from that of Clearfield.

The rainfall varies from 35 to 45 inches and the dates of the first and last frosts show a marked range.

The following tables give the temperature and rainfall at some of the principal stations (Johnstown, Somerset, Altoona, State College, Lewisburg, Huntingdon, Harrisburg, and Gettysburg):

Normal monthly and annual temperature and precipitation.

Month.	State College.		Johnstown.		Somerset.		Lewisburg.	
	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	Inches.	°F.	Inches.	°F.	Inches.	°F.	Inches.
January	26.2	2.80	29.8	4.13	26.0	4.53	25.4	2.72
February	25.5	2.73	29.0	3.79	26.7	4.12	26.3	2.79
March	35.0	3.51	39.6	4.11	35.5	4.85	35.3	3.62
April	47.6	3.04	49.5	3.76	46.2	6.06	49.1	3.23
May	59.3	4.03	61.2	4.27	56.9	5.29	59.7	4.23
June	67.2	4.31	69.4	5.16	65.7	4.91	69.2	4.31
July	70.6	4.03	73.2	4.72	68.5	4.82	73.1	3.86
August	68.9	4.09	71.2	4.63	67.0	4.85	70.0	4.68
September	62.8	2.70	65.3	3.37	60.4	3.13	63.0	3.24
October	50.5	2.99	53.4	2.69	48.4	2.98	50.6	3.25
November	39.5	2.68	41.5	3.30	38.6	3.37	39.5	2.77
December	30.0	2.88	32.6	3.68	28.7	4.10	29.4	3.15
Year	48.6	39.79	51.3	47.61	47.4	53.01	49.3	41.85

Normal monthly and annual temperature and precipitation—Continued.

Month.	Huntingdon.		Harrisburg.		Gettysburg.		Altoona.	
	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	Inches.	°F.	Inches.	°F.	Inches.	°F.	Inches.
January	28.5	3.12	28.7	2.82	28.3	3.00	26.3	3.04
February	28.3	2.88	29.9	2.70	30.6	2.65	24.0	2.32
March	37.7	3.73	37.8	3.12	38.9	3.00	37.8	4.21
April	49.2	3.02	50.7	2.49	51.1	3.58	47.3	3.09
May	60.6	4.80	61.7	3.67	61.1	4.03	59.2	3.77
June	68.7	4.45	70.3	3.55	69.0	3.70	66.4	4.02
July	72.0	4.00	68.5	3.87	73.7	3.35	.....	.....
August	70.8	4.09	72.1	4.25	71.4	3.81	.....	3.85
September	64.3	3.00	64.9	2.85	64.2	3.09	63.0	2.79
October	52.0	3.15	54.0	2.95	50.6	3.15	51.5	2.76
November	41.5	2.55	41.7	2.35	40.3	2.87	39.7	2.46
December	32.1	3.16	32.8	2.65	31.5	3.32	28.8	3.00
Year	50.5	41.95	51.6	37.27	50.9	39.55	.....	.....

AGRICULTURE.

Because of the great diversity of the different sections of the area it is impossible to give a general description of the agricultural practices. Therefore this subject will be taken up by sections.

On the Allegheny Plateau the farmers, as a whole, are not in a prosperous condition. There are many farms that are giving excellent returns, but those yielding the owners a mere living are far more numerous. Grass and grain farming is the rule, and regular rotations are not usually followed. Corn, oats, wheat, rye, and grass are the main crops, while buckwheat and potatoes are also grown extensively. Over most of the area but little stock is kept, most of the hay and grain grown on the farms being sold in town or at the mines. As one of the great needs of the soils on the Allegheny Plateau is humus, this practice is rapidly impoverishing the land. In sections of Somerset County where dairy farming is practiced and the land is receiving periodic applications of manure, crop yields are very much better than in the other sections and the general prosperity of the country much higher.

Many untenanted or "abandoned" farms are to be found over this area. Some are owned by coal companies, which can not or do not care to carry on farming. In many cases, after a coal company has acquired a piece of land it is farmed by tenants until it no longer yields profitable returns and then is abandoned. In some cases abandonment is necessary because of damage to crops by smoke

and gases from the mines and coke ovens, or by the sinking in of the surface due to caving in of abandoned and worked-out mines. A great deal of the land could still be profitably farmed if the right methods were followed.

The supply of humus should be maintained, either by keeping stock and applying the manure, by plowing down green crops, or by both methods. The application of lime should be more generally and systematically practiced and better tillage should be given the crops.

Regular rotations are not generally followed. Corn is usually the first crop planted after a sod has been plowed down; oats follow corn, and wheat follows oats. Grass, usually timothy with some clover, is seeded with the wheat, and the mowings thus obtained are left as long as they will give reasonable yields of hay. Potatoes occupy part of the land that would have been devoted to oats, most farmers growing less than an acre. Buckwheat does not have a regular place in the rotation, but is sowed wherever a crop fails, or on pieces of grass land that are too poor to leave for hay. It is usually the first crop on newly cleared land that is covered by stones and stumps.

The markets justify more extensive cultivation of cabbage, potatoes, onions, tomatoes, etc., and also of tree fruits. Strawberries do well on many of the soils and are a paying crop when well handled. Apples and peaches thrive in favored localities, and berries and other fruits are profitably grown by those who understand their culture.

Taken as a whole, the Allegheny Plateau section has fair soils and is in a fairly good condition. More thorough tillage and the application of manure, lime, and fertilizers will increase the yields and render the farms more profitable. More stock should be kept, and regular rotations of crops practiced.

The Allegheny Mountain region has a much more diversified character than the plateau. It consists of a series of more or less parallel mountain ranges, separated by narrow valleys of shale and sandstone soils. The broad limestone areas will be discussed under a separate head.

In this region the agricultural practices are rather behind the other sections. There are some excellent farming communities, but they are the exception. Most of the land is hilly and subject to severe erosion. Because of the mountains, transportation is usually poor and markets inaccessible. Farm improvements, buildings, and fences are rather poor. The general crops are the same as in the other sections—corn, oats, wheat, and grass. Buckwheat and potatoes are generally grown, while rye is little cultivated in comparison with the plateau counties. Regular rotations are not followed, though corn usually follows where grass lands are plowed. Grass is seeded with oats or wheat, and the grass is mowed or pas-

tured as long as possible. Little care is taken of the mowing lands and the majority become badly infested with weeds by the second year.

Some stock is raised on all the farms and constitutes one of the sources of cash income. The best farmers plan to sell several head of cattle and one or more colts every year. The manure from the stock is applied to the corn and wheat ground, generally being plowed under. In the better sections it is top-dressed on wheat lands, using a manure spreader. Much of the value of the manure is lost through exposure and leaching.

In the sections having good market facilities agricultural practices are more advanced. In parts of Mifflin, Snyder, Union, Perry, and Juniata Counties the farmers are in fairly prosperous condition. Dairying is promoted by the presence of creameries and the local demands of the towns of the area. Considerable milk is shipped from the eastern section of the area to Philadelphia, Baltimore, Harrisburg, and other towns. In these regions the farms are better tilled and better results are obtained.

Over the whole area fertilizers are being used, generally on corn, potatoes, and wheat. Little attention is paid to the composition or to the needs of the soil, price being the deciding factor. In the more remote sections 100 to 150 pounds of $14 to $18 fertilizer are generally applied. In the better sections acreage applications of 150 to 200 pounds of $18 to $22 fertilizer are made. The farmers could well afford to study the problem of fertilizing and the composition and effects of the material they are buying.

Lime is needed on all the soils of the region and is quite generally used.

Fruit is grown to some extent, with good results wherever the trees are properly handled. In southern Fulton County, near the Maryland line, some orchards have been set out. Apples and peaches do well where conditions are favorable, and bush fruits can be made profitable.

A high state of agricultural development is found in the limestone valleys that form such an important feature of the Appalachian Mountain and Piedmont Plateau regions. The farmers are fairly prosperous, with well-tilled farms and good buildings and fences. Grass and grain farming is the rule, with a five or six-year rotation of corn, oats, wheat, and grass. Considerable stock is kept and a large part of the forage is fed on the farm. The manure that is made is one of the main factors in the maintenance of the high crop yields.

Wheat and animal products are the principal sources of cash income. Considerable fruit is grown in some sections, and potatoes

form an important crop in the Cumberland Valley and in Adams County.

Farm machinery of the best type is extensively used. Manure spreaders, hay loaders, and such apparatus are in common use. Fertilizers are used in larger quantities than in the other sections, but very little attention is given to the elements purchased. Lime is in general use throughout the region, with excellent results.

Along the South Mountain region fruit growing is highly developed and here may be found some of the finest apple and peach orchards in the State. The fruit growers are using the most up-to-date methods with a thoroughness that is giving excellent results.

Reviewing the whole area, we find that the general crops grown are corn, oats, wheat, grass, potatoes, and buckwheat, with fruit growing and trucking as special industries of some importance. The lands are not as well tilled as they should be. Plowing is shallow and cultivation is not carried on throughout the season. Erosion is one of the most extensive and active agents of soil destruction, a fact not appreciated by the farmers, little being done to check or prevent its ravages. Lime, manure, and fertilizers are used to some extent, but without a general, definite plan. In the limestone valleys the applications of lime and manure are more regular and systematic and the best type of farm machinery is in general use. In some of the Dekalb regions this is not the case.

A large proportion of the farms are being worked by the owners. Where the tenant system is common three to five year leases are generally given. This gives the tenant a more active interest in the land, and results in a better system of soil management.

Farm help is a serious problem throughout the whole area. Wages are high and most of the abler men go to the mills and mines. The labor problem is most acute in the three western counties, where the mines with their high wages draw many of the younger men. As a result the farmers are leaving large areas of the land in grass and pasture, and in some sections the older men who remain on the farms have markedly lowered their standard of farming, with the result that land is becoming poorer, buildings and fences are falling to ruin, and whole communities are deteriorating.

SOILS.

The soils of south-central Pennsylvania belong in the three great physiographic provinces of the eastern United States—the Piedmont Plateau, the Appalachian Mountains, and the Allegheny Plateau. The Allegheny escarpment or Front forms the boundary between the two latter and the eastern foot of the Blue Ridge the boundary between the two former. Figure 5 shows the arrangement of the mountain ranges.

The soils have been classified in 18 series—11 residual soils, 2 colluvial-residual soils, 1 colluvial soil, and 4 terrace and bottom-land soils.

Because of the close relations between the topography and geological formations on the one hand and the soil series in this area on the other, a brief description of those features is given.

The area mapped covers nearly the whole section of geological formations that are found in the State of Pennsylvania. The oldest formation is of pre-Cambrian age and the youngest, not including

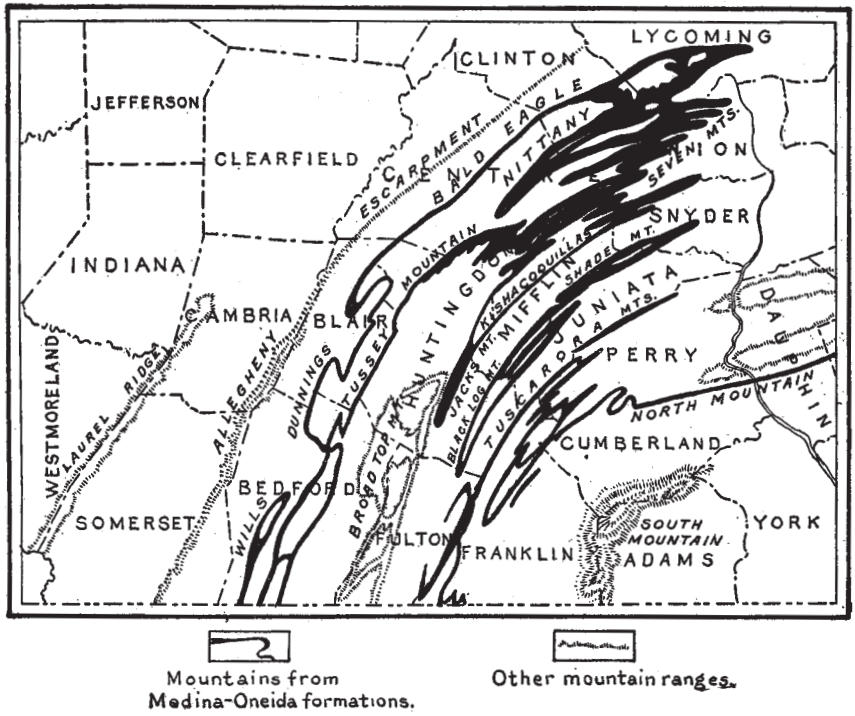

FIG. 5.—Sketch showing position and arrangement of mountain ranges formed by the main mountain-forming rocks.

the river terraces of Quaternary age, of Triassic age. From the pre-Cambrian to the Carboniferous all of the great geological periods are represented. Between the Carboniferous, however, which occurs in Cambria, Somerset, and Clearfield Counties, and the Triassic, which occurs in Adams County, the Permian period is not represented.

The pre-Cambrian rocks consist of greatly altered volcanic rocks, some of which have been so profoundly changed that their original character can be detected only by careful microscopic study. They occur in the South Mountain region only.

The Cambrian rocks include the quartzites and sandstones of South Mountain, the slates and other metamorphic rocks of the southeastern corner of Adams County, and some of the limestones and sandstones occurring along the eastern border of the Great Valley.

The Silurian rocks consist of a series of limestones at the base of the series and of sandstones, shales, and conglomerates higher up in the series. The limestones are known as the Trenton and calciferous limestones. They form the greater portion of the Great Valley and of the limestone valleys within the Appalachian Ridge belt, such as Black Log, Kishacoquillas, and Nittany. The sandstones, shales, and conglomerates occur in the Ridge belt only—in the area between the Great Valley on the east and the Allegheny Front on the west. The shales form hilly lowland belts, while the heavier sandstone beds form the ridges. The principal sandstone is the Medina group, while the shales make up the Clinton, Niagara, and Salina formations. The top of the Silurian rocks is made up of the Helderberg formation, a limestone, thin and of limited extent, but producing a soil of marked characteristics.

The Devonian rocks occur within the Ridge region also, with a narrow belt along the base of the Allegheny Mountain. They consist of shales and sandstones with a very thin limestone. The shales are represented by the Marcellus, Hamilton, Chemung, and Genesee formations, while the sandstones are represented by the Pocono, Oriskany, Catskill, and Portage formations, with thinner members in the other formations just mentioned.

The Carboniferous rocks occur almost exclusively in the Allegheny Plateau west of and in the Allegheny Mountain. The exception is the occurrence of these rocks in the Broad Top region of Huntingdon County. They consist of sandstones, shales, and coal beds, the latter a negligible factor in the formation of the soil.

The important sandstone is the Pottsville, while others occur at various places in other portions of the series. The other formations are the Mauch Chunk shale, the Allegheny and Conemaugh Coal Measures, and a few small areas of the Monongahela Coal Measures. These are all made up of shales and sandstones.

The Triassic rocks occur in the extreme southeastern part of the area east of the Blue Ridge and in the Piedmont Plateau province. These rocks consist of red sandstones and shales, with intruded dikes and sheets of dark, rather fine-grained igneous rocks.

Topographically the south-central Pennsylvania area includes five types of country. On the extreme west lies the Allegheny Plateau. Its eastern boundary coincides with the eastern boundary of the Allegheny Plateau soil province (Allegheny escarpment, fig. 5), but it extends westward beyond the area as far as central Ohio. East of the Allegheny Plateau lies the Appalachian Ridge belt. It extends

eastward to the western boundary of the Piedmont Plateau province. It consists of a series of narrow, even-topped ridges, with intervening valleys making up about three-fourths of the total width of the belt occupying its western part; a broad undulating to hilly valley known as the Great Valley, about 20 miles in width, lying east of this; the South Mountain or Blue Ridge, running as a broad, uneven, hilly belt southwestward from the Susquehanna River, a few miles below Harrisburg; and, finally, in the extreme southeastern corner of the area lies the low undulating country known as the Piedmont Plateau.

The Allegheny Plateau region is well described in the report of the Reconnoissance Soil Survey of Southwestern Pennsylvania in 1909 and only a brief description will be given here.

From the escarpment the country slopes toward the west, broken by the elevation of Chestnut Ridge, which forms the western boundary of Somerset and northern Cambria Counties and then swings northeast across Clearfield County.

The country is irregular and broken by many hills, the plateau surface being underlain by sandstones and shales of the Carboniferous age. These were originally laid down in a horizontal position, but now show an inclination to the southwest slightly different from the pitch of the plateau surface.

This region has suffered severely from erosion in the past, and the action is still going on at a rapid rate. The plateau has been cut up into a very intricate series of steep-sided hills and ridges and narrow V-shaped valleys. In places the topography is so rough as to be almost mountainous in character.

The weathering of the rocks of the plateau has produced the soils of the Dekalb series, the finer grained shales giving the silt loams and loam, while the coarser-grained rocks, notably the Pottsville conglomerate and the Pocono sandstone, having given rise to the sandy loams, sands, and stony soils.

There are a few areas where from the weathering of the Mauch Chunk red shales the Upshur soils have been formed, and in depressions in the Dekalb area irregular bodies of Jefferson soils occur, while along the streams the Huntington, Wheeling, and Holston soils are developed.

In contrast with the Allegheny Plateau, consisting of a series of irregular hills and valleys, the Appalachian Mountain region consists of parallel mountain ranges, with intervening valleys. This region is formed largely of sedimentary rocks of Cambrian, Silurian, Devonian, and Carboniferous age.

The Catskill red sandstone crops out on the flank of the escarpment, extending from the Maryland line in Somerset County through Bedford, Blair, and Center Counties, as indicated on the soil map by

the more or less continuous bands of Upshur soils extending across those counties.

Below the Catskill lie the Chemung, Portage, Genesee, Hamilton, and Marcellus, making up formation No. 8 of the second Pennsylvania geological survey. These rocks outcrop on the west side of the Bald Eagle Valley, forming a region of rounded hills with shaly Dekalb soils. The next two formations, the Oriskany sandstone (No. 7) and Lower Helderberg limestone (No. 6), form the floor of the Bald Eagle Valley in Center County, being covered by the stream deposits and wash from the hills. South of Tyrone they appear as a low ridge and become an important factor in soil development. The next formation, the Clinton (No. 5), forms the lower west slopes of the Bald Eagle Mountains, while the Medina and Oneida (No. 4) rocks form the double crest of that range. On the lower east slope of the mountain the Hudson and Utica shales (No. 3) show in outcrops, and below them the Trenton (No. 2) limestone formation. The latter forms the country rock in the broad Nittany Valley, sinking beneath the Tussey Mountains on the east. These mountains are made up of the Hudson-Utica shales at the base, the Medina and Oneida on the crest, Clinton on the east flank, and the other formations appear in succession until the Catskill is reached in the west slope of Terrace Mountain and the Carboniferous in the Broad Top country. This vast arch,[1] or fold, extending from Sullivan County, northeast of the area, into Bedford County on the south, has its highest part over the Nittany Valley in Center and Huntingdon Counties, where the outcropping limestones give the Hagerstown soils. To the south there are several smaller arches or folds, two of which give Brush and Penns Valleys in Center County. Beyond these is another great arch, extending from Lycoming to Fulton County, with its highest section over the Kishacoquillas Valley in Mifflin County. A third arch extends from outside the area on the northeast to the Maryland line over Shade and Black Log Valleys. This arch was not so high as the others mentioned, and only in a small part of Black Log Valley is enough of the Trenton formation exposed to give rise to Hagerstown soils. A fourth arch, with its highest point over Path Valley in Franklin County, parallels the other folds, while a fifth extends from the northeast across Perry, Cumberland, and Franklin Counties beyond the Maryland line. All of these arches lie along a great curve running east-northeast to south-southwest. Between them lie deep rock basins in the eroded upland valleys where the rock layers are exposed. They are irregular in outline, undulating lengthwise, so that the lines of outcrop on the present surface form a series of zigzags and loops. The position of outcropping limestone strata is shown in figure 6.

[1] Material adapted from Leslie's Hand Atlas of Pennsylvania, second Geological Survey.

As the rocks of the different formations that were exposed by this folding and the subsequent erosion are of varying degrees of hardness and resistance, the effects of the erosive agents have been to cause a marked difference in topographic forms.

There are four formations that are responsible for the existence of the mountain ridges. The Pottsville conglomerate and Pocono sandstone form the crest of the Allegheny escarpment and are responsible also for Terrace Mountain and Sideling Hill Mountain in Huntingdon, Bedford, and Fulton Counties. The Potsdam sandstone and earlier rocks form South Mountain between Cumberland, Franklin,

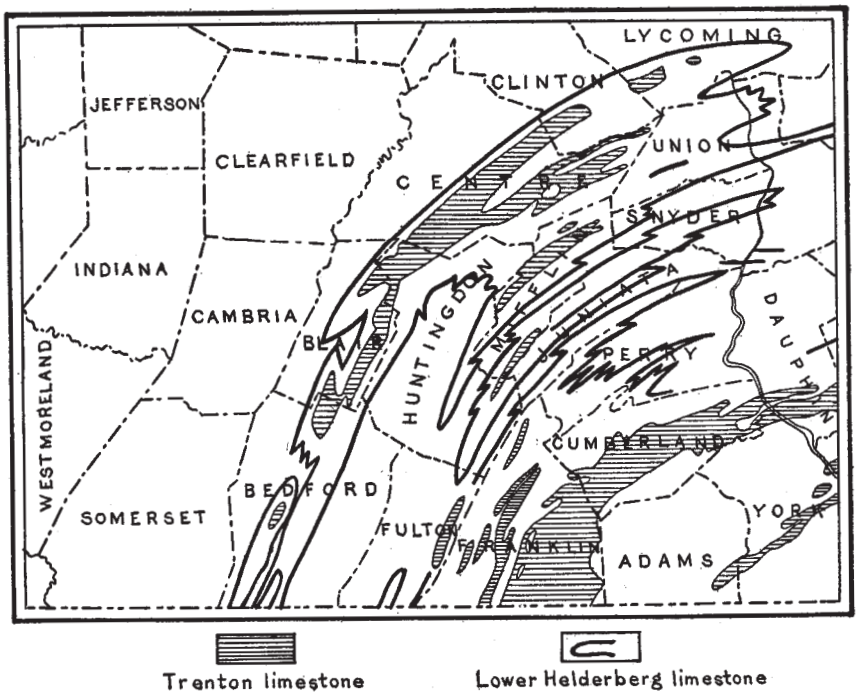

FIG. 6.—Sketch showing outcropping of Trenton and Lower Helderberg limestones.

and Adams Counties, and the Medina-Oneida sandstones form the series of mountain ranges lying between the Allegheny escarpment and South Mountain. The various valleys have been worn in the soft rocks that are interbedded with the harder rocks forming the mountain ridges. The double crests and " terracing " on these mountains are brought about by the different weathering of the three layers of the formation, the gray Medina and Oneida being much more resistant than the red Medina, which lies between the other two.

All of these formations give Dekalb soils, except the red Medina, from which some small areas of the Upshur soils are derived, and the

igneous rocks of South Mountain, which weather into the Porters soils.

The Catskill formation generally occurs as a series of rounded hills and knobby ridges, giving rise to the red soils of the Upshur series. It is exposed along the lower slopes of the Allegheny escarpment, along Terrace Mountain and Sideling Hill Mountain in Bedford, Huntingdon, and Fulton Counties, along the Cove Mountain and Buffalo and Berry Mountains in Perry County, and in a strip in northeastern Snyder County. In southern Bedford and Fulton Counties the Catskill area exists as a broad, rolling valley, in Snyder County as a rolling upland, and in all the other outcroppings as rolling to hilly areas along the lower slopes of the Pocono sandstone mountains.

The No. 8 formation of the second Pennsylvania geological survey, embracing the Chemung, Portage, Genesee, Hamilton, Marcellus, and Upper Helderberg rocks, is composed of layers of rocks of varying degrees of hardness. All weather rapidly and usually occupy steep valleys or hilly upland regions. The weathering of these shale rocks produces the soils of the Dekalb series, though some small areas of rather dark, almost chocolate-colored soils are derived from the outcropping of the Chemung shales. These were found too small to map on the scale used, and were included with the Dekalb series. The No. 8 formation outcrops extensively in all counties east of the Allegheny escarpment, except Franklin, Cumberland, and Adams, and from it are derived some extensive areas of rather poor quality soils.

The Oriskany sandstone is of little importance in the development of the soils of the area surveyed. The only extensive outcrop is on that part of Warriors Ridge lying between Huntingdon and Petersburg in Huntingdon County. Here it exists as a hilly, ridged upland of rocky and sandy soils about 400 feet above the surrounding country. The soils are in most cases too poor and too stony for agricultural purposes and are now largely forested. The area is indicated on the map by diagonal dash lines.

From an economic standpoint the Oriskany sandstone is of considerable importance, as it forms the basis of the important glass-sand industry. The weathered rock, when properly pulverized and washed, produces a clean sand that is shipped in large quantities from the numerous quarries and mines.

The lower Helderberg or Lewisburg limestone, which outcrops in every county between the Allegheny escarpment and North Mountain, consists of thin layers of limestone with narrow partings of shale. The formations occur as narrow outcrops, flanked by the Oriskany sandstone, the two usually forming a long, narrow ridge. Where irregularities in the outcrop have exposed larger sections of the

limestone some important soil areas have been formed, but usually the band of limestone soil is too narrow and stony to be of marked importance. When weathered it produces the Hagerstown soils, the stony and heavy types predominating. The most important soil areas occur in Perry and Juniata Counties.

Associated with these rocks are the water limes of the Onondaga series that give rise to a very cherty, stony loam of limestone origin that has been mapped in the Johnstown area as the Frankstown stony loam. On maps of the scale used in this survey these areas could not be shown without exaggeration, and they have in most cases been included in the areas of the Hagerstown soils derived from the Lower Helderberg. In Bedford County one large area of the Frankstown stony loam on Chestnut Ridge has been shown on the map.

While this limestone formation is of minor importance in a soil-formation sense, it is of very great importance economically. It has yielded some workable beds of iron, lead, and various other ores, and the interesting phosphatic deposits of southwestern Juniata County are associated with this formation. It is more important as the source of lime for agricultural purposes, its numerous outcrops forming an available supply of readily burned limestone in nearly every section of the area between the counties mentioned. In Perry, Juniata, Union, Snyder, and Fulton Counties and in the larger part of Mifflin and Huntingdon Counties it affords the only local source of this exceedingly important soil amendment.

The outcrops appear in series of long bands, with zigzags and bends that nearly double their normal length. The sketch map (fig. 6), adapted from Leslie's Geological Hand Atlas of Counties, Second Pennsylvania Geological Survey, gives an idea of the wide distribution of the formation. Since nearly all the soils of south-central Pennsylvania are greatly benefited by the application of lime, the importance of this outcrop can be appreciated.

The Clinton, or No. 5, formation lies just below the Lewisburg limestone and outcrops in all the counties in which the latter is found. It does not enter extensively into the formation of the soils except in Huntingdon, Perry, Juniata, Union, and Snyder Counties. The formation consists of a series of red, gray, olive, and drab shales, occurring mainly as narrow bands, and when weathered forming rolling upland or valley regions. The weathering of the variously colored layers of shale produces soils of corresponding colors, bands of red, brown, yellow, or olive soils from one to several rods in width often being found in one field. The bands of red shale give the Upshur soils, the others giving the Dekalb. Wherever possible the Upshur was separately mapped. but in most cases the bands of

Upshur and Dekalb soils were so narrow that they could not be separately shown on the reconnoissance map and in many cases could not be shown on a detailed map of the scale 1 inch=1 mile. In most of such areas of Dekalb-Upshur soils the Dekalb series predominated and the soils have been mapped as Dekalb. In Union County the Bloomsburg shale member of the Clinton formation outcrops as extensive bands, and in many places it has been possible to show on the map Upshur soils derived from these rocks. The Dekalb-Upshur soils are very typically developed between Neffs Mills and McAlevys Fort, in Huntingdon County. In this region several areas of the limestone bands that sometimes occur with the Clinton rocks are exposed and areas of Hagerstown soils have been formed therefrom.

Deposits of iron ore are found in the Clinton formation and many of these have been extensively mined in the past. No beds of importance are being worked at the present time.

The No. 4, or Medina-Oneida formation, which lies next to the Clinton, in its outcrops produces the very marked and characteristic relief forms of the central Pennsylvania region. The formation is composed of the Oneida gray sandstone, Medina red sandstone, and Medina gray sandstone, all of which are hard, resistant rocks, slow to disintegrate under the action of the weathering agencies.

The outcrops of this formation occur as a series of more or less parallel mountain ranges occurring in three groups. One group is made up of the North Mountain and Tuscarora Mountain Ranges, extending in a broad curve from the Susquehanna River above Harrisburg to the Maryland line on the boundary between Fulton and Franklin Counties. These ranges are made up of several parallel folds and ridges, inclosing narrow valleys, one of which, Path Valley, is of considerable size. The second group is made up of three long, canoe-shaped mountain ridges. One is formed by Black Log and Shade Mountains, inclosing Black Log Valley, and extends from Fort Littleton to Mifflintown; the second, made up partly by Blue Ridge, extends from Newton Hamilton to beyond Mifflintown; while the third extends from Lewistown to Selinsgrove. North and west of these ranges come the long ridges and contorted mountain masses of the "Seven" or Tussey Mountains. Beginning northeast of the area, these are very extensively developed in Union and Center Counties, where they make up the typical "Seven Mountain" region. To the south the ranges bear away under different names, as the Tussey Mountains, the Muncy Mountains, and others, reaching from Center County south to the Maryland line.

These ranges reach an altitude of from 1,200 to 2,000 feet, rising from 600 to 1,000 feet above the valleys.. The separate ridges are remarkably uniform in height, presenting an unvarying sky line, which is one of the striking features of the central Pennsylvania topography.

These mountains are the result of folding and subsequent erosion and weathering. Some of the rocks being hard and resistant, weathered more slowly than the rocks adjacent to them, which wore away, forming the valleys, leaving the Medina-Oneida rocks as the mountain ranges.

Wherever the wave or fold had a uniform elevation the mountain ridges formed by the outcropping of this Medina-Oneida formation are parallel. If the wave dipped, the mountain ranges converge, and if the dip were sufficient to carry the Medina-Oneida rocks below the present floor of the valley the two ranges unite. On the other hand, if the wave form rose in elevation the mountain ranges separate. Spurs and "crumples" in the mountain ranges indicate the occurrence of minor undulations in the rock waves or folds.

All of the mountain ranges of this formation have double crests, caused by the variations in the weathering of the three layers of rock that make up the mountain mass. In most cases the valley formed by the soft Medina red sandstone is so narrow that the red material does not affect the soil mass, which is made up of the disintegrated Oneida and gray Medina rocks that have worked down from the ridges onto the red Medina rocks. Where the valley has some width, which occurs where the fold forming the mountains is rather flat, the red material forms a light-colored phase of the Upshur soils.

With the exception of these occurrences of the red Upshur soils, the disintegration of this Oneida-Medina formation has produced soils of the Dekalb series. Most of the types found are stony, the larger part of the mountains being covered with rough, stony land. This has been shown on the map by the use of horizontal lines on the Dekalb color.

The great valleys of the central and southeastern part of the area are formed by the weathering of the outcrops of the massive Trenton limestone (No. 2) formation. In the Cumberland Valley the Utica-Hudson shale formation (No. 3) plays an important part.

These shales and limestones occur where the upward fold or anticline was sufficiently high to bring about their exposure when the weathering lowered the surface to its present level. The limestones being comparatively quite soluble, were acted upon very rapidly by the atmospheric waters, and on exposure wore away much more rapidly than did the harder and less soluble rocks.

The Utica-Hudson shales are thin bedded and soft, and erode nearly as fast as do the limestones. They lie just beneath the Oneida-Medina sandstones and are not a very thick deposit. Wherever the folds are sharp and the rocks dip steeply under the mountains there is not a wide exposure of these shales. In nearly every case they occur as the lower slopes of the mountains, forming the slope between the steep rock mountain side and the first outcropping of the limestones. In these positions the shale material is so mixed with the sandstone debris that has worked down from the mountain side that the soils are not distinct but form the heavier members of the Dekalb series. In some places where drainage is poor the Lickdale series is found. Very few areas of any size were noted, and the series is not shown on the map.

In the Cumberland Valley the shales outcrop in a belt from 4 to 6 miles wide. Here the soil is wholly derived from these shales and makes up the Berks soils. The topography is rather steeply rolling, with some of the large drainage lines deeply eroded. The soil material is rarely very deep, and on the steeper slopes the rocks are exposed.

Outside of Cumberland and Franklin Counties there is only one outcrop of these shales sufficiently large to form the Berks soils. This occurs in the Kishacoquillas Valley, in Mifflin County. In all other places the soil is so mixed with the material from the overlying sandstones as to throw it into the Dekalb soils.

The limestones are exposed in the great fold forming the Cumberland Valley and those lying between it and the Tuscarora Mountains. Path Valley, just north of the Tuscaroras, is the largest of these. North of the Tuscarora Mountains the Trenton limestone is exposed on the McConnellsburg anticline, where it forms a fertile limestone valley of considerable extent. The next exposure is in Black Log Valley, where the limestone barely occurs, forming a small area of limestone soil along the road between Shade Gap and Orbisonia. Other outcrops are encountered in the anticline of the Kishacoquillas Valley in Mifflin County and others forming the Nittany system of limestone valleys. The Trenton limestone gives the Hagerstown soils—the most productive soils of the area.

Depressions usually occur along the junction of the limestones and shales on each side of the valley, through which surface streams flow. This is especially true in the Nittany and Penns Valleys, in the Kishacoquillas Valley, and in the Cumberland Valley. In the last-named valley, in Cumberland County, the Conodoguinet Creek, throughout nearly its entire length, follows the boundary between the Hudson-Utica and the Trenton formations, while the Yellow Breeches lies between the Trenton and the South Mountain. In Franklin

County the Conococheague Creek occupies a position similar to Conodoguinet Creek in Cumberland County.

In the Nittany system of valleys and in the Morrisons Cove region most of the local drainage is through underground channels that have been dissolved in the limestone rock. The courses of some of these subterranean streams can be traced by the occurrence of many sinks, into which drainage waters disappear. In some instances these underground streams have developed caverns of considerable extent. Penn Cave, in Center County, is one of the largest of these.

The South Mountains, between Cumberland, Franklin, and Adams Counties, represent a wholly different formation from those heretofore considered. The mountain ridges begin near the eastern corner of Cumberland County and extend southwest in a great crescent to beyond the Maryland line, representing the northern end of the Blue Ridge Mountains of the Virginias. They have an altitude of about 2,000 feet, and the range is from 8 to 10 miles wide in this State. These mountains are made up of a mass of very old metamorphic and sedimentary rocks. Sandstones and quartzites make up a large proportion of the northwestern slopes, while the southeastern slope is feldspathic and micaceous in character. On the northwest flank of the mountains, where erosion has carried the weathered material to the foot of the slopes, the Montalto and Ledy soils are formed.

The mountains proper, when weathered, form the stonier members of the Dekalb and Porters soils, the latter derived from the igneous and metamorphic rocks and the former from the sedimentary rocks. On the southeastern slopes some excellent Porters soil types occur.

Adams County lies in the Piedmont Plateau region, and here the soils are derived from sedimentary rocks, sandstones, and shales, with some areas of intruded igneous masses. The Penn soils occupy the rolling areas derived from the red sandstones, while the Montalto and Chester soils are from the areas of igneous rocks. From South Mountain, Adams County stretches to the southeast as a rolling plateau, broken by depressed drainage lines and by the low, rounded knobs and ridges of igneous dikes. A low ridge in the southeastern part of the county bounds the central part.

The colluvial soils—the Jefferson—are described separately, though they are not extensively developed in the area. The bottomland and terrace soils are classified in the Wheeling and Holston series when occurring on the terraces, and in the Huntington and Moshannon series when on the bottoms, or flood plains. Meadow and Swamp areas were encountered, but in such small tracts that they could not be shown.

The following table gives the relative and actual extent of each of the several soil groups found in the survey:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Dekalb soils	4,946,688	70.8	Jefferson soils	29,376	0.4
Hagerstown soils	702,720	10.1	Frankstown stony loam	29,376	.4
Upshur soils	432,576	6.2	Ledy soils	15,296	.2
Berks soils	210,240	3.	Duffield soils	14,400	.2
Penn soils	165,312	2.4	Moshannon soils	12,096	.2
Porters soils	106,560	1.5	Wheeling soils	10,368	.2
Huntington soils	104,832	1.5	Colyer silt loam	9,216	.1
Montalto soils	79,744	1.2	Chester soils	9,216	.1
Morrison soils	52,992	.8			
Holston soils	50,112	.7	Total	6,981,120	

DEKALB SOILS.

The Dekalb soils are the most extensively developed in the area, including as they do the larger part of practically all of the counties, except Adams, Cumberland, and Franklin. The types are derived from a number of geological formations and occupy varied topographic positions. The surface soils are yellow, gray, grayish yellow, and brownish yellow, while the subsoils are yellow.

The largest single area, occupying nearly all of Somerset, Cambria, and Clearfield Counties and the northwestern third of Center County, occupies the eastern part of the Allegheny Plateau region. The soils lie at high elevations, occupying the eroded and dissected surface of the plateau and the crest and eastern slope of the Allegheny escarpment. Eastward the Dekalb soils cover the tops and slopes of the mountain ranges and those hilly valleys, derived from weathered shales, between the mountains.

In the former region the Dekalb soils are derived from the shales and sandstones of the Coal Measures and the Pottsville conglomerate. The latter rock gives the more sandy soils, stony and rough, and of low agricultural value, while the Coal Measures give the fine-grained soils, the silt loam being the type most extensively developed. These latter soils vary in value, depending largely on their topographic position. In the softer shale regions, where the eroding streams have worn the plateau surface into a series of rounded knobs and ridges with more gradual slopes, the soils are readily tilled and cared for and give good results with grasses and grains, the staple crops of the region. Where the harder sandstones predominate the topography is much more severe and the soils occupy the remaining fragments of plateau, the steep-sided gorges, and narrow V-shaped valleys. In

these regions farming is much more difficult, the cultivated fields eroding badly.

Throughout all of this area the underlying rocks occur in a nearly horizontal position, and where heavy ledges of these rocks approach the surface on rolling hilltops or on the slopes considerable seepage takes place. In many cases the seepage caused by the position of these rocks causes local areas of the soils to be too wet for cultivation. With these exceptions the Dekalb soils are well drained.

East of the Allegheny escarpment the Dekalb soils occupy two topographic positions, on the flanks and tops of the many mountain ridges, and in those valleys that are derived from shales or sandstones. Most of the soils on the mountains are very stony over large areas. These have been shown on the map wherever practicable by horizontal lines on the Dekalb color. On many of the mountain slopes they consist of great masses of broken rock, adapted only to the growth of forest trees. Most of the area marked on the map by the horizontal lines is unsuited to agriculture, though there are occasional small areas of arable land.

On the lower flanks of some of the mountains and the ridges the Dekalb soils are quite steep and stony, and while in many cases cleared and in farms, they are not well suited to cultivation and should be left in forest or pasture. Such areas, wherever possible, have been indicated by suitable symbols on the map. On the lower flanks of the mountains, where the slope is much gentler, the soils are generally heavier in texture. The silt loams and clay loams, with the stony phase of each type, are found in such positions.

In the shale valleys the Dekalb soils occupy a variety of topographic positions. Usually they occur on a series of narrow ridges or as local plateaus dissected by the drainage channels. The soils in these valley areas are derived from rather hard, thin-bedded shales, and as a consequence are shallow, the shale loam and silt loam being most extensive. In these regions erosion is very active and damage from this source is severe. On the ridges and slopes the soil material is removed almost as fast as formed, the broken shale lying usually within 1 or 2 feet of the surface. Drainage is generally excessive, and as the soils are shallow and loose they have a very low water-holding capacity, rendering them subject to drought. Reducing erosion and increasing the water-retaining power of the soil are the most important soil problems of these valleys.

Where the shales of the Clinton formation outcrop to form the soil mass a peculiar soil condition is developed. This formation is composed of gray, drab, red, olive, and green shales, laid down in bands of no great thickness. When the rocks are tilted and these layers are exposed in succession there is a striking variation in the

soil colors. Bands of red soils from 1 to 3 rods in width may alternate with wider bands of brown, yellow brown, or drab soils. The yellowish-brown colors are typical of the Dekalb, while the red is the typical Upshur color. In most cases the bands of Upshur were too narrow to show on the map, or even on the scale of the detailed maps (1 inch=1 mile). Wherever they could be shown separately these red soils were mapped as Upshur, but in most cases they were included in the Dekalb areas.

The variation in these soils is mostly in color, the texture being uniform over the different strips. No variations in crop yields could be found, mainly because the strips are too narrow to show individuality. The soils occupy rolling topography, are somewhat subject to erosion, and are well drained. They are more clayey than most Dekalb soils east of the Allegheny and retain moisture fairly well. Local conditions will be brought out under the county descriptions.

On South Mountain, between Cumberland and Franklin Counties and Adams County, the Dekalb soils are derived from a variety of rocks, sedimentary and metamorphic. This region has a very broken topography, and Rough stony land is the prevailing type, with some stony loam. These soils are practically all forest or cut-over lands.

Eleven types have been recognized in the Dekalb series within this area, of which the stony loam, shale loam, silt loam, and loam are the most extensively developed. A brief description of the types follows.

The surface soil of the Dekalb clay consists of 8 to 10 inches of tenacious clay loam or clay resting on a yellowish, hard, tenacious clay subsoil.

The Dekalb clay loam consists of a surface soil, 6 to 8 inches deep, of a yellowish to brownish-yellow heavy silt loam to a silty clay loam, resting on a yellow or mottled, heavy, plastic silty clay.

The surface soil of the Dekalb silt loam is about 6 inches deep. It is a light, friable, light-colored silt loam, grading heavier with depth until a mottled silty clay loam is reached within the 3-foot section.

The Dekalb stony silt loam is essentially the same as the silt loam, with the addition of from 30 to 60 per cent of flat shale fragments. The soil usually grades into broken rock within 3 feet of the surface.

The surface soil of the Dekalb shale loam consists of 6 to 8 inches of a gray or yellow silty loam resting on a heavier subsoil. Soil and subsoil contain large quantities of shale fragments, which become more numerous with depth until at about 2 feet the material grades into a mass of broken rock.

The surface soil of the Dekalb loam consists of about 8 inches of a fine, friable, yellowish-brown loam resting on a yellowish heavy loam, grading to clay loam with depth.

The Dekalb stony loam consists of 6 to 10 inches of a brownish loam or heavy sandy loam, grading into a yellowish, compact clay loam or clay. Soil and subsoil contain high percentages of angular stone fragments of considerable size.

The Dekalb fine sandy loam consists of about 6 to 8 inches of light-yellow fine sandy loam, resting on yellowish sandy loam to sandy clay loam.

The Dekalb stony sandy loam consists of a loose gray sandy loam, 7 to 10 inches in depth, resting on dark yellow, sticky sandy loam. Soil and subsoil contain large quantities of stone fragments.

The Dekalb stony sand consists of 6 to 8 inches of a coarse gray or yellow sand, with a subsoil of the same character, becoming somewhat sticky. The soil mass contains large quantities of stone fragments of varying sizes.

The Dekalb sand consists of 5 or 6 inches of a medium loamy yellowish sand, with a compact yellow sandy subsoil.

Throughout the whole Dekalb area the staple farm crops—corn, oats, wheat, and grass—are most extensively grown. The yields vary greatly, depending on the character of the soil and the tillage given to the crop. In the best farmed districts corn will yield 60 to 100 bushels, wheat 20 to 25 bushels, and other crops in proportion. In many regions corn rarely goes above 50 bushels, and wheat yields less than 15 bushels. Buckwheat is extensively grown, and potatoes, in some sections, are an important crop, and could be much more extensively grown, with excellent results, if the farmers understood their culture.

Land values vary greatly over the Dekalb soils, ranging from $5 to $100 an acre, depending on character of the soil, location, and accessibility to markets. The Dekalb soils occupy such hilly and broken topography that hauling on the farm and between the farm and market or shipping point is a serious problem and often the one factor that determines the valuation of the land.

Clearfield County.—With the exception of small areas along the streams, the Dekalb soils occupy all of Clearfield County. Here they are derived from the sandstones and shales of the Coal Measures and from the Pottsville conglomerate and Pocono sandstone. A band of the two latter formations extends across the northern part of the county, covering about one-third of its area. The topography here is very rough and rugged, being hilly and mountainous, with rough stony land and stony loam types prevailing. The area is all in cut-over lands, having at one time supported a fine growth of timber. The land is unsuited for agriculture and is valued at from $3 to $10 an acre.

The northwest corner of the county and the southern half are derived from the "productive" and "barren" Coal Measures, from

shales and softer sandstones. In these regions silt loam, loam, and shale loam prevail, and some good farming land exists. The topography is steeply rolling to hilly, but the hills are rounded and not rugged, as in the northern section of the county.

The soils are well drained, though on some slopes seepage causes considerable damage. Erosion is active but not severe, the soils not tending to wash deeply unless unduly exposed by poor farming methods.

Corn, oats, wheat, rye, grass, and buckwheat are the general farm crops. Practically no effort is made to grow the special crops, such as potatoes, cabbage, and tomatoes, that are in demand at the numerous markets. Rotations vary greatly over the county, but the practice of mowing the grass lands as long as possible is very general. Crop yields are not high, corn yielding 20 to 50 bushels shelled, oats from 20 to 40 bushels, wheat 12 to 20 bushels, rye 15 to 20 bushels, buckwheat 12 to 25 bushels, and potatoes 75 to 150 bushels an acre. Hay yields are usually less than 1 ton, though 1½ and 2 tons are grown on the best farms. Land values vary greatly, owing to the presence of coal, from $20 to $200 an acre, with a general farming value of about $25 to $40.

It can scarcely be said that the farmers are prosperous, for while many good farms can be found, the majority are in poor condition and are barely paying expenses and a living for the owner. This is not due to the soil, but to the poor methods of farming that have been followed. But little live stock is kept, most of the hay and grain are sold from the farm, and little manure or fertilizer or lime is used. With its exceptionally fine local markets and inherently good soil, Clearfield County can be made a very successful farming section if the most up-to-date methods are followed.

Cambria County.—In Cambria County the occurrence of Dekalb soils is very similar to that in Clearfield County. The series embraces all except some small areas of alluvial or colluvial soils and is derived from the sandstones and shales of the Upper, Lower, and Barren Coal Measures. The series occupies rolling to hilly topography, becoming mountainous along the east and west boundaries. The eastern boundary follows the crest of the Allegheny Mountains, and from one of the eminences of this range the county is seen to the west as a rolling, elevated valley, with Chestnut Ridge on the west. On driving across the county one encounters an endless succession of hills and valleys formed by the erosion of local drainage channels.

The stony loam, silt loam, and shale loam are the prevailing types in the area, with loam and stony sandy loam somewhat developed. The soils are well drained in the main, but suffer severely from erosion wherever exposed by poor farming methods.

General farm crops are grown with results about the same as in Clearfield County. Land values range from $25 to $100 an acre, depending on location and character of the soil. Farm improvements are fairly good, taking the county as a whole. Near Johnstown considerable truck is grown, cabbages and potatoes proving very profitable crops. The growing of these crops could be well extended.

Somerset County.—With the exception of some bottom lands and two areas of Upshur in the southeastern townships, the Dekalb soils make up the whole area of Somerset County. The soils are derived from the Coal Measures and the Pottsville and Pocono formations, the two latter forming the mountainous sections along the east and west boundaries. The remainder of the county is steeply rolling to hilly in character, with the loam and silt loam the prevailing types.

The loam is the most extensive type and forms the important agricultural region about Somerset and north to Scalp Level. This region is the best developed and the most productive in the three counties (Clearfield, Cambria, and Somerset) on the Allegheny Plateau. In the southern part of the county, near Salisbury and Meyersdale, occurs another important agricultural section. Here again the loam is the prevailing type. The stony loam occupies the mountainous sections and is not generally farmed. The sandy loam occupies extensive areas east of Berlin and north of Confluence, but little of the type is farmed, most of it being in forest.

The staple farm crops, corn, oats, wheat, and grass, and also buckwheat, rye, and potatoes, are generally grown. Dairying is an extensive industry in this county, and the result of manure used is shown in the higher crop yields. The farmers are prosperous, and the fences, buildings, etc., in the sections where dairying is practiced are of a substantial character. Potatoes are extensively grown about Jenner, with good yields. Oats and wheat are two of the principal money crops. Most of the corn is fed on the farm. Most of the farms are managed by their owners and land values range from $30 to $100 an acre, for cleared and fenced land.

Center County.—The Dekalb soils occupy the northwestern half of Center County on the Allegheny Plateau and the foothills in front of the escarpment. They also occur over a large part of the southern and eastern sections of the county on the Appalachian Mountain ridges. Of the county, 71 per cent is mapped as Dekalb soil, 35 per cent of which is Rough stony land.

On the Allegheny Plateau the soils are steeply rolling to hilly and are not extensively farmed, being mostly cut-over lands. They are derived from the Coal Measures and from the Pottsville and Pocono formations. The stony loam type is the most prevalent. About Snow Shoe and Philipsburg the silt loam type is farmed to some extent. The mountainous front of the Allegheny escarpment ex-

tends across the county west of the Bald Eagle Valley. East of the escarpment is a belt of Dekalb shale loam and stony silt loam from 2 to 3 miles wide. These soils are derived from the Chemung, Portage, Hamilton, Genesee, and Marcellus shales and are farmed to a considerable extent. They occupy steep-sided, rounded hills and ridges and are subject to rather severe erosion. They give fair yields of the staple crops, potatoes doing very well. The land is valued at from $15 to $30 an acre.

The Dekalb soils in the southern half of the county occupy the tops and sides of the narrow, steep mountain ranges and are mostly Rough stony land and stony loam. Only on the lower slopes, where the loam and clay loam are developed in narrow bands, are the soils farmed. The clay loam is often wet and poorly drained, owing to seepage waters from the higher areas. The soils vary widely in productiveness and in value, making it hard to give averages.

Blair County.—In Blair County the occurrence of the Dekalb soils is very similar to that of Center County. The soils on the Allegheny top and front are wholly in forest or cut-over lands, while the band of shale loam extends across the county just in front of the Allegheny escarpment. This strip occupies the typical rounded hills and ridges in this county and is largely cleared and in farms. The soils are excessively drained and suffer severely from erosion. They give fair results with the general farm crops, corn yielding 30 to 50 bushels, oats 30 to 35 bushels, and wheat 10 to 12 bushels an acre. The land is valued at from $30 to $75 an acre, according to location. Trucking is becoming more general near the larger cities, potatoes, cabbages, and tomatoes being the leading crops.

Practically all the other Dekalb soils of the county occupy the tops and slopes of the mountain ranges. Rough stony land and stony loam are the prevailing types, though on the lower slopes loam, clay loam, and shale loam are often cleared and farmed with excellent results. The soils of the lower flanks, where conditions are suitable, give good results with fruit.

Bedford County.—In Bedford County the rough, mountainous Dekalb soils from the Pottsville and Pocono formations are found along the northwest and eastern boundary, and in Broad Top Township in the northeast corner of the county. In the central mountain belt they occupy the tops and flanks, with some arable soils on the lower slopes. Between the Allegheny Mountains and Buffalo and Dunnings Mountains lies a belt of the Chemung, Portage, Hamilton, and other shales, giving the shale loam types. This area is cleared and in farms. The topography is steeply rolling to hilly, with good drainage and considerable tendency to erode. The land is farmed to the general crops of the region with fair returns, and within the last few years considerable attention has been paid to dairying and fruit

growing. In the eastern part of the county a similar belt of shale loam and stony loam is found, derived from the same formation. These soils occupy rounded ridges and hills and are devoted to general farming and some stock raising. Land values are lower than in the other sections because of the greater distance of most of the soils from railroads or markets.

Huntingdon County.—In Huntingdon County the Dekalb soils are derived from several geological formations and occupy a variety of topographic positions. The rough stony land and stony loams from the Oneida-Medina Mountain ranges occupy the Bald Eagle, Tussey, Standing Stone, Jacks, and other mountain ridges, and Sideling Hill, Terrace, and Broad Top Mountains. The last three are composed of the Pocono and Pottsville formations. Between these mountain ranges occur areas of Dekalb soils derived from the Oriskany, Clinton, Chemung, Portage, Hamilton, and other formations.

The Warriors Ridge section, derived from the Oriskany sandstone, is rough and made up mostly of stony sandy loam, sand, and stony sand. It is not generally farmed. The largest body of this soil lies northwest of Huntingdon.

The Clinton formation gives the interesting Dekalb-Upshur soils, with the band of red soils across the general brown or yellow soils of the Dekalb series. These soils are most typically developed between McAlveys Fort and Alexandria. They also occur south of Alexandria in a narrowing band, and in Hill and Germany Valleys, in Shirley Township. The soils from this formation occupy rolling to hilly topography, and the loam and silt loam types predominate. The larger part of these soils are farmed, with good returns. Corn yields 60 to 80 bushels, oats 50 bushels, wheat 15 to 20 bushels, and hay does well. The soils are well drained but not droughty. They are somewhat subject to erosion. Land values vary greatly, ranging from $20 to $50 an acre, depending on location and character of the soils and improvements.

Between Warriors Ridge and the Raystown Branch of the Juniata lies an area of Dekalb derived from the Chemung, Portage, and other formations, occupying ridged and rolling uplands composed mainly of shale loams and loams. This area continues in a large body north of the Juniata River in Henderson and Miller Townships, an extension reaching south along the east side of Sideling Hill Mountain. The Aughwick Valley and Shade Valley are also from this formation. The shale loam and loam predominate over this whole area. The shale rocks from which the soils are derived are hard and thin bedded, while the resulting soils are shallow and droughty. They are extensively farmed, although there is considerable timber and waste land. Crop yields are low, corn giving from 30 to 60 bushels,

oats 20 to 30 bushels, wheat 10 to 18 bushels, and buckwheat about 20 bushels per acre. Land values are low, $15 to $25 being the general range. Buildings are fair in some sections, notably in the Aughwick Valley, where yields and land values are higher than those quoted. In Penn, Juniata, and Henderson Townships considerable fruit is grown. Cherries do very well, and apples promise to become a profitable crop. In Henderson Township some truck is produced. In Shade Valley not over one-half of the land is cleared.

Fulton County.—In Fulton County the Dekalb soils are very similar to those in Huntingdon County. Stony loam and Rough stony land are the predominating types over Sideling Hill and Town Hill Mountains in the west and the ranges in the eastern part of the county. East of Sideling Hill, in Licking Creek Valley, there is a wide stretch of the Dekalb shale loam and loam derived from the Chemung-Portage-Hamilton formation, occupying steeply rolling to hilly topography, except in Dublin Township, where it is more level. In this township lie some of the best farms of the county, on Dekalb silt loam, loam, and shale loam. Corn, oats, wheat, grass, and buckwheat grow well. Owing to the lack of markets and transportation facilities, land values are low, $10 to $25 an acre being the general range. Stock raising is practiced to some extent, and the condition of markets and soil should warrant a further extension of this industry. With the manure from the stock and with better tillage these soils can be made very productive.

Mifflin County.—In Mifflin County most of the Dekalb soils occur on the mountain tops and slopes, with but small areas that can be farmed. In Fergusons Valley and in the Juniata Valley the Dekalb soils are derived from the Clinton formation. Much of the land is cleared and in farms. General crops are grown with good results. In Oliver and Wayne and in East and West Decatur Townships occur two areas of Dekalb soils from the Chemung-Portage-Hamilton formation. These occupy rolling topography and are well farmed. Crop yields on some of these soils are high, 18 to 25 bushels of wheat, 75 to 100 bushels of corn, and 1 to 2 tons of hay being grown. Farm lands range from $25 to $100 an acre, depending on location, soil, and improvements. These areas of Dekalb soils have the reputation of being valuable and productive, and some excellent farms were seen.

Union County.—The western and northwestern one-third of Union County is occupied by a succession of steep, rocky mountain ranges, forming the eastern end of the Seven Mountains. With the exception of some areas of Hagerstown soils and some bottom and terrace lands, the rest of the county is made up of soils derived from the Clinton formation. The weathering of this formation gives the Dekalb soils, with the strips and bands of Upshur soils that have been

previously described. In this county the Bloomsburg red shale member of the Clinton formation outcrops as an irregular band of Upshur soils, being the only area of these soils large enough to map. The Dekalb soils occupy rolling to hilly topography, with shale loam and loam as the prevailing types. They are well drained, though in some fields seepage waters produce wet, unproductive areas. The shale loam type does not retain water well and will not carry crops through any protracted period of drought. The loam is more retentive of water, but it, too, is somewhat droughty. The latter is much the better type.

The soils are well farmed in this county, the land being well tilled, and manure and fertilizers regularly applied. Manure is one of the most important soil amendments and is here carefully saved. The general farm crops are grown, and potatoes have come to occupy a prominent place. Land values range from $40 to $100 an acre, the latter price being paid for Dekalb loam with good buildings and improvements near a town or shipping point.

Snyder County.—In Snyder County the Dekalb soils occupy the greater part of the area. Rough stony land covers all of Jacks and Shade Mountains, while loam, silt loam, and shale loam prevail in the valleys. Shale loam is the dominant type over the north half of the hilly valley between Jacks and Shade Mountains, while loam is more extensive in the southern half. Shale loam is the ruling type in the four southeastern townships. The soils all occupy rolling to hilly topography, are subject to severe erosion, and are droughty. They are well farmed in some sections, but in general crop yields are not as high as in Union County. The soils are low in organic matter and are greatly benefited by applications of barnyard manure.

Juniata County.—Juniata County lies as a single basin 10 to 15 miles wide and 60 miles long between Shade Mountain on the north and Tuscarora Mountain on the south. With the exception of some bands of Hagerstown soils, the whole area is composed of the Dekalb series. The mountains are rough and rocky and of no agricultural value; the basin is rolling to hilly, with most of the land in farms, though not all cleared. The Dekalb soils are derived from two formations, the Chemung-Portage-Hamilton and the Clinton. The latter give the characteristic streaked condition appearing in the description of Huntingdon County. These soils are rolling to moderately hilly, with silt loam, loam, and shale loam types. They are quite productive and are devoted to the general crops—corn, oats, wheat, and grass. The soils from the thin, hard shales of the other formation contain more shale and lack depth. They are also more subject to erosion and drought. The general farm crops are grown with fair results. In the eastern part of the county some peaches are

grown profitably on a commercial scale. The excellent transportation and market facilities should lead to more extensive plantings.

Land values in the county vary greatly, depending on the character of the soil, location, etc., ranging from $15 to $60 or more for the Dekalb soils. The increase in the number of cattle fed on the farms, due to the establishment of creameries in some of the larger towns, is increasing the productivity of the soil and raising the price of land.

Perry County.—In Perry County the occurrence of the Dekalb soils is not different from that in the counties already described. The Tuscarora and Blue or North Mountains, forming the northern and southern boundaries, and the mountains surrounding Hunters Valley and "The Cove" are rough and rocky and of no agricultural value. Between the mountains the county is steeply rolling to hilly, with long parallel ridges that sometimes approach the mountains in topography. The soils are derived from the Clinton and Chemung-Portage-Hamilton formations. The shale loam, silt loam, and loam types are most prevalent and are given over to general farm crops, four or five year rotations of corn, oats, wheat, and grass being the usual practice. Corn yields 40 to 60 bushels, oats 30 to 40 bushels, wheat 12 to 20 bushels, and grass 1 to 1½ tons. The land is valued at from $25 to $60 an acre.

The soils are subject to severe erosion, which, when not checked by suitable cultural means, causes much damage to the fields. The soils are low in organic matter and are much benefited by barnyard manure. An increase in dairying would do much to raise the productiveness of the soil and the net returns to the farmers.

Fruit does well on the Dekalb soils, peaches giving excellent results, and if growers would study the proper methods of caring for the trees and fruit more extensive plantings would prove profitable.

Cumberland, Franklin, and Adams Counties.—In Cumberland, Franklin, and Adams Counties the Dekalb soils are of little agricultural importance. They occupy the mountain ranges and are rough and stony and adapted only to forestry. South Mountain, lying between Cumberland and Franklin Counties and Adams County, is very largely Rough stony land, with some Dekalb stony loam on the lower slopes. Some of these soils are cleared and farmed, with fair results. Apples and peaches are grown, the latter crop doing well.

North or Blue Mountain, on the north side of Cumberland County, has little farming land—some stony loam and loam lying along the lower slopes. In Franklin County the Dekalb soils occupy Tuscarora Mountain, North Mountain, Jordan Knob, Cove, Two Top, and Caseys Mountains. Along the lower slopes some agricultural land is found on the stony loam and loam types. In Ambersons Valley, Fannett Township, some areas of shale loam and loam are farmed,

with good results. In Warren Township Dekalb soils derived from the Clinton formation are farmed, giving good returns with the staple farm crops. This area is the best section of Dekalb soils in the county.

HAGERSTOWN SOILS.

The Hagerstown soils are made up of the yellow and reddish-yellow soils, with yellowish-red or red subsoils, derived through weathering of limestones. They are widely developed in the area, being found in every county east of the Allegheny escarpment and most extensively in Franklin, Cumberland, Center, and Blair Counties.

The soils are derived from two geological formations, the Trenton limestone and the Lower Helderberg limestones. While similarity in formation exists, the topographical positions are quite distinct. The areas derived from the Trenton formation occupy broad, anticlinal valleys, with a moderately rolling topography, while the soils from the Lower Helderberg limestones occur in long, narrow bands, occupying steep ridges. Where two of these bands join they form an elevated, rolling plateau. The Hagerstown soils from the Trenton formation usually occupy a lower elevation than the other series of the region, while soils from the Lower Helderberg formation usually occur at a much higher elevation than the adjacent soils derived from shales or soft sandstones.

Closely associated with the Hagerstown soils formed from the Lower Helderberg rocks is the Frankstown stony loam. This soil is derived from the impure water limes and usually occupies a portion of the limestone ridges so characteristic of the Lower Helderberg outcrops. In most cases the combined area of Hagerstown soils and the Frankstown stony loam is barely wide enough to be shown and is always indicated by the Hagerstown color. In the few places where the occurrence is extensive enough the Frankstown stony loam is mapped and described separately.

In the weathering of the limestones to form these soils solution has played an important part. The Trenton limestones are nearly pure and the waters, which usually contain small quantities of acids derived from decaying organic matter, have dissolved and carried away the larger part of the calcium and magnesium carbonates that make up from 75 to 90 per cent of the rock. Underground channels formed in the rock masses carry nearly all of the drainage in Center, Blair, and Mifflin Counties, where there are few surface streams in the Hagerstown soil areas. Numerous sink-hole depressions are a characteristic of this series of soils.

The Hagerstown soils, though formed from limestones, are generally deficient in lime, as that material was removed by solution in the process of soil formation. The soil mass is made up of the more

or less insoluble residue of the rock mass, and it has been estimated that each foot of soil represents the remains of at least 100 feet of rock. The drainage of the series is uniformly good, being mainly through underground channels. Water seldom stands on the surface, and the soils can be plowed and worked very soon after rains or the spring thaws. Owing to this feature the soils are quite friable and do not clod, but break up into a pulverulent mass when properly plowed and harrowed. At the same time the soil contains sufficient clay and silt to insure good water-holding capacity and crops do not suffer severely from droughts of ordinary duration.

Erosion is not severe over the series as a whole, though on the steep ridges derived from the Lower Helderberg it causes much damage. In the broader valleys only the steeper slopes suffer, the high clay content serving somewhat to bind the soil together and retard severe washing. The most serious feature of erosion is that the farmers fail to see its damaging effects and great losses that could easily be prevented are sustained.

Six types were encountered in the area—clay, stony clay, clay loam, silt loam, loam, and stony loam. A brief description of each follows.

The surface soil of the Hagerstown stony clay consists of from 2 to 6 inches of a dark-red or brown heavy clay loam resting on a subsoil of stiff red clay. Soil and subsoil contain from 30 to 60 per cent of angular limestone and chert fragments. The soil usually rests on limestone rock at depths of less than 3 feet.

The Hagerstown clay consists of a surface soil of from 2 to 6 inches of a dark-red or reddish-brown heavy clay loam resting on a stiff red clay subsoil. In some places the surface soil consists of 2 to 4 inches of a light silt loam or loam resting on a stiff clay subsoil.

The Hagerstown clay loam consists of 8 to 10 inches of brown or yellowish-brown loam or silty loam surface soil resting on a heavy yellowish-brown silty clay loam, which grades into stiff red clay at from 20 to 30 inches.

The Hagerstown silt loam consists of from 10 to 12 inches of a dark-yellow or brown silt loam. The subsoil to a depth of 24 inches is a yellowish silt loam resting on a reddish-yellow silty clay loam or clay.

The surface soil of the Hagerstown loam consists of 8 to 10 inches of a brown or yellowish-brown rather silty loam resting on an immediate subsoil of a light yellow heavy silty loam or silty clay loam, which becomes heavier with depth until a heavy red clay is reached. The soil is loose and friable.

The Hagerstown stony loam surface soil consists of 6 to 8 inches of a brown silty loam resting on a subsoil of heavy red clay. The

soil and subsoil contain from 30 to 60 per cent of limestone and chert fragments of various sizes.

The soils of this series are among the most productive in the State and in this area are nearly all in farms. In the larger areas they are valued at from $40 to $150 an acre, while the narrow, hilly strips derived from the Lower Helderberg run from $15 to $50 an acre, depending on location and character.

The soils are well adapted to the staple crops, corn, oats, wheat, and grass, and give excellent returns where well farmed. Alfalfa has proved a profitable crop on the Hagerstown soils when the lime content has been maintained.

The farmers on these soils are the most prosperous of any in the area, and the farms are well kept. Buildings are generally good, big stone barns and well-built frame or stone houses being most common.

The soils are generally in need of lime. Organic matter is somewhat deficient, especially on the heavier types, but in general the soils have a satisfactory content of this material. In the description of the soils as they occur in each county a more detailed description of conditions is given.

Center County.—In Center County the Hagerstown soils are the most important, though not the most extensive series. They occupy the valleys in the southern and eastern parts of the county and are derived wholly from Trenton limestone. Nittany Valley, the largest body, extends across the county from the Clinton to the Huntingdon County line in a strip from 4 to 8 miles wide, interrupted only by the Barrens, or Morrison soils, lying in Half Moon, Patton, and Ferguson Townships, west of State College. Penns Valley, extending northeast as an arm of Nittany Valley, with Brush and Georges Valleys, make up the balance of the 106,750 acres of this series in the county.

The soils occupy the rolling uplands of the larger valleys and the floors and lower slopes in smaller valleys. Their topography is generally rolling, with a few hilly regions. Clay loam and loam are the prevailing types, the former being the more productive. The loam occurs in three large bodies, one south of Center Hall, one west of State College, and the other north of it. Small, isolated areas of clay, silt loam, and stony loam are scattered over the whole area.

The soils are productive, yielding from 60 to 90 bushels of corn, 15 to 30 bushels of oats, 18 to 25 bushels of wheat, and 1 to 2 tons of hay. Corn, oats, wheat, and grass is the common rotation, the grass being cut for two or more seasons. Dairying is becoming important and stock raising is receiving considerable attention.

The land is held at from $30 to $60 an acre, depending on location and character of the soil. Practically all of this series is in farmed land, little being in forest or permanent pasture. The land is well tilled, though cultivation is rarely continued long enough during the growing season properly to conserve the moisture supply.

The soil is generally in need of lime and the practice of applying this material is becoming common. The lime is generally burned on the farm in "lime piles," but considerable quantities are purchased from local kilns or from the big kilns at Bellefonte.

Alfalfa is grown to some extent, giving excellent results when the lime content of the soil is maintained.

Huntingdon County.—The broad band of Hagerstown soils that form the Nittany Valley in Center County extends across the western part of Huntingdon County in Warriors Mark, Franklin, and Morris Townships. In the two former townships the loam and clay loam types are most extensive, while in the latter the clay loam and silt loam types prevail. The soils are well farmed and productive, though they are not as good as those in Center County. Land values vary from $25 to $60 an acre.

On the east side of the Tussey Mountains, from McAlevys Fort past Petersburg and Alexandria and south to the Bedford County line, runs an irregular, rather narrow band of Hagerstown soils, derived from the Lower Helderberg limestones. Near Neffs Mills another irregular body appears, derived from the Niagara limestones, which here outcrop to form soils. This strip is generally hilly, and the clay, clay loam, and stony loam types are most prevalent. The northern part of this area, between McAlevys Fort and Petersburg, comprises some good farming land, where crop yields are high and farms are well handled. South of Porter Township the Hagerstown soils occupy the steep slopes of a ridge and suffer severely from erosion.

Values range from $15 an acre in the hillier sections to $40 in the more level and productive regions.

In Shirley Township, southeast of Mount Union, occurs another area of Hagerstown soils, rolling in character and very productive. Three other areas of some extent are found in the county. One along the pike in Black Log Valley between Orbisonia and Shade Gap is of small importance. Another is in Dublin Township, east of Burnt Cabins, while in Brady Township, in the northeast corner of the county, the upper end of the Hagerstown soils of the Kishacoquillas Valley is found. Several other small areas of Hagerstown soils are mapped where the Lower Helderberg limestone outcrops in sufficient extent to give areas large enough to be shown on a map of this scale. All along the outcrops of this formation occur small,

irregular areas of these soils, most of which are too small to be shown on the map. Their chief importance is as a source of lime for use on the other soils of the region.

Blair County.—In Blair County there are two large bodies of Hagerstown soils derived from the Trenton formation. One, the extension of the Nittany anticline, forms a triangular body in Tyrone Township. The soils occupy a rolling topography and are productive and well farmed. The clay loam type is most prevalent, with considerable areas of loam and clay. The second body, which is really an extension of the Penns Valley anticline of Center County, continues south from Morris Township, in Huntingdon County, through Catharine, Woodbury, Huston, North Woodbury, and Taylor Townships into Bedford County. This area, with its extension in Woodbury, South Woodbury, and Bloomfield Townships in Bedford County, forms the well-known, fertile Morrisons Cove district. Throughout the district the silt loam type prevails, with loam, clay loam, and clay types of considerable importance. The soils are productive and well farmed, corn, oats, wheat, and grass being the staple crops, with dairying occupying an important place as a farm industry. The land is valued at from $40 to $75 an acre, most of the silt loam being held at from $60 to $75. As is common with the whole series, the soils need lime in order to give best results.

A long, irregular band of Hagerstown soils derived from the Lower Helderberg limestone extends in a broken area from Tyrone south past Altoona to Hollidaysburg, thence northeast to the northern corner of the "Loop," in Franklin Township, with an arm of the band in the southern part of that township. Another area starts in the southeastern part of Greenfield Township. The soils are mostly of the clay type, with some silt loam and stony loam, occupying hilly topography, and are subject to considerable erosion. They are closely associated with the Frankstown stony loam herein described.

Bedford County.—In Bedford County, in addition to the area described above as part of the Morrisons Cove area, there are several small bodies of Hagerstown soils derived from the Lower Helderberg limestone. The largest of these lies in Colerain and Snake Spring Townships, with other areas in Cumberland Valley, Bedford, Kimmell, and King Townships. These soils are not as hilly as in Blair County and are less subject to erosion. They are productive and farmed to the general crops of the region. Clay is the most extensive type, with silt loam and stony loam next in importance.

Mifflin County.—In northwestern Mifflin County the Hagerstown soils cover the productive Kishacoquillas Valley. They are derived from the Trenton formation and occupy a rolling topography. Silt

loam and clay loam are the prevailing types. The soils are very well farmed and productive, giving high yields of corn, oats, wheat, and grass. The farms are well tilled, buildings, fences, and other improvements being well kept, and the farmers progressive. Land values are high. The Kishacoquillas Valley is one of the most uniformly productive and prosperous sections of the central part of the State.

Besides this area Mifflin County has several irregular, broken strips of Hagerstown soils derived from the Lower Helderberg limestone. Most of them are narrow and, with the Frankstown stony loam, occupy steep-sided ridges. It was impossible on this scale to show both the Frankstown and Hagerstown soils, and as the latter are the more important they were always shown, their area including the associated Frankstown. The clay and stony loam types were most extensively developed, but owing to their topographic position are not markedly productive. Staple crops are grown with good results. The presence of these outcrops is most important as a source of available limestone for burning.

Juniata County.—In Juniata County the Hagerstown soils occur on the long zigzag outcropping of the Lower Helderberg limestone. On the narrower ridges the Hagerstown and Frankstown soils have been shown together. Of the former the clay and stony clay are the predominating types. In places where the bands of soils broaden out the loam and silt loam types are extensively developed and the soil productive. In such regions the topography is rolling to hilly. Near McAlisterville and Walnut are found some of the best farms of the county. The soils here are valued at from $60 to $90 an acre. Corn, oats, wheat, and grass are the standard crops, with considerable timothy grown for seed.

Union County.—In Union County the Hagerstown soils are found in Buffalo, East Buffalo, and Limestone Townships. They are derived from the Lower Helderberg limestone, but occur as broader, more extensive areas than is usually the case. The silt loam and clay loam are the prevailing types, and occupy rolling topography. The soils are well farmed and give exceptionally high yields, corn giving from 75 to 100 bushels, oats 25 to 30 bushels, wheat 20 to 25 bushels, while clover and timothy do well. The land is held at from $60 to $125 an acre. The soils are well drained, suffer little from erosion, and the farm improvements are of a high character.

Snyder County.—In Snyder County the Hagerstown soils occur in three bands along the outcrops of the Lower Helderberg. The northern band is very narrow and is shown on the map only in Adams and Union Townships. The soils are closely associated with the Frankstown, and occupy steep positions. The second band extends through the central part of the county, being mapped in West

Beaver, Beaver, Franklin, and Penn Townships. Here the areas are broader and not so hilly. Clay and silt loam types prevail. The third area crosses the southern part of the county, being mapped in West Perry and Washington Townships. The band here is wide and the soils occupy a rolling to hilly topography. The soils are here separated from the Frankstown, which are extensive enough to be shown separately on the map. The Hagerstown clay and stony loam are most extensive and are classed as valuable lands where not too steep to be farmed.

Perry County.—The Lower Helderberg limestone outcrops across Perry County in a long zigzag, carrying along its length areas of the Hagerstown soils. These soil areas are of considerable width and make up some of the most important and productive soils of the county. They occupy rolling topography and the loam and silt loam types are most widely developed. In most sections the general corn, oats, wheat, grass rotation is followed, but in the Pfouts Valley section a rotation of corn, oats, wheat, wheat and grass, is followed. In either case the grass is allowed to stand for two or three years. Land values, where the farms are wholly of Hagerstown soils, vary from $75 to $100 an acre.

The soil formation is of great importance, as it is productive and also furnishes lime, which is sorely needed by all the soils. Lime kilns are numerous, and because of the zigzag outcrop of limestone across the county all the soils are near some kiln or source of lime.

Fulton County.—In Fulton County there are two occurrences of Hagerstown soils. One area, derived from Lower Helderberg limestone, is found in Bethel Township, south of Needmore to the Maryland line. The soils occupy rather steep slopes and are associated with the Frankstown stony loam. The clay loam is the prevailing type, with considerable stony loam. Land values vary, owing to speculation in orchard lands, prices ranging from $20 to $60 an acre. The second area, in the valley south of McConnellsburg, is derived from Trenton limestone. The soils occupy rolling topography, with silt loam and clay loam prevailing. They are productive and well farmed, but the distance to market reduces their value.

Cumberland County.—In Cumberland County the Hagerstown series is the most important and extensive group of soils. They occupy a broad belt the whole length of the county, more than half of the Cumberland Valley and about one-third of the total width of the county.

The surface is rolling to slightly hilly and the land lies in such a position that practically all of it can be cultivated. The soil is not very deep, bedrock usually lying within 6 feet of the surface, with numerous limestone outcrops, which form one of the striking char-

acteristics of the area and cause considerable wear and breakage of farm machinery. The silt loam and loam are the prevailing types, with appreciable areas of clay. Sink holes are common, but not as numerous as in the "up-State" valleys.

A feature that attracts attention in the area is the occurrence of what is locally known as "Ironstone Ridge." This ridge, with an elevation of 40 to 50 feet above the surrounding country, crosses the county about 4 miles east of Carlisle. It marks the location of an intrusive dike and is made up of metamorphic bowlders. The soils are a heavy brown clay, generally stiff and difficult to handle. The ridge is generally wooded and where farmed is considered inferior to the Hagerstown soils. It is too narrow to be shown as a separate series and does not appear on the map.

The soils here are not subject to erosion, but are more inclined to puddle and bake than in the "up-State" areas. Care must be used in handling to till only when in a favorable condition of moisture.

Crop yields are good, though not as high as they could easily be made. Corn runs from 40 to 60 bushels, oats 30 to 50 bushels, wheat 12 to 25 bushels, and grass 1 to 2 tons per acre. The Hessian fly does considerable damage to the wheat. Farm buildings and improvements are good and land values are high. Very little land is for sale, but the prices range from $100 to $175 an acre. Farms have sold for over $200 an acre.

Franklin County.—Franklin County is crossed by a belt of limestone from Cumberland County, which increases to 15 miles in width as it approaches the Maryland line to the south. In addition to this belt there are other areas of limestone, one band from 2 to 4 miles wide extending from the Maryland line north beyond St. Thomas; another oval area, with a width of 1 to 2 miles, extends from Blairs Valley to Jordan Knob; while other small areas lie west of this, in Montgomery and Peters Townships.

In Path Valley there is a long, irregular strip of Hagerstown soils, varying in width up to 2 miles, which occupies parts of Metal and Fannett Townships. All of these areas are derived from the Trenton limestones. There is a small, unimportant area of Hagerstown soil in Warren Township derived from the Lower Helderberg limestone. The soils occupy gently rolling to somewhat hilly topography, but in most cases lie so that practically all of the land can be farmed. Over all the areas the outcrops of limestone rock are numerous, in some sections materially reducing the value of the land. On crossing the county one is struck with the difference in elevation between the Berks soils, derived from shales, and the Hagerstown soils, the latter lying from 50 to 100 feet below the general level of the former.

The silt loam and clay loam are the prevailing types, with large areas of clay and loam. Along the Conococheague, between Scotland and Marion, are found the remains of some old terrace material on the limestone soils. These are not of sufficient area or importance to be shown on the map. The soil is loam, with considerable quantities of gravel and rounded waterworn sandstone fragments scattered over the surface. They lie much above the present bed of the stream.

The Hagerstown soils are well farmed, the usual crops being grown. Corn yields 50 to 90 bushels, oats 20 to 40 bushels, wheat 15 to 25 bushels, and hay 1 to 2 tons. Some alfalfa is grown, with excellent results. Aside from the rock outcrop areas there is little waste land in the county, and land prices are high. In the Cumberland Valley prices range from $75 to $150 an acre. In Path Valley values are somewhat lower, because of poorer marketing facilities. The farm buildings and other improvements are uniformly good and the soils are well handled. Lime is being quite generally used, with very beneficial effect, while barnyard manure forms one of the most efficient fertilizing materials.

Adams County.—In Adams County the Hagerstown soils occur in two areas. The most extensive occupies practically all of the Conewago Valley in the southeastern part of the county, near Littlestown. The other occupies parts of Hamiltonban and Franklin Townships from Fairfield north to Cashtown. The prevailing type is loam, with some areas of stony loam. The soils occupy rolling topography and are well drained.

MORRISON SOILS.

The Morrison soils are not extensively developed in the area, being found only in Center, Huntingdon, Blair, and Bedford Counties. Their greatest development is in Center County, where they form a large part of Half Moon, Ferguson, and Patton Townships in western Nittany Valley, and in Walker and Marion Townships, east of Bellefonte. The former area extends southwest across the line into Huntingdon County and the townships of Franklin and Warriors Mark. Its western extremity crosses the Juniata River at Birmingham, occupying a small area of Tyrone Township in Blair County. Other limited areas occur in Woodbury, Huston, and Taylor Townships, and one small tract is found in Bloomfield Township in northern Bedford County.

The soils are closely related to the Hagerstown soils of the limestone valleys and occur on the eroded crests of the great anticlinal folds of the Trenton limestone. The exact source and geological horizon of the sandy material from which the soils are derived has

never been satisfactorily determined. The soils are derived from weathered sandstones, quartzites, and clays, and are generally sandy in character. The soil material is usually rich in iron and most of the stones, which in some places are very numerous, are made up of iron-cement sandstones. Over the whole area covered by the Morrison soils are found deposits of iron ore of sufficient value to be mined, and many open workings or "ore banks," some of considerable size, can be seen. Several of these are still in operation, the one at Scotia, in Center County, being the most important and extensive. The presence of these iron deposits led to the building of railroads and roads into these so-called "Barrens" and opened them up for development to a greater extent than would otherwise have occurred.

The soils occupy ridges and rolling areas that have suffered much from erosion. The stonier types generally occupy steeply sloping hills and ridges, while the sandier types occur on gently rolling land.

Drainage is excessive over most of the series, the soil and subsoil being so loose and open as to allow water to be readily lost by seepage. The soil has a low capillary power and crops suffer severely from drought. The soils are low in humus and in productiveness. The region as a whole lacks water, which can only be secured by driving wells from 200 to 600 feet deep.

Only the heavier types have been cleared and farmed. The sand, sandy loam, and stony loam types are almost wholly timbered or cut-over lands. The term "Barrens" is a misnomer, as the region has supported a heavy growth of chestnut, oak, and pine, and where forest fires do not prevent the "cut-over" lands become reforested with fair stands of merchantable timber.

If sufficient water could be secured on the soils, they could be developed for fruit and trucking. They are valued at from $5 to $35 an acre, depending on location and development. In any farming operations on this series great care must be taken to maintain the humus content and to control the moisture conditions. The following is a brief description of each type encountered in the area.

The surface soil of the Morrison sand consists of 6 to 10 inches of a yellow or yellowish-brown fine loamy sand, resting on a subsoil of yellow or reddish-yellow sand or fine sand, somewhat sticky in spots.

The Morrison sandy loam consists of 8 to 12 inches of a fine to medium yellowish-brown heavy sand or light sandy loam surface soil, resting on a subsoil of yellow or reddish-yellow sticky sandy loam, grading to clay loam.

The surface soil of the Morrison stony loam consists of a heavy reddish-yellow sandy loam, resting on a reddish-yellow sandy clay loam, grading to sandy clay. Soil and subsoil contain large quanti-

ties of iron-cemented sandstone and iron ore fragments of varying sizes.

The surface soil of the Morrison loam consists of 8 to 10 inches of yellow or brownish-yellow, rather sandy heavy loam, resting on reddish-yellow clay loam to clay.

The surface soil of the Morrison clay loam consists of 6 to 8 inches of brown or yellowish silty clay loam, resting on a reddish-brown clay or clay loam.

The two latter types occur along the junction of the Morrison and Hagerstown series and represent a mixture of the sandy material of the "Barrens," and the heavier clayey material derived from the limestone rocks. They are more productive than the lighter types.

COLYER SILT LOAM.

The Colyer silt loam is mapped only in Center County, though some small areas occur on the east flank of the Bald Eagle Mountains, in Warriors Mark Township, Huntingdon County. The soil is derived from the black, carbonaceous shales, which lie between the Trenton limestone and the Utica shales, and occupies a rolling topography. It is well drained and of high agricultural value.

The Colyer silt loam consists of 8 to 10 inches of yellow or yellowish-brown silt loam, while the subsoil is a heavy yellow very silty clay loam, which rests on soft, rotten black shale at depths of less than 3 feet. The soil is locally known as "soapstone land," and is most extensively developed in Potter, Gregg, and Penn Townships, in Penns and Georges Valleys. The soil is uniform in texture, does not clod readily, and is very productive. It is unique in having over 95 per cent of the soil grains in the silt and clay class smaller than 0.05 millimeter in diameter.

This soil ranks next to Hagerstown clay loam in value. Corn yields 60 to 100 bushels, oats 20 to 25 bushels, wheat 15 to 18 bushels, hay 1½ to 2 tons, and potatoes 75 to 125 bushels per acre. The land is valued at from $40 to $60 an acre.

UPSHUR SOILS.

The Upshur soils, though not extensively developed from an areal standpoint, are widely distributed over the region surveyed, occurring in every county except Clearfield, Juniata, Cumberland, and Adams. They are derived from four different rock formations, the Catskill red sandstone, Mauch Chunk red shales, Clinton shales, and Medina red standstones. The Catskill formation is by far the most important, the soils derived from it comprising fully three-fourths of the total area of the series. The Mauch Chunk formation is next in importance, the Upshur development from the Clinton and Medina being inextensive.

The topography occupied by these soils depends to a large extent on the formation from which derived and the dip of the rock strata where they outcrop. The Catskill regions are usually rough, with many rounded hills and hogback ridges. Most of the outcrops occur on the lower slopes or just at the foot of mountains, and the large quantity of surface waters that has flowed over them has cut and eroded the region into a very irregular, hilly topography. Where the Catskill formation outcrops as a broad synclinal or anticlinal fold, the topography is broadly rolling to hilly.

This formation is made up of layers of soft, red shales and thin-bedded, shaly sandstones, both of which weather readily. The soil is rarely deep, usually resting on the broken shale at from 18 to 30 inches in the hillier regions and at from 2 to 4 feet on the more rolling or level areas. The shale loam and stony loam types make up practically all of the soil area derived from the Catskill rocks, this being due in part to the varying character of the rocks and to the very active erosion on these soils.

Where the Mauch Chunk formation is the source of the soil material, a different topography is found. In the few areas where this formation is exposed west of the Allegheny escarpment the soils occupy a very intricately cut up region of steep-sided, round-topped hills and irregular ridges. In such regions erosion is excessive and the soils poor. Ordinarily the Mauch Chunk formation outcrops as broad, rolling to hilly valleys or sloping coves inclosed by steep, rugged mountains. In such regions erosion is an active agent, but its work is not severe, and on well-tilled farms the damage is slight. The soils derived from this formation are among the most valuable in the series.

When weathered the layers of red shales in the Clinton formation give soils of the Upshur series. When the outcrops are sufficiently extensive to be mapped to this scale, the areas of Upshur have been shown. The soils are usually rather heavy in character, as the shales are somewhat calcareous and fine grained and weather to a fine clayey soil material. An exception occurs in Union County, where the Bloomsburg red shale member of the Clinton formation, made up of a thin-bedded, decidedly hard shale, occurs as a series of narrow, steep ridges, on which but little soil, of a very shaly nature, is found. Normally the Upshur soils from the Clinton formation occupy rolling to hilly areas in the broad valleys.

The few areas of Upshur derived from the Medina red sandstones are found in narrow valleys on the tops of the synclinal mountain ridges or where an upward bend of the fold causes the more or less parallel mountain ranges to come together. In the latter case the Upshur usually occurs as an irregular crescent-shaped area on the

flanks of the knob of Oneida sandstone or Medina gray sandstone which ends the two ranges of mountains. These soils are generally sandy in character and run lighter in color than the typical Upshur, owing to the mixture of the red Medina material with sands from the Oneida or gray Medina rocks.

The soils of the Upshur series are normally well drained. The underlying rock, of whatever formation, is rarely so dense or unbroken as to prevent the percolation of water. In some sections areas lying near stream heads and drainage lines are kept wet by seepage waters from higher areas, but such places are never extensive enough to be important.

Erosion is a very important factor to be considered in the farming of these soils. The loose nature of the most extensive type, the shale loam, renders it readily subject to damage by washing, and extreme care must be taken to maintain the depth of soil on the exposed slopes. On the heavier types the soils are not so readily washed, but unless care is used they will suffer losses of fertility through erosion.

The soil mass contains an appreciable quantity of clay and is quite retentive of moisture. Wherever there is good depth, the capacity is sufficient to carry crops through an ordinary drought. The soil section of the shale loam is so shallow that crops suffer severely from drought of any duration.

There are six types in the area surveyed—shale loam, stony loam, loam, silt loam, stony sandy loam, and fine sandy loam. Of these the shale loam, stony loam, and loam are most extensive.

The surface soil of the Upshur shale loam to a depth of 4 to 8 inches consists of a dark brownish-red or yellowish-brown fine loam, resting on a subsoil of dark-red or red-brown heavy loam or clay loam. It contains from 30 to 60 per cent of shale fragments, with a higher content in the subsoil, which grades at from 12 to 20 inches into a mass of broken shale fragments.

The Upshur stony loam to a depth of from 6 to 8 inches consists of a reddish-brown or dark-red fine loam, resting on a subsoil of a dark-red clay loam, resting on broken rock at depths of from 2 to 4 feet. Both soil and subsoil contain from 15 to 50 per cent of flat, irregular fragments of red sandstone and shale.

The surface soil of the Upshur loam consists of from 8 to 10 inches of an Indian-red loam, generally heavy, but sometimes rather sandy, resting on a heavier subsoil of dark-red clay loam, grading into a light clay at from 25 to 36 inches.

The Upshur silt loam surface soil consists of from 8 to 12 inches of an Indian-red or brownish red mellow silty loam or silt loam, resting on a heavier dark-red silty loam, which grades into dark-red clay at 30 to 36 inches.

The Upshur stony sandy loam surface soil consists of from 8 to 10 inches of a reddish-gray or light-brown sandy loam, which becomes redder and sandier with depth. Occasionally the subsoil consists of a heavy loam or sandy loam. Surface and subsoil contain from 10 to 40 per cent of angular rock fragments.

The surface soil of the Upshur fine sandy loam consists of from 8 to 10 inches of a yellowish-red or brown fine sandy loam, resting on a subsoil which grows heavier in texture and redder in color with depth.

The soils, because of their varied topography, differ much in value, crop production, and adaptability to farming. Where they can be farmed they give good yields of corn, wheat, buckwheat, potatoes, and grass. Fruit trees do well on these soils when properly cared for. Potatoes give good results on the deeper soils, yielding from 100 to 200 bushels an acre. As a general thing they are not well cared for, are not cultivated often enough to maintain good mulches to save the moisture, and are not sprayed regularly for blight. They could be made a very profitable crop if properly handled.

A large part of the series, by reason of its rough topography, is better adapted to forestry than to farming. Originally the soils supported excellent growths of chestnut, oak, and, in some sections, of pines, and if protected from forest fires and destructive erosion good growths of timber can be developed. In value they vary from $4 an acre for cleared and fenced thin shale loam at a distance of 12 to 20 miles from a market to $50 or $60 an acre for the loam or silt loam that is in a good state of development and near a market.

In farming the Upshur soils emphasis must always be placed on the importance of maintaining the supply of humus. With the incorporation of plenty of organic matter, either through the application of barnyard manure or by plowing under stands of clover or other green crops, the water-holding capacity of the soil can be much increased. Where erosion is active it can be overcome by plowing across the hill and leaving strips of sod across the slopes at intervals. Grass should be allowed to grow in the draws and depressions. On some of the steeper slopes terracing would be very efficient, though it would probably be justified only in orchards or on such soils as might be used for gardening or truck growing.

Lime is of benefit to nearly all of the Upshur soils, especially to the heavier types and to those derived from the Mauch Chunk formation. It should be applied in quantities ranging from 1,000 to 2,000 pounds an acre.

Much of the Upshur soil lies on such steep slopes that the use of labor-saving machinery is restricted. This makes the proper handling of the soil and crops expensive. In many fields the grain must be

cut with cradles and tied by hand, and on some farms all the hauling from field to barn is done on sleds. The productiveness of the soils warrants their being farmed, but the steeper areas in many cases could better be left in forests. Chestnuts, walnuts, hickory nuts, and other nuts might be profitably grown on these soils.

Center County.—In Center County the Upshur soils occur in two localities. The most extensive development is in a band extending northeast and southwest across the county just in front of the Allegheny escarpment. The soils here are derived from the Catskill formation and are made up wholly of the stony loam type. They occupy a series of steep, rounded hills and irregular ridges and are usually so stony that the rock has to be picked off before the land can be cultivated.

The soils are productive, giving from 10 to 20 bushels of wheat, 30 to 60 bushels of corn, 25 to 30 bushels of oats, 100 to 200 bushels of potatoes, and 1 to 1½ tons of hay per acre. Fruit does very well on the type. The land is valued at from $25 to $75 an acre.

The second occurrence of the soil is in narrow bands in the depression on the top of the Bald Eagle and Nittany Mountains in Harris, Benner, and Spring Townships. The loam type is here developed and farmed to some extent. Crops do not do as well as on the stony loam in Bald Eagle Valley and the land is of lower value. It is deficient in organic matter and droughty.

Blair County.—In Blair County the Upshur soils occur identically as in Center County. The band of Upshur foothills parallels the front of the Allegheny escarpment, widening out in Juniata and Greenfield Townships to form an extensive area. This area of Upshur is all stony loam, but it is not so extensively farmed as in Center County. More of the land is in forest, especially the large area which is rather inaccessible. This soil where farmed is valued at from $10 to $100 an acre, depending on location. Mann in his Johnstown survey places yields of wheat at 10 to 20 bushels, oats 20 to 35 bushels, corn 40 to 60 bushels, and buckwheat 15 to 20 bushels to the acre.

The stony loam and stony sandy loam occur on the flanks of the mountains surrounding Morrisons Cove, being here derived from the Medina formation. The soils occur as narrow bands, most of which are timbered, and the land is inaccessible.

Several strips and irregular patches of Upshur loam are found in Blair and Cambria Counties on the top of the Allegheny Plateau from 2 to 4 miles west of the escarpment. Very little of this land is under cultivation. It is rough and broken and should be left in timber.

Somerset County.—In Somerset County the outcrop of Catskill at the front of the Allegheny escarpment is partially buried by material from the higher lying rocks. Two bands of Upshur soils occur. The first of these lies across Allegheny, Northampton, and Larimer Townships, the smaller area occurring in eastern Larimer and Greenville Townships. Stony loam and shale loam predominate, with rough and broken topography. The land is partly cleared and farmed, but the greater part is in forest growth. It was impossible to obtain crop yields. Land values are low, owing to distance from markets and shipping points.

Bedford County.—In Bedford County the Upshur soils are found in several detached areas, four of which are of considerable size. The larger areas are derived from the Catskill formation, the smaller ones are from the Medina. Only one is important agriculturally. It lies in the broad, hilly valley between Warriors Ridge and Rays Hill, covering East Providence, West Providence, Monroe, Southampton, and Mann Townships almost completely. The series is steep and hilly and is excessively drained. The larger part of this body of the Upshur soils is in farms, some of which are very productive. Shale loam and stony loam are the prevailing types.

Another body of Upshur soils at the base of Broad Top Mountain occupies portions of Broad Top, Hopewell, and Liberty Townships. Two other areas lie in front of the Allegheny escarpment along the western boundary of the county. Still other areas occupy narrow bands in Harrison, Colerain, and Snake Spring Townships. These latter are derived from the Medina rocks and are of practically no agricultural value.

The Upshur soils in this county vary greatly in productiveness and value. Prices range from $40 or $50 to as low as $5 an acre.

Huntingdon County.—In Huntingdon County the Upshur soils are derived from three formations. One strip resulting from exposures of the Catskill sandstones extends from the south point of Hopewell Township northeast along the foot of Terrace Mountain to the Juniata River. The Raystown Branch of the Juniata has scoured its channel out of this soft rock formation and winds across the Catskill outcrop. As the river lies at from 100 to 300 feet below the Upshur soils and its valley is very narrow, this area is very much cut up. There is no level land, the whole Upshur area consisting of rounded hilltops, precipitous slopes, and small gently sloping areas near the wide curves of the river. The soil is mostly stony loam, with some loam and fine sandy loam. The more level areas give good results with the staple crops. It is valued at from $15 to $35 an acre.

This area of Upshur soils extends across the Juniata River, east of Huntingdon, in Henderson Township, as a hilly, broken region

of stony loam, shale loam, and loam of fair value. The outcrop of Catskill sweeps around the knob formed by the union of Terrace and Sideling Hill Mountains, extending south as a narrow strip at the foot of the latter mountain. Here the soils are stony loams and fine sandy loams, rather lighter in color than the typical Upshur. This strip of Upshur soil is unbroken along the eastern side of Sideling Hill Mountain, reaching from the Juniata River south across Huntingdon and Fulton Counties into Maryland. An area of considerable size extends through Taylor Township, Fulton County, into Springfield Township, in Huntingdon County. It is steeply rolling to hilly, of stony loam, shale loam, and loam types. Where not too steep, crops give good returns. It is valued at from $10 to $40 an acre, and is distant from market.

The most important areas of Upshur soils in Huntingdon County occur in Trough Creek Valley, occupying large areas in Union, Cass, and Todd Townships. In the latter township particularly the soils occur as a broad, rolling to somewhat hilly valley, with loam, stony loam, and silt loam types developed. The land is easily tilled and gives good returns of staple crops. It is hemmed in on all sides by mountains, the only outlet being through the gap cut in Terrace Mountain by Trough Creek, thence to Marklesburg, or over Sideling Hill at Cassville to Saltillo or Three Springs. In spite of this the land is well developed, with good farms and improvements, and is valued at from $20 to $60 an acre.

A few isolated areas of Upshur occur in other parts of the county, notably north of McAlevys Fort and south of Alexandria, where the soils are derived from the red shales of the Clinton formation. These are of small extent and importance. Many narrow bands of Upshur occur with the Dekalb.

Fulton County.—The Upshur soils, which were described in Huntingdon County as derived from the Catskill rocks and lying at the east side of Sideling Hill Mountain, are developed in Fulton County as a long, narrow band, with one lobe in Taylor Township, which has already been described. This strip and the similar one that surrounds Scrub Ridge, east of Licking Creek, are made up largely of rough, hilly soil, with some good farming land on the slopes. In Thompson Township, where the loam, silt loam, and stony loam are well developed, the land is productive and of considerable value.

In Union and Brush Creek Townships the broad Catskill Valley is made up largely of loam, sandy loam, with some shale loam and stony loam. The land occupies broadly rolling to somewhat hilly regions, and is in a fair state of cultivation. Wheat yields 10 to 18 bushels per acre, buckwheat 10 to 15 bushels, potatoes 75 to 150 bushels, and corn 30 to 50 bushels. Oats and hay do not thrive. The

soils need lime, which must be hauled 14 to 20 miles. The land is valued at from $12 to $15 an acre.

In Wells and Brush Creek Townships there are two valleys or "coves" of Upshur soils derived from Mauch Chunk red shales. Of these the Wells Township area is the better developed. The soils are loam and shale loam, valued at from $15 to $30 an acre. Crops do well where well tilled. Oats yield 30 bushels, wheat 15 to 18 bushels, potatoes 75 to 150 bushels, corn 70 to 90 bushels, and buckwheat 20 bushels per acre. Hay does well. The soil needs lime, which is available in the exposure of a layer of limestone in the Mauch Chunk shale along Sideling Hill Creek. In this valley the areas are broadly rolling to hilly, while in the Brush Creek Valley they are more broken, being steeply rolling to hilly, with the shale-loam type predominating. Crop yields are about the same as in Wells Township, but land values are a little lower, $10 to $20 being the usual price.

Lack of transportation facilities retards the development of these two valleys.

Franklin County.—In Franklin County there is one area of Upshur soils, the stony loam and shale loam being found in a narrow, eroded strip in Horse Valley. It is of little value for farming.

Perry County.—In Perry County the Upshur soils are found in four bodies, two, the "cove" and "Hunters Valley," being derived from Mauch Chunk formation, the other two, lying on the lower outer flanks of the mountains that inclose the first two areas, being derived from Catskill rocks. The soils are generally loam, shale loam, and stony loam, and occupy rolling to hilly areas. On the slopes of the mountains and near the larger streams the surface is steep and broken. The soils are quite productive, yields of 40 to 60 bushels of corn, 30 to 40 bushels of oats, 12 to 20 bushels of wheat, 1 to 1½ tons of hay, and 100 to 200 bushels of potatoes per acre being common. The land is fairly well farmed, and is valued at from $30 to $60 an acre.

Mifflin County.—The one small area of Upshur soils in Mifflin County, lying just west of Burnham, is of little importance.

Snyder County.—In Snyder County the Upshur soils occur as two areas, one small area in Union Township and a larger one in Monroe, Jackson, Center, and Middle Creek Townships. Both areas are derived from the Catskill formation, and the soils occupy rolling to hilly uplands composed mostly of shale loam and stony loam, loam, and fine sandy loam. The soils are moderately productive, and are valued at from $30 to $60 an acre.

Union County.—In Union County the Upshur soils are found mainly as irregular strips, occurring on the outcrops of the Bloomsburg red shale of the Clinton formation, and occupy narrow, steep

ridges composed almost wholly of thin shale loam. The series is not extensively developed in any one place, and crop yields or land values could not be obtained. Near Kelly Crossroads and west of Cowan are found the best developed areas.

BERKS SOILS.

The Berks soils are extensively developed in Cumberland and Franklin Counties, where they make up approximately half of the Cumberland and Path Valleys. A small area was mapped in the northern end of Kishacoquillas Valley in Mifflin County and smaller areas, which could not be shown on a map of this scale, were noticed in Blair, Center, and Bedford Counties. The series is found closely associated with the Hagerstown, lying between the limestone soils and the mountains.

The soils are derived from the slaty shales and shaly sandstones, termed the Utica and Hudson slates in the Second Pennsylvania Geological Survey, but which were correlated with the Martinsburg shales by the United States Geological Survey in the Chambersburg-Mercersburg folio.

These shales lie immediately above the Trenton limestone formation and, in the Cumberland Valley, outcrop to form a band from 4 to 6 miles wide extending along the northern and western half of the valley. In all the other anticlinal valleys where the degradation has been sufficient to expose the Trenton the Utica-Hudson outcrop as a narrow band along the foot of the Oneida-Medina sandstone mountains. Usually these outcrops are deeply buried under sandstone débris washed down from the higher slopes. In Path Valley in upper Franklin County, and in the section of Mifflin County just north of Milroy the shales outcrop in rather extensive bodies free from the sandstone débris and here develop the Berks series.

The shale formation is made up of rather thin-bedded compressed shales that have been folded and have acquired a marked slaty structure in some sections. It weathers out to form thin, platy fragments, or, if the cleavage is well developed, it weathers into long, slender fragments ranging in size from a shoe peg to a whetstone. With the shales occur some shaly sandstones, which on weathering give a lighter, sandier soil than that derived from the argillaceous shales.

Under the weathering agents these shales have been worn away more slowly than the limestones. The Berks soils, therefore, occur from 50 to 100 feet higher than the Hagerstown soils, usually with a distinct terrace front facing out toward the limestone valley. In Cumberland County the Conodoguinet Creek follows the foot of this terrace from near Newville east to the Susquehanna River, its channel cutting back and forth across the junction of the limestone and shale. In Franklin County the Conococheague Creek follows

the same line from Red Bridge, north of Chambersburg, south to Stone Bridge Station. From this point south the stream flows through the shale area. In Path Valley and in Mifflin County the Berks soils also lie at a higher level than do the Hagerstown, but the terrace formation is not so evident.

The Berks soils occupy a sharply rolling region. The region has been cut by the numerous streams and drainage channels into a succession of steep, round-topped hills from 50 to 100 feet above the level of the streams. In Path Valley and in the Mifflin County area the soils occupy a more sloping position and are more eroded by local drainage channels.

Drainage over the area as a whole is good. The underlying shale rocks are usually so broken by joint and cleavage planes that the water readily seeps through. In some few areas, where the shales lie in a nearly horizontal position and a comparatively deep soil section has accumulated, drainage is not well established. This, however, is a very rare occurrence. Near the heads of some of the streams some small wet areas are found, produced largely by seepage from the higher levels.

Erosion is very active over the whole Berks area. The loose nature of the soil causes it to wash easily, and as a result the soil mass is never very deep. Usually the broken shale of the bedrock is within 24 to 36 inches of the surface, and on the steeper slopes and other exposed places the soil material is washed away almost as fast as formed. The control of this erosion is one of the most important difficulties to be overcome in the successful farming of these soils.

Three types have been found in the Berks series, although only the shale loam and silt loam are extensive. The loam type rarely appears. A brief description of these types follows.

The surface soil of the Berks shale loam consists of from 6 to 8 inches of a brown or yellowish-brown light silty loam, containing from 40 to 60 per cent of small shale fragments. The subsoil usually consists of a mass of broken shale fragments of small size, with a matrix of yellowish heavy silt loam or silty clay loam. With depth, the quantity of shale increases.

The Berks silt loam consists of a surface soil of brown or yellowish-brown silt loam 6 to 10 inches deep, resting on a yellowish-brown to yellow silty clay loam, which grows heavier with depth. The subsoil becomes stonier with depth and at from 18 to 30 inches grades into broken shale rock.

The surface soil of the Berks loam consists of 6 to 8 inches of a fine, light-yellow or yellow-brown loam containing in places considerable fine sand. The subsoil is a lighter colored loam or silty clay loam, grading into the usual broken rock well within the 3-foot section.

In the Cumberland Valley region the Berks series is known as the "slate land," as distinguished from the "limestone land" (Hagerstown), "gravel land" (Ledy), and "ironstone" (Montalto) that also occur in the valley. In Mifflin County the Berks series is known as the "slate" land or as "gravel" land, the terms being used by some to distinguish between the loam and shale loam types.

The shale loam is everywhere the most extensive type. Crops grown on this soil suffer severely from droughts, and protracted dry weather may cause complete failure of corn and potatoes. The soils are not inclined to bake or crust and can be readily plowed and reduced to excellent tilth even when in a very dry condition. Cultivating when wet does not harm the structure of these soils to any extent. They are usually deficient in organic matter, and care should be taken to maintain a good supply of humus material in the soil. Where barnyard manure is not available green cover crops, preferably legumes, should be plowed under. With a good supply of humus the soils are better able to carry crops through dry periods, and the larger water-holding capacity renders them less subject to damage from erosion.

The soils give good results with the general crops of the region, corn yielding from 50 to 75 bushels per acre, with 100-bushel yields not uncommon, oats from 25 to 35 bushels, wheat 18 to 20 and sometimes 30 bushels, and hay from 1½ to 2 tons per acre. Clover does well the first year after seeding, the second year's hay crop being mostly timothy. Meadows should not be left down over two years without special treatment, as they tend to run out. Potatoes do very well on these soils, especially on the shale loam, the average yields running from 125 to 175 bushels per acre, with yields of 200 to 250 bushels sometimes reported. For this crop a good supply of humus is necessary. A large application of fertilizer carrying from 3 to 4 per cent of nitrogen, 8 to 10 per cent of phosphoric acid, and 8 to 10 per cent of potash will give excellent results.

Fruit does well on the Berks soils in all the areas. The orchards need more care than is usually given in these regions to prevent losses by erosion and also in the way of fertilization and proper tillage. In the Cumberland Valley the development of fruit on the Berks series will be retarded by their nearness to the Montalto and Ledy soils, which are exceptionally well adapted to fruit and which are being widely exploited. In Path Valley and Mifflin County the distance to markets is a serious handicap.

Where market facilities are good, potatoes offer the best opportunities on this series. Care should be taken in the selection of seed, and the crop should be thoroughly cultivated and fertilized. The plants should be sprayed to prevent blight.

A three-year rotation of wheat, clover, and potatoes should give good results. If corn is to be grown it probably would be better to put the potatoes on the sod and grow corn on the potato ground. This is the reverse of the usual custom, but the advantages of planting the potatoes on a sod have been proven many times.

In most sections the Berks soils are benefited by applications of lime. This material should never be applied in very large quantities, as its use tends to reduce the humus content of the soil. From 1,000 to 2,000 pounds per acre applied at from 4 to 8 year intervals gives best results.

Because of the soft character of the shale, there is little wear and tear of tillage implements and plows, harrows, cultivators, etc., have a longer life on Berks soils than on Hagerstown or Dekalb soils. In many cases a shallow soil can be deepened and its crop-producing power increased by deep plowing, even though a large mass of the shale fragments be turned up. These fragments soften and weather quickly and soon form good soil material. Because of the soft nature of the soil and rock, lighter draft horses can be used on the Berks series than on the Hagerstown.

The Berks soils range in value from $40 to $80 an acre in Cumberland and Franklin Counties, depending on the condition of improvements and location. In the Path Valley, in Franklin County, values range from $30 to $50 an acre, the limestone land here being worth from $40 to $60 an acre. In Mifflin County the land is valued at from $30 to $60, depending on location and development of the land.

MONTALTO SOILS.

The Montalto soils occur in this area in two physiographic positions. One area lies along the western slope of South Mountain in Franklin County, with a few occurrences in the same position in Cumberland. It lies, therefore, in a somewhat debatable position on the boundary between the Limestone Valleys and Uplands and the Appalachian Mountains and Plateaus. These soils have not heretofore been mapped in either of the provinces named, so that at present they can not be regarded as typical. On account of their general character, however, and their occurrence only a short distance from typical Montalto soils in Adams County, it has been thought best to consider these as Montalto for the present, or until they have been studied further, rather than to give them a new name.

The true Montalto soils occur in the Piedmont Plateau province, east of South Mountain, and are therefore derived from the trap sheets and dikes occurring in the Triassic rocks of the northern Piedmont Plateau. They occur in a series of rather narrow belts, some of them continuous for long distances, others broken up into a large number of small areas, the whole area of occurrence having a north-

east-southwest trend. They extend from the Susquehanna River in the northwestern part of York County southwestward across Adams County to the State line in the southwestern part of the latter county. The greater part of these areas consists of one type, the Montalto clay loam. There are, however, a few small areas of the stony loam. These are described under the name Cecil by Mr. Wilder in his Adams County report, and from this report the following condensed descriptions are taken:

The surface soil of the Montalto clay loam to an average depth of 10 inches consists of reddish-yellow or light-brown clay loam. The subsoil consists of reddish-yellow or light-brown clay loam, grading into a clay in its lower depths. The subsoil often contains a considerable amount of particles of the disintegrated rocks from which the type is derived. This character of material may extend to a depth of 36 inches or more, but frequently the clay content decreases below 30 inches, and the amount of disintegrated rock particles increases until the underlying mass of stones and rocks is reached. From 10 to 30 per cent of stones and bowlders, principally syenite, are commonly present in both soil and subsoil, and spots are not infrequent which are very stony, but, in general, the amount of stones is not sufficient to interfere seriously with cultivation.

The Montalto clay loam as mapped presents a variation which, though usually small in extent, occurs in numerous instances. In nearly all parts of Adams County where this type has been mapped it includes areas of clay underlain by a stiff heavy clay. Such areas would have been mapped as Montalto clay had their extent warranted it.

The Montalto clay loam occurs in long strips, which extend entirely or partially across the central part of the county from northeast to southwest. This position and the topographic features of the type depend directly upon the nature of the intrusive dikes of trap rock, principally syenite. The surface features of the type range from moderately to steeply rolling, with but small areas of level land. It usually occupies entire dikes or the lower slopes of dikes of which the upper and steeper slopes and the summits are occupied by the Montalto stony loam, or Rough stony land.

Surface drainage is rapid with such topographic features, and small gullies are sometimes formed. Soil transportation steadily takes place, where gullies are not formed to an appreciable extent, and consequently the soil, as a rule, is much deeper on the lower and more gentle slopes than on the upper slopes and the summits of the hills and ridges. The heavy character of the subsoil makes it retentive of moisture, and this enables the type to withstand drought much more successfully than soils of the Penn series.

The Montalto clay loam is a good corn soil, and is much safer for that crop than the Penn shale loam, because it is much less susceptible to drought, though in favorable seasons there is little difference in yields. Good crops of wheat, oats, rye, and hay are also grown.

The surface soil of the Montalto stony loam to an average depth of 10 inches consists of heavy red loam or clay loam. The subsoil consists of light-red clay loam or clay, which usually grades heavier in texture with increasing distance from the surface, but in places it begins to grow lighter at a depth of 30 inches, and grades gradually into a mass of disintegrated syenitic rock. Both soil and subsoil contain from 30 to 60 per cent of stones and bowlders.

The Montalto stony loam occurs in small areas on the intrusive dikes which have cut across the county. The topographic features are always more or less

broken and hilly. The type often occupies the steep slopes at lower elevations than the Rough stony land.

Surface drainage is so rapid, on account of the physiographic features of the type, that washing often takes place on the cultivated fields. The subsoil is so retentive of moisture, however, that the type seldom suffers from drought. The Montalto stony loam is derived from syenite and also in a slight degree from the other metamorphic rocks of the intrusive dikes mentioned as giving the Montalto clay loam. A large part of the type is covered with forest growth, which consists largely of oak, with lesser amounts of chestnut and locust.

The least stony parts of the Montalto stony loam are adapted to the general farm crops of the region. The least stony areas are also well suited to the growing of apples, and where well drained offer good opportunities for the profitable development of this industry. The areas unsuited to the above uses can best serve as pasture or woodland.

In Franklin County the Montalto soils occupy a strip 2 to 3 miles wide, extending from just north of Waynesboro through Quincy and Guilford Townships, and ending against the mountain just north of Black Gap, in Greene Township. A detached area occurs at the foot of the mountain just east of Scotland. In Cumberland County the soils are developed in small, irregular bodies west of Mount Holly Springs and in a larger area south of Boiling Springs.

The soils in these two counties have been derived from the weathering of the ironstones, quartzites, cherts, and other metamorphic and sedimentary rocks of the mountains. From the prevalence of the so-called ironstones the series gets its local name of "ironstone land." The stone fragments are angular or rounded and show the wearing effect of transporting agencies. The larger part of the soil material is in place, but the portions lying farther from the foot of the mountain have been moved by colluvial wash and form a thick deposit over the underlying limestones. The sink holes that are so characteristic of the Ledy soils are very rarely found on the Montalto.

The Montalto soils of Franklin and Cumberland Counties are normally well drained, though some areas are affected by seepage from higher lands. Erosion, while active, is not severe. Continual transportation of soil material is going on, and unless this be checked gullies will be formed and considerable damage done on the steeper slopes. The soil has good water-holding capacity and crops do not readily suffer from drought.

The soil here is rather rich in iron, has a brownish or reddish yellow color, and is rather sticky when wet. Unless plowed in exactly the right state of moisture, the soil tends to stick to the moldboard, making plowing rather difficult. This characteristic is peculiar to the typical Montalto soils.

In Franklin and Cumberland Counties but two types were observed, loam and stony loam, the latter making up practically the entire area.

The loam consists of a yellow-brown or reddish-yellow gritty loam or sandy loam surface soil to a depth of 6 to 8 inches, resting on a loose, friable, reddish-yellow heavy loam subsoil, which grades into a somewhat sticky reddish clay loam or clay at depths of from 24 to 36 inches.

The surface soil of the Montalto stony loam consists of from 6 to 8 inches of a brown or reddish-yellow heavy loam, in places somewhat gritty or sandy, resting on a subsoil of reddish or yellowish-red, friable clay loam or clay. Both soil and subsoil contain from 30 to 60 per cent of angular ironstone and chert fragments, varying in size from small grains to rocks several inches across. Stones from 2 to 4 inches across are very numerous.

In both the loam and stony loam types the soil and subsoil have naturally a loose, friable, granular structure that is finely shown in the exposures along road and railroad cuts and on sides of gullies or ditches. When compacted the soil shows the presence of large quantities of clay and becomes sticky and plastic.

The soil gives excellent returns with the staple crops, corn, potatoes, wheat, and grass, though the very numerous stones make the proper tillage of crops rather difficult. The soils are especially adapted to the growth of fruit, apples and peaches doing exceptionally well, and in Franklin County a large proportion of the total area of these soils is devoted to fruit culture. Peaches and apples do well, and the fruit grown is of good color and quality. Most of the land is under cultivation, though there are still some wooded areas near the mountains. The land is held at from $75 to $300 an acre, depending on the condition of the soil and the extent of the development of the fruit industry in the neighborhood.

LEDY SOILS.

The Ledy soils occupy the band of gently rolling land sloping to the west and northwest from South Mountain in Franklin and Cumberland Counties. The series is not extensive, the largest area beginning near Fayetteville, in Franklin County, and extending north across the Cumberland County line near Shippensburg and thence in a narrowing strip east along the foot of the mountain. Other areas occur near Mount Holly Springs and near Williams Grove.

The soil occupies the same topographic positions as the Montalto soils, beginning at the foot of the steep, rocky slopes of the mountain and extending in an undulating slope to the depressed line where it joins the limestone soils of the Hagerstown series.

The soils are derived from the weathered remains of the mountain rocks that have been worked out from the foot of the mountain by the agents of erosion acting through a period of thousands of years. These rock fragments, composed mainly of sandstone and quartzite

fragments, with some chert and ironstones, form a deep deposit of material laid over the native limestones, though in places projecting spurs of the lime rock come so close to the surface as to alter the color and nature of the subsoil. The presence of the limestone beneath the Ledy soils is further shown by the numerous sink holes that dimple and pit the surface of the fields. This "dimpled" or pitted topography is a striking feature of this series of soils. Very few of the sink holes retain water, most of them having excellent subterranean drainage, and in most cases they are not so deep or steep sided as to interfere with the tillage of the rest of the field. The series is generally very well drained and is not subject to erosion, though around the rims of the deeper sink holes the local washing often exposes the subsoil.

The surface soil is yellow or brownish yellow in color, resting on a yellowish subsoil The soil and subsoil contain fairly large quantities of rock fragments, largely sandstone or quartzite in character, and nearly all showing by their rounded, worn angles the action of running water. Several types were recognized in the area.

The Ledy stony loam surface soil consists of from 4 to 8 inches of yellowish-brown rather sandy loam, resting on a yellow or reddish-yellow heavy loam grading into a clay loam. The subsoil contains considerable sand. The type is not extensive.

The Ledy loam surface soil consists of from 8 to 10 inches of a brown or yellowish-brown somewhat sandy loam, resting on a reddish yellow or yellow silty clay loam, grading into clay. Both soil and subsoil contain from 30 to 60 per cent of worn rock fragments. This is the most extensive type. The Ledy sandy loam consists of from 6 to 8 inches of a yellowish-brown heavy sandy loam, resting on a yellow clay loam or reddish-yellow clay. This type is next in importance to the stony loam.

The clay loam and clay have reddish-yellow surface soils of heavy loam or clay loam, resting on reddish-yellow to red clay subsoils. The surface soil of the clay loam is deeper than that of the clay. These types, more particularly the clay, occur in those places where the underlying limestones come close enough to the surface to influence the soil section.

The larger part of the series is farmed, though a considerable area in Franklin County is still in timber. The land is well adapted to apples and peaches. Corn, oats, wheat, and potatoes do well, but grass does not last, meadows and pastures tending to run out after a few seasons. In general the land is not as well developed as the Montalto soils, although there are some excellent farms and some commercial orchards of considerable size. The land is held at high values, from $100 to $300 an acre being asked, depending on location and development of the immediate region.

Locally the land is known as the "pine-belt" land, and until the recent development of the fruit industry has been considered of low value when compared with the excellent general farming soils of the limestone region. With the further extension of fruit growing the Ledy soils will become much better developed and of greater value. The soils have a tendency to be somewhat deficient in organic matter, and in order to obtain the best results the humus content must be carefully maintained.

DUFFIELD SOILS.

The Duffield soils are found only in Franklin County. They cover an area of about 22 square miles lying in Guilford, Quincy, and Washington Townships, between the towns of Fayetteville and Waynesboro.

The soils occupy a rolling area, sloping toward the streams and broken by steep hills and ridges. They are derived from the weathering of the calcareous shale and shaly limestones of the Elbrook formation (Chambersburg-Mercersburg folio of U. S. Geological Survey). This formation consists of layers of yellow, reddish, and some green shales, highly calcareous in nature and parted by layers of limestone, usually quite thin but sometimes thick and massive. On weathering these rocks give a brown or yellow-brown surface soil, which frequently contains a high percentage of shale fragments, and in places fragments of limestone. The subsoil is generally yellow or reddish yellow, though in places it is somewhat darker, owing to the presence of the bluish shales. Where the heavier layers of limestone have weathered to form the soil the subsoil is usually a red or reddish-yellow color.

The soils are naturally well drained and in general do not suffer from erosion. The silt loam is the predominating type, though there is a considerable area of loam in Guilford Township, where the soil seems to be derived largely from the sandy remains of a siliceous limestone. The soils of this particular section closely resemble those of the Dekalb series in color and character, but are much more productive.

The Duffield soils as a whole are considered equal in productiveness to the soils of the Hagerstown series. The soils are more easily tilled than the Hagerstown soils, owing to their higher sand content and looser structure. They retain moisture fairly well, and crops do not readily suffer from droughts. They give excellent yields of the general farm crops of the region, corn, oats, wheat, grass, and potatoes of a good quality. Land values are high, ranging from $100 to $150 an acre.

There were just two types noted, the loam and silt loam. The Duffield silt loam surface soil consists of 6 to 10 inches of a brown or

yellow-brown silt loam containing in places varying quantities of thin, platy fragments of calcareous shale and fragments of thin-bedded siliceous limestone. The subsoil is a yellow silty clay loam to a reddish-yellow silty clay, the red color being more pronounced where the soil is derived from the calcareous rocks. The surface soil of the Duffield loam consists of from 6 to 8 inches of yellow or yellowish-brown silty loam, sometimes rather sandy, resting on a subsoil of yellow silty clay loam. The subsoil usually grades into a mass of rotten shaly yellow sandstone or sandy shale, at depths of from 2 to 6 feet.

FRANKSTOWN STONY LOAM.

The Frankstown stony loam is of small extent in this area, though the soil occurs in most of the counties surveyed. It is shown on the map only in Bedford, Mifflin, and Snyder Counties, the other areas being too small to show on a map of this scale. The soils are derived from the water limes that adjoin the Lower Helderburg limestones, and usually lie on one slope of the limestone ridges derived from that formation. Because of the greater importance of the Hagerstown soils, wherever the occurrences were so narrow that the two series could not be shown separately both were combined and mapped as Hagerstown. In many cases the width of both series was too slight to be shown on the map.

The surface soil of the Frankstown stony loam consists of from 8 to 10 inches of a light-gray silt loam, underlain by a slightly yellowish silty clay loam, grading into a stiff yellowish clay or into a sandy clay loam at 30 to 36 inches. On the surface and in the soil mass occur from 30 to 75 per cent of angular chert and limestone fragments ranging in size from a walnut to the size of a man's fist. The soil is known by a number of local names in different regions, "bastard limestone," "firestone," and "gravel lands" being the commonest terms. Staple crops do well, corn yielding 40 to 50 bushels, oats 30 bushels, and wheat 12 to 20 bushels. Grass gives only three-fourths ton to 1½ tons. The soil is very well adapted to the growing of fruit, apples and peaches doing well. In some regions the land commands high prices, because of this adaptation to fruit.

The soil erodes readily, as it lies on slopes, and damage from this source is very pronounced. The soils are very low in humus content, and for good crop yields this must be supplied.

In Bedford County the Frankstown stony loam occurs in several large bodies, Chestnut Ridge, Black Oak Ridge, Beans Cove, and the areas near Otttown and Osterburg being shown on the map. The soil is extensively used for orchard sites. In Mifflin County the soil occupies the top of the ridge east and west of Lewistown; in

Snyder County it occupies a part of the ridge between Richfield and Freeburg, in West Perry, Perry, and Washington Townships. In other counties it exists as narrow bands associated with the Hagerstown soils and mapped with that series. With the increasing interest in fruit raising this soil should become of more importance to the farms on which it occurs.

CHESTER SOILS.

The Chester soils are found only in Adams County. They belong in the Piedmont Plateau province and are well developed in the northern portion of the Piedmont Plateau.

The soils are derived from metamorphic rocks, and in this area mainly mica and chlorite schists. They occur only in the extreme southeastern corner of the area and occupy moderately rolling areas of country.

The soils are generally well drained, surface drainage being rather too rapid in some cases. Only one type, the loam, is known to occur in this area. This type was mapped by Wilder and Belden in the soil survey of Adams County and is described in that report as follows:

> The surface soil of the Chester[1] loam to an average depth of 8 inches consists of medium light-brown loam, often containing a relatively high percentage of silt. This material is always mellow, and when not well moistened by rain it becomes light and fluffy. The subsoil consists of heavier loam than the soil, and with increasing depth the color grades from light brown to pale red or yellow. The subsoil contains varying quantities of mica particles, but always enough to give it the greasy feel characteristic of soils derived from rocks which carry a high percentage of mica. Good crops of corn, wheat, rye, and hay are obtained. Many small peach orchards are found on the Chester loam. Land can be bought with improvements at an average price of $40 an acre.

PENN SOILS.

The Penn soils are found in Adams and Cumberland Counties, forming the most extensive soil found in the former. There is but one area in Cumberland County, in the south extension of Upper Allen and Lower Allen Townships. The soil occupies broad, gently rolling areas and suffers little from erosion. As a whole drainage is good, though on some slopes seepage causes wet areas. The shale loam type, which is usually rather shallow, suffers from drought. The series is derived from the weathering of the red sandstones and shales of the Mesozoic age and the soils vary considerably in productive power, depending on the depth of the soil mass.

[1] Mapped as Cecil loam in the Adams County report.

Wilder, in his Adams County report, describes the types as follows:

The surface soil of the Penn shale loam consists of dark Indian-red loam from 8 to 10 inches deep. The subsoil consists of heavy Indian-red loam, silty loam, clay loam, or loam grading into clay loam. From 10 to 40 per cent of shale fragments occur in the surface soil, and the quantity always increases in the subsoil until it is impossible to bore at depths ranging from 12 to 36 inches. The Penn shale loam is used for the general system of farming which obtains throughout the area and is better adapted to this purpose than to the production of any special crop. Corn often suffers more from drought than do the cereal grains, because the latter are harvested in many seasons before dry weather has serious effect. The average yield of wheat is 15 bushels; oats, 30 bushels; shelled corn, 25 bushels; and hay 1½ tons per acre.

The surface soil of the Penn loam consists of dull-red or brown silty loam from 8 to 12 inches deep. The subsoil consists of heavy Indian-red or light-brown loam, which grades into red clay loam at depths ranging from 15 to 36 or more inches. The Penn loam is adapted to the general farm crops which are grown upon it, and as it is much less susceptible to drought than the Penn shale loam, it far surpasses the average of that type in the production of corn and is somewhat superior for the small grains and hay. Corn yields an average crop of 35 bushels, wheat 18 bushels, oats 35 bushels, and hay 1½ tons per acre.

The surface soil of the Penn sandy loam consists of light, medium, or heavy sandy loam, which ranges from coarse to fine in texture, from 6 to 15 inches deep. Its color is brown, Indian-red, or rarely yellow. From 10 to 30 per cent of sandstone fragments are not uncommon, but these are not a constant feature. The subsoil consists of a variety of materials, but is usually a loam or silt loam. The general farm crops of the area are grown upon this soil. Corn yields from 25 to 65 bushels of shelled grain, wheat from 12 to 25 bushels, oats 30 to 55 bushels, rye 15 to 30 bushels, and hay from 1 to 2 tons per acre. The type is well adapted to potatoes and early garden produce.

PORTERS SOILS.[1]

The Porters soils are found only in the South Mountains, in Adams, Cumberland, and Franklin Counties. The greater portion of the whole area is in Adams County. The soils are derived from gneiss, quartzite, and other metamorphic rocks that make up the greater portion of the south slope of South Mountain. In the more level areas the soil mass is wholly residual, but on the steeper slopes there has been some displacement of soil material, due to colluvial creep and wash.

The soils occupy the steep slopes, ridges, and gentler sloping foothills of the South Mountain range. There are few level areas in broad covers or on plateaulike elevations. The area is much broken by steep-sided hills and ridges of Rough stony land and by stream channels and gorges with rough stony walls. One isolated area,

[1] The Porters soils are now confined to soils with deep red color. They are the mountain representatives of the Cecil soils. In the detailed work of the future the mountain soils with yellowish subsoils will be differentiated from the Porters and placed in a new series and these South Mountain soils will be included in it.

mostly of Porters clay, is found on the Pigeon Hills, in Berwick Township, in eastern Adams County.

There are three types included in this area, Rough stony land, clay, and stony loam. Of these the Rough stony land is of no agricultural value, being simply areas of land too rough for cultivation. This type is generally in forest or in stump and brush land, and some sections are used as pasture.

In the Adams County report, by Henry J. Wilder, the following descriptions of the types are given:

The surface soil of Porters clay consists of heavy loam or clay loam, brown or dark-gray in color, from 6 to 15 inches deep. The subsoil consists of pale red or light-brown clay loam or clay. From 15 to 25 per cent of stones and angular rock fragments are usually present in both soil and subsoil, but they are never of sufficient size to materially impede cultivation. The surface drainage * * * is ample for most of the type. Small, unimportant level areas adjacent to the streams which drain the main valleys in the mountains are so wet as to be swampy, and small gullies are sometimes formed on the steepest slopes by surface washing.

The Porters clay is derived from rocks of Archean age, of which the South Mountains are composed, chiefly gneiss, orthofelsite, and quartzite. The Porters clay of the mountain areas is fairly well adapted to general farm crops, and where the type is sufficiently rolling to have adequate drainage it is well adapted to the production of apples and peaches. The copperstone phase and the adjoining part of the type along the lower mountain slopes are excellent soils for general farming and are also well adapted to fruit production. In the mountains the average yield of wheat is 14 bushels per acre, when it is not injured by the Hessian fly; rye, 12 bushels; and corn, 25 bushels. Grass generally grows short and thick, and the average yield of hay is three-fourths ton per acre. The lower portions along stream courses are too cold for the production of hay. On the "copperstone" and adjoining areas the average yield of shelled corn is 40 bushels, wheat 18 bushels, and hay 1 ton per acre.

The surface soil of the Porters stony loam consists of light to heavy brown loam or occasionally clay loam, from 8 to 12 inches deep. The immediate subsoil is heavy loam, but with increasing depth this material grades into a clay loam, which usually extends to a depth of 36 inches, though in places it is replaced by light-red clay at a depth of 30 inches. The stone content varies widely. The most level portions contain from 20 to 50 per cent of gneiss fragments, quartz conglomerate, etc., with but few large stones. The gneiss fragments are mostly small, and because of their presence this soil is usually termed "Mountain gravel land." The ridges and steep slopes are more stony than the areas just described, and the latter often lead to Rough stony land on higher slopes or the tops of hills and ridges. Numerous patches of Rock outcrop or Rough stony land are often found scattered about the steepest parts of the type.

Good surface drainage is provided for this type by its physiographic position, and in the steeper places the drainage is often excessive. Due to washing, crops are unable to withstand periods of drought.

The Porters stony loam is derived principally from the gneiss, orthofelsite, and quartz conglomerate rocks included in the South Mountain range. It seems eminently adapted to the production of apples and peaches, and several orchards have already been started. The trees thrive and fruit of excellent

quality is produced. Freight rates to the nearest cities are so high as to seriously interfere with the production of peaches on a large scale, and the steady spread of the San Jose scale will soon ruin the apple industry unless effective measures are used to combat this pest. Fair yields of the general farm crops are obtained. Corn averages 20 bushels, wheat 12 bushels, rye 12 bushels, and hay three-fourths of a ton per acre. The most stony and steepest places are often used as permanent pasture.

JEFFERSON SOILS.

The Jefferson soils are not extensively developed in this area. Small areas occur in Clearfield, Cambria, Somerset, and Franklin Counties, with isolated areas near Neffs Mills in Huntingdon County and McVeytown in Mifflin County. The soils occupy saucer-shaped depressions and colluvial terraces and are formed by the colluvial creep of the soil mass, aided by some alluvial wash. In the areas east of the Allegheny escarpment the soils occupy alluvial-colluvial terraces and are generally stony loams of low value. In the three western counties silt loams and clay loams are most prevalent and are of considerable value for crop growth. The soils have a tendency to clod, and care should be taken in handling them. They would be benefited by applications of lime and the incorporation of organic matter in the soil.

The modes of formation and character of these soils are well described in the report of the Reconnoissance Survey of Southwest Pennsylvania, pages 44 to 46.

TERRACE AND BOTTOM LAND SOILS.

In this area the Terrace and Bottom land soils fall into four series—the Huntington, Moshannon, Wheeling, and Holston. Meadow, or low, flat, poorly drained areas along streams, is also encountered, but in such small areas that it has not been separated, but included with the adjoining bottom or terrace series.

The streams are all swift flowing, with narrow valleys, and but small deposits of alluvial material have been made. The bottoms and terraces are often too narrow to be shown on the map. Where of sufficient importance they have been shown, even if necessary to exaggerate their size and extent. Often where a narrow Huntington bottom and a narrow Wheeling terrace occurred it was necessary to map both under the one color, indicating the most important one.

The Moshannon soils are composed of the dark Indian-red soils with red subsoils derived from reworked material from the Upshur soils. They occupy the narrow bottoms along the streams flowing through the Upshur regions and are found in several counties. They are developed to some extent along the tributaries of Bald

Eagle Creek in Center County, along the Raystown Branch of the Juniata and Aughwick Creek in Huntingdon and Fulton Counties, and along Buffalo and Sherman Creeks in Perry County. Some other smaller areas also exist.

The loam and fine sandy loam types are most prevalent.

The Moshannon loam consists of a dark-brown or Indian-red fine silty loam surface soil, 8 to 10 inches deep, resting on a dark-red silty clay loam subsoil.

The surface soil of the Moshannon fine sandy loam consists of 8 to 10 inches of a dark-brown or Indian-red fine sandy loam, resting on a sandy fine loam, which grows finer and heavier with depth.

The soils are excellent for grass and grain, and where well drained give good results with potatoes and truck crops. Where extensively developed and accessible they are valued at from $30 to $60 an acre.

The Huntington series is made up of the first bottom lands in the Dekalb, Hagerstown, and Berks areas and have yellow to brown surface soils with yellow, drab, or mottled subsoils. They are found in narrow strips along streams in all parts of the area, though nowhere are they extensively developed. The most important areas occur along the Juanita River in Blair and Huntingdon Counties and along the Susquehanna River in Snyder and Perry Counties. The soils vary greatly in texture, though the fine sandy loam and loam are the most extensive types. Where well drained the series is valuable for trucking, but owing to the danger from overflows it is usually in grass or pasture. The land varies in value according to location and condition and no averages can be given.

The Holston soils occur as second terrace soils along most of the larger streams except the Susquehanna. The largest areas occur along the Juniata River and along Penns and Buffalo Creeks. In many cases there are two terraces instead of one, the upper one being often more stony than the lower terrace.

A few small areas of Holston soils occur along the streams in Clearfield and Somerset Counties. These soils consist of light-yellowish to gray surface material, usually overlying pale-yellow or reddish-yellow subsoils. Rounded and subangular gravel, consisting of various kinds of rock, are scattered about on the surface and through the subsoil. The bedrock is generally encountered at no great depth. The soils occur as high noninundated terraces in the Appalachian province.

The soils are generally well drained and are above all but the highest floods. The types vary through a wide range, though fine sandy loams and loams are most prevalent. The soils are well adapted to the growth of grass and grain crops, and near the towns are extensively used for truck and potatoes. Land values vary,

depending on location and condition of the soils. Town sites are often laid where the junction of two streams has produced a Wheeling terrace, many of the larger towns of this area being so located.

The Wheeling soils occur as terrace soils along the Susquehanna River. They occur at a number of places, but the largest areas are in the neighborhood of Selinsgrove and Lewisburg. These soils are much like the Holston soils in all essential respects except that they have been derived in part from glacial material. Their agricultural value is much the same as these soils. The main reason for differentiating them is for purposes of classification on the basis of origin. They are good productive soils.

SUGGESTIONS FOR SOIL IMPROVEMENT.

Better tillage, the use of lime, and increased quantities of organic matter are the essential requirements for increasing the productiveness of the soils of the area.

With the exception of a few farms in the limestone valleys and in the most progressive communities in other sections, the land is not plowed and cultivated with sufficient thoroughness. Plowing and harrowing are not well done. Jointers or coulters on the plows are very little used, and as a result stubble, trash, and manure can not be well buried unless the soil mass is completely inverted. Plows should be used that will give the maximum amount of pulverization, reducing the soil mass to a fine granular condition, putting manure, stubble, weeds, etc., down where the harrow will not reach them and bring them to the surface. To do this a plow of a shape suited for the type being tilled must be used. The same type of plow will not give equally good results on sandy and clay soils.

Deeper plowing should be practiced. Instead of the 4 or 5 inches now customary, the soils should be plowed to 6 or 8 inches. This should be done gradually to avoid turning up too much raw subsoil at one time. This system would increase the feeding area of the plants, reduce erosion, and lessen the surface run-off by increasing the moisture-holding capacity of the soil, enabling crops better to resist drought.

Harrowing, especially in preparing land for wheat, should be more thorough. This will not only fine the soil and make an excellent seed bed, but will also leave a mulch that prevents the loss of water by evaporation.

In the subsequent tillage more thorough cultivation is necessary in all parts of the area. Crops are usually cultivated two or three times, then "laid by." While this is sufficient to keep down the weeds, it does not maintain a mulch that would prevent the evaporation of water. As a result the crops suffer severely during periods of drought. A satisfactory water supply throughout the growing

season is necessary to secure the best yields. To do this a surface covering of loose, dry earth, a mulch, must be maintained. This calls for shallow cultivation of corn, and especially of potatoes, every 10 days or 2 weeks. During the last two seasons the yields of corn and potatoes have fallen off materially, owing to dry weather, when with proper cultivation at least one-half this loss could have been avoided.

With the exception of some of the alluvial series, all of the soils of this survey are deficient in organic matter. This feature is most marked in the Dekalb, Berks, and Upshur soils and also apparent in the Hagerstown. Organic matter can be best supplied in the form of barnyard manure, but as this material is often lacking, systems of green manuring should be followed. Corn and potato ground should never be left bare during winter. Some crop, rye, cowhorn turnips, vetch, etc., should be grown and plowed down the next spring. This would not only add organic matter to the soil but would also serve to retard washing and erosion during the winter. Shorter rotations would also tend to reduce the drain on organic matter. Increase of the water-holding capacity of the soils could thus be secured, rendering them less susceptible to drought.

Another serious problem in the management of all the soils in this area is the control of erosion. Most of the land is hilly, and the rain water that flows from the surface carries away large quantities of soil material. Erosion is particularly severe on the Dekalb shale loam and active on all the types that occupy slopes. So accustomed have the farmers become to gullies and washes in their fields that they do not consider erosion a serious factor in the decrease of crop yields.

Contour farming, or laying out the work so that the rows will run around the slopes, and leave no furrows or channels up and down the hill, will serve to check erosion. Leaving strips of sod across the hill at intervals down the slopes will serve to check the flow of waters and prevent their cutting deep channels. Where a field is subject to sheet washing from a more level field above it, a ditch at the top of the slope to catch and carry the water away to a near-by drainage way is very effective. The ill effects of erosion can not be too generally emphasized, and every farmer on hilly land should constantly guard against it.

Practically all of the soils of the area are in need of lime. In order to get satisfactory results with clovers it is necessary to maintain the supply of lime in the soil. Alfalfa can not be grown unless there is a plentiful supply of this material present in the soil mass. Lime is also necessary for the proper growth and development of the beneficial bacteria in the soil, especially the nitrogen-fixing bacteria that serve to add that important element to the soil.

Over most of the region lime can be secured from local sources, as the outcrops of the Trenton, and especially those of the Lower Helderberg, afford extensive supplies of the raw limestone. Lime can usually be purchased at from $1.50 to $3 a ton at the numerous local kilns, and at a lower figure in carload lots. The three western counties—Clearfield, Cambria, and Somerset—are the only ones that have to ship lime in from outside points. In these counties its value is generally recognized.

Considerable quantities of hydrated lime, "prepared" lime, and "agricultural" lime are purchased at prices ranging from $6 to $9 per ton. Usually only 200 to 400 pounds per acre are used. At these prices farmers can not afford to purchase these preparations of finely pulverized water-slaked limes when lump lime or ground limestone can be had at less than one-half the price. More thorough study should be made into the different forms of lime and their relative values.

In some sections applications of 200 or more bushels are made once in 10 or 20 years. A better method is to apply 25 or 30 bushels every 4 to 6 years, preferably on the corn or wheat ground. This would keep the land sweet and yet not "burn out" the organic matter. Lime is not a fertilizer and should not be considered as such. Its use alone, even though it at first increases the crop yields, will ultimately reduce the productiveness of the soil. Where lime is used it is especially important to keep up the supply of organic matter by the use of manure or green crops plowed under.

Fertilizers are used in small quantities throughout the region covered by the survey, but in nearly all cases the form or brand to be used depends on the price. Few farmers recognize the need of knowing the analyses of the fertilizers they are purchasing or the effect of the different elements in promoting plant growth. As a whole the soils need phosphoric acid more than any other element, though many of them lack potash and nitrogen as well. Farmers should study these elements and the forms in which they are sold, and when purchasing fertilizers should buy with the idea of applying certain quantities of nitrogen, phosphoric acid, and potash per acre rather than of applying 200 pounds of some particular brand. The practice of the home mixing of fertilizers will become extended as the farmers learn more of their actual composition, and this will undoubtedly save a part of the present fertilizer expense.

Fertilizers are generally applied to the grain crops and to corn, but little is ever used on the mowing lands. In the hillier sections, where erosion is severe and it is necessary to keep the land in grass as long as possible, fertilizing will undoubtedly pay.

More attention should be given to rotations and to the working out of suitable systems of cropping and fertilizing the land so as to keep

up the crop yields without reducing the inherent fertility of the soil. The standard rotation of corn, oats, wheat, then grass for two years, is generally practiced wherever any rotation is followed. There is no doubt that for some regions better rotations could be found, more suited to the ability of the soil and to the demands of the crops and the markets for which they are grown.

The raising of more stock on the farm to consume roughage and make manure and to supply a more "finished" product to sell would undoubtedly pay well. Those sections that are interested in dairying show marked increases in soil fertility and in the general prosperity of the farmers. Dairying, selling milk or cream, or making butter or cheese on the farm will prove one of the most profitable lines of farming in the section where pasture is ample and roughage can be readily grown. Hogs are a very profitable form of stock, especially on dairy farms, where they will consume much that otherwise would be wasted. Sheep raising could well be extended in most of the area, especially in the hillier regions, where pasturage is plentiful but where the soils can not be plowed on account of erosion.

If the proper use were made of pasture land and none but high-grade animals grown, beef cattle could be made a profitable industry in this region. In the sections of the State where corn crops are large and considerable corn stover is grown the practice of purchasing steers for winter feeding should prove profitable.

In order to get the full benefits from the feeding of farm animals the manure should be carefully saved. Under present conditions practically all of the liquid manure is lost, and much of the value of the solid is lost by leeching in the barnyards. Tight floors, preferably of cement, would save the liquid manure, and a good manure shed, or better, the practice of daily hauling the manure and spreading it on the field would reduce the other losses.

There are excellent opportunities in this region for the development of the truck and gardening industries. There is a good local demand for potatoes, cabbage, and other vegetables over the whole area, and in most cases shipping facilities to the East and West are excellent.

Potatoes could be made a very profitable crop if their culture were better understood and they were better cared for. Union and Cumberland Counties have the reputation of raising large quantities of good quality potatoes, but in neither of these counties do the farmers use the best methods in caring for the crop.

A good deal of interest is being shown in the development of the fruit industry in the area, and many extensive plantings of apples and peaches are being made. It must be remembered that the fruit industry demands special knowledge and ability, and that in order to succeed the varieties must be planted on soils that are suited to their

needs. There are excellent opportunities to make money growing apples and peaches, but before investing money in an orchard one should make sure that soil and climatic conditions are right and that he is planting the varieties best suited to the locality. Information on this point can be secured from the experiment station and from the Department of Agriculture.

Labor is one of the most difficult farm problems. It is not that the compensation demanded is too high, but that the laborers are scarce and generally incompetent. It is believed that under a more efficient system of management, whereby the man could be given work the whole year, a good class of farm help could be secured.

Throughout the area one is impressed with the fact that the best care is not taken of the farm machinery, fences, and buildings. This is especially true in the Dekalb regions, where buildings are generally unpainted and where machinery is often left standing in the field where last used until again needed. Even such expensive implements as binders and other harvesting machinery are often left in the fields, orchard, or barn lot, exposed to snow and rain. The proper housing of tools, with care to keep them painted, oiled, and in repair, will materially reduce the cost of running the farm, and annual care and repair of fences and buildings will not only improve the looks of the farms but also prevent possible loss and damage.

SUMMARY.

Sixteen counties of south-central Pennsylvania, embracing an area of 10,908 square miles, were surveyed.

The area includes parts of the following physiographic provinces: Allegheny Plateau, the Appalachian Mountains, and the Piedmont Plateau, covering a wide range of geological formations and topography.

Eighteen series were mapped: 11 residual soils, the Dekalb, derived from sandstones and shales; Upshur, red soils, from red sandstones and shales; Hagerstown soils, from limestones; Berks soils, from soft shales; Frankstown stony loam, from impure limestones; Colyer silt loam, from soft black shales; Morrison soils, in the "Barrens"; Duffield soils, from the limestone and shales; Penn soils, from the dark-red sandstone; Chester soils, from the metamorphic rocks; and Porters soils, from the metamorphic rocks and sandstones; two colluvial-residual soils, the Montalto and Ledy, from the mixed residual and colluvial creep material; one alluvial-colluvial soil, the Jefferson; and four terrace and bottom series, the Wheeling, Holston, Huntington, and Moshannon.

The soils vary greatly in fertility, those of the Hagerstown and Berks series being the most productive.

All are subject to severe erosion, and nearly all are deficient in organic matter and lime.

Several are well adapted to the production of fruit of various kinds.

When well handled, most of the soils will give good results with the general farm crops.

Dairying can be made very profitable in some sections.

Stock raising is the most profitable industry in the more remote sections, while gardening and trucking could be carried on profitably near the larger cities.

There is ample room for improvement in all lines of farm work, tillage, fertilization, rotations, management, etc.

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