

## SOIL SURVEY OF LANCASTER COUNTY, PENNSYLVANIA.

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### DESCRIPTION OF THE AREA.

Lancaster County, Pa., is located in the southeastern part of the State. It is irregular in outline; its greatest length from east to west is approximately 46 miles, and its greatest width from north to south about 40 miles. The county is bounded on the south by the State of Maryland, on the southwest by York County, from which it is separated by the Susquehanna River, on the northwest by Dauphin and Lebanon Counties, on the northeast by Berks County, and on the southeast by Chester County. Lancaster County has an area of 941 square miles, or 602,240 acres.

Physiographically, Lancaster County consists of a central valley or lowland occupying about 50 per cent of its total area, surrounded on all sides by highland, except where narrow belts of the lowland project from the main area and extend to or beyond the county line. Projecting into the main area of the valley are a number of tongues of the highland which give the lowland, in combination with the narrow belts of the latter which extend beyond the main body, an irregular boundary line. The three valleys or belts of lowland which extend across the county line are what will be called the Churchtown belt running northeastward from the eastern part of the county, the Little Valley belt running northeastward from Quarryville in the southern part of the county, and the York or Columbia belt extending across the Susquehanna River at Columbia and southwestward to York and beyond. The northern part of the main central lowland area is separated from the larger portion by a low ridge extending from the northern border ridge near Manheim eastward past Kisselhill and Ephrata to the main border ridge again. It is broken near Lititz, the gap connecting the main valley with the nearly isolated northern portion.

The relief of the valley floors is low, as well as the elevation above sea level. The local range of elevation is rarely as much as 100

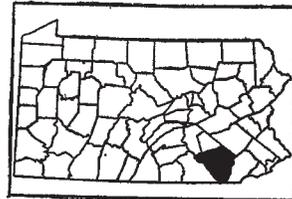


FIG. 3.—Sketch map showing location of the Lancaster County area, Pennsylvania.

feet, except in the narrow belts along the larger creeks and along the Susquehanna. The surface is typically undulating to gently rolling, none of it too flat for good surface drainage and rarely so steep as to erode seriously if cultivated. These areas are typical of old-age topography, in which all trace of original surface features has disappeared, but one that has not yet reached so flat and featureless a form that surface forces have become stagnant.

The boundary highland belts on the north and east are belts of hill land standing from 200 to 600 feet or more above the floor of the central lowland, though they are traversed by creek valleys lying at much lower levels. The topography is best described as hilly, the hilliness being due mainly to valley cutting alone, though varying resistance of the rocks to erosion has been a factor in some cases. There is no strong suggestion of high plateau topography since the extremes on general ridge-top levels are not uniform in height. They are broad, uneven, somewhat irregular ridges that have been thoroughly dissected. They range in elevation from a little more than 500 feet along the northwestern to about 1,000 feet along the eastern part of the county. The dissection is thorough and cut to a depth ranging from 350 feet to about 600 feet. Much of the area is not too rough for cultivation, yet the danger of erosion is much greater than in the central lowland.

The southern border highland is a low plateau sloping southward, with an even plateau elevation that has been thoroughly dissected, but not enough to destroy the evidence of its plateaulike surface. Its elevation along the northern boundary ranges from about 800 feet on the eastern line of the county northeast of Quarryville to about 400 feet near Safe Harbor on the Susquehanna, and to about 200 feet on the Maryland State line. It rises rather more abruptly from the central valley along its northern boundary than the other border highlands and has a nearer even topped upland surface. The dissection is complete, though sharper near the Susquehanna River. In general, the greater part of its area is strongly rolling and most of it cultivated, though it is much more liable to erosion than the central lowland.

Lancaster County lies entirely within the drainage basin of the Susquehanna River, and the general direction of the drainage is toward the southwest. A complete system of meandering, sluggish tributaries to the river indicates the maturity of the regional drainage. The streams flowing through the valley lands are particularly slow and carry larger quantities of suspended materials. Within areas of higher elevation or rougher topography the streams, though still relatively swift flowing, have cut deep, V-shaped, and gorge-like valleys, and there are no broad areas of bottom land. This is especially true of those streams draining the southern plateau.

Practically all the streams are perennial, and an abundance of water for live stock is available in all parts of the county. Water power was used early in the history of Lancaster County along many of the smaller streams, mainly for flour milling. The water power afforded by the Susquehanna River has been developed near McCalls Ferry.

The earliest settlers in Lancaster County were the Swiss Menonites, who procured a warrant from William Penn for 10,000 acres of land in this region in 1710.<sup>1</sup> They settled in the vicinity of Willow Street. Later German and French immigrants settled in this vicinity, and still later some English, Scotch-Irish, and Friends, or Quakers, took up lands within what is now Lancaster County. The Swiss and German immigrants settled in the rich, heavily forested limestone valleys, while the Scotch-Irish selected the hills in the southern part of the county. The present population is predominantly German, many of the people being direct descendants of the early German settlers. There are a large number of descendants of the early Scotch-Irish settlers, however, in the southern part of the county.

Lancaster County was set off from Chester County in 1729, and originally included part of the present area of York County. The population is reported in the 1910 census as 167,029, this being one of the most densely populated counties in the State. Lancaster County ranks first among the counties of the State in agricultural wealth and is noted also for the diversity and wealth of its manufacturing enterprises. In addition to the important manufacturing industries at Lancaster City, many small manufacturing establishments are scattered throughout the county. Among the larger towns affording good local markets for farm produce are Lancaster, Columbia, Marietta, Elizabethtown, Manheim, Lititz, Ephrata, Millersville, New Holland, Christiana, and Quarryville.

The main line of the Pennsylvania Railroad passes through Lancaster, entering the county near Elizabethtown and leaving at Christiana. The Columbia and the Philadelphia, Baltimore & Washington branches traverse the county from north to south, extending along the Susquehanna River. The Atglen and Susquehanna Branch, extending across the county from east to west, is used mainly by heavy freight trains. Short branches of the Pennsylvania Railroad and several branch lines of the Philadelphia & Reading Railroad afford abundant transportation facilities. The southern part of the county is reached by the Lancaster, Oxford & Southern Railroad (narrow gauge), which connects with the Quarryville branch of the Pennsylvania Railroad at Quarryville. Shipping points are accessible to all the farms in the county.

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<sup>1</sup> Histories of Lancaster County by J. J. Mombert, and by Evans and Ellis.

In addition to the steam railroads, electric lines radiate from Lancaster, extending to all the more important towns of the county. Freight and express service are furnished to farmers living along these lines, in addition to good passenger service.

The public wagon roads, as a whole, are fair. Turnpikes, or toll roads, have been built from Lancaster in all directions to the neighboring towns, and these are good highways for wagons and automobiles. Only a few miles of macadamized State roads have been constructed, but plans are made for their extension. The poor condition of dirt roads in the remote parts of the county, particularly in the hilly regions, makes the cost of hauling both to and from markets high and limits the use of lime and fertilizers.

Nearly all farms are reached by rural mail delivery, and telephones are in general use throughout the county. All sections are well supplied with good schools and churches, the buildings being substantial and in many cases built of brick or stone.

Lancaster is the most important local market. The public markets at Lancaster are said to be the most extensive of their kind in the country. At these markets the farmers sell direct to the consumer. Harrisburg, Philadelphia, Baltimore, and other large eastern cities constitute good markets for Lancaster County products.

#### CLIMATE.

Lancaster County has a healthful and temperate climate. Prolonged hot or sultry periods and extremely cold winters are rare. The cold of winter is seldom severe enough to injure fruit trees of any kind or to cause the freezing out of clover except on the lower and heavier types of soil. The mean annual temperature is reported at Ephrata as 51° F. and at Harrisburg as 51.6° F.

The average annual rainfall is reported as 41.14 inches at Ephrata and 36.93 inches at Harrisburg. The precipitation is well distributed throughout the year, so that crops seldom suffer from drought or excessive moisture. Only crops grown on the more excessively drained soils suffer from the occasional short periods of summer drought.

The average date of the last killing frost in the spring is reported at Ephrata as May 3 and of the first in the fall October 15. The latest date of killing frost recorded in the spring is May 29 and the earliest date recorded in the fall September 22. At Harrisburg the average date of the last killing frost in the spring is given as April 10 and of the first in the fall October 23, while the latest date in the spring recorded is April 26 and the earliest in the fall October 3.

The tables below give the normal monthly, seasonal, and annual temperature and precipitation at Harrisburg, in Dauphin County,

and at Ephrata, in Lancaster County. The records of the Ephrata station represent the climatic conditions of the greater part of Lancaster County.

*Normal monthly, seasonal, and annual temperature and precipitation at Harrisburg, Dauphin County, and Ephrata, Lancaster County.*

Month.	Harrisburg.							Ephrata.	
	Temperature.			Precipitation.				Temperature.	Precipitation.
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.	Mean.	Mean.
	° F.	° F.	° F.	Inches.	Inches.	Inches.	Inches.	° F.	Inches.
December.....	32.8	62	4	2.76	3.38	2.11	5.6	30.2	3.57
January.....	28.7	67	-5	2.74	3.80	2.86	7.7	27.0	3.00
February.....	29.9	74	-13	2.81	.54	1.48	10.4	27.4	3.44
Winter.....	30.5	74	13	8.31	7.72	6.45	23.7	28.2	10.01
March.....	37.8	84	5	3.19	1.94	3.26	7.4	39.9	2.99
April.....	50.7	92	22	2.41	3.67	3.96	1.0	49.8	3.12
May.....	61.7	95	34	3.68	1.98	9.51	0.0	60.7	3.15
Spring.....	50.1	95	5	9.28	7.59	16.73	8.4	50.1	9.26
June.....	70.3	97	43	3.37	1.66	7.18	0.0	68.5	4.32
July.....	74.5	101	50	3.87	1.16	8.68	0.0	74.6	4.40
August.....	72.1	98	50	3.96	2.36	3.58	0.0	70.6	4.63
Summer.....	72.3	101	43	11.20	5.18	19.44	0.0	71.2	13.35
September.....	64.9	95	36	2.88	2.18	4.53	0.0	66.5	3.48
October.....	54.0	88	28	3.00	1.63	3.33	0.0	54.4	3.06
November.....	41.7	75	11	2.26	1.72	6.59	1.5	42.1	1.98
Fall.....	53.5	95	11	8.14	5.53	14.45	1.5	54.3	8.52
Year.....	51.6	101	-13	36.93	26.02	57.07	33.6	51.0	41.14

AGRICULTURE.

Lancaster is one of the older agricultural counties of the country and has long ranked as one of the leading general farming communities in which intensive farming methods are employed. Agriculture has been the most important industry from the time of earliest settlement.

Corn, wheat, hay, and tobacco have been the principal crops for a long time. According to the census the acreage and yield of corn, wheat, and hay were practically the same in 1909 as in 1879. The acreage of tobacco, however, for 1909 was double that of 1879, the acreage of potatoes three times as much, while the acreage of oats and rye showed considerable decrease between these dates. The

table below gives the acreage and yield of the principal crops as given by the censuses of 1880 and 1910:

*Acreage and yield of principal crops in Lancaster County, 1880 and 1910.*

Crops.	1880				1910			
	Total area.	Total production.	Average yield per acre.	Average yield per acre for State.	Total area.	Total production.	Average yield per acre.	Average yield per acre for State.
	<i>Acres.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Acres.</i>	<i>Bushels.</i>	<i>Bushels.</i>	<i>Bushels.</i>
Corn <sup>1</sup> .....	80, 284	3, 293, 292	41. 2	31. 0	80, 825	3, 825, 787	40. 7	41. 0
Wheat.....	108, 277	1, 929, 767	17. 8	12. 6	115, 568	2, 532, 406	21. 9	17. 8
Oats.....	44, 613	1, 412, 694	31. 7	28. 1	20, 093	622, 401	30. 9	35. 2
Rye.....	6, 751	77, 818	11. 5	10. 6	3, 583	62, 879	17. 5	17. 0
Potatoes.....	4, 690	345, 675	73. 7	72. 0	12, 654	831, 723	65. 7	88. 0
		<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>		<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
Tobacco.....	16, 992	23, 946, 326	1, 409. 2	1, 213. 0	32, 783	36, 892, 869	1, 128. 4	1, 500. 0
		<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>		<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>
Hay.....	105, 858	117, 059	1. 1	1. 15	108, 672	140, 181	1. 2	1. 38

<sup>1</sup> The yields of corn are given in bushels of shelled corn wherever mentioned in this report.

The number of cattle sold or slaughtered in this county, according to the last census, was 58,702, while the corresponding number for hogs was 79,729.

The census gave the value of the farm products for 1909 as \$20,756,473. The principal items constituting this total were as follows: Cereals, \$5,459,810; hay and forage, \$2,287,361; vegetables, \$1,137,034; other crops consisting chiefly of tobacco, \$4,175,383; animals sold or slaughtered, \$3,670,272; dairy products, excluding home use, \$2,343,594; and poultry and eggs, \$1,679,466.

The present system of agriculture consists of general farming, with some dependent live-stock industries and the raising of vegetables. Corn, wheat, tobacco, hay (chiefly timothy and clover), and potatoes are the principal crops. Oats, rye, millet, and a few other crops are grown, but these are of relatively little importance in the agriculture of the area. Apples, peaches, cherries, berries (raspberries, dewberries, blackberries, and strawberries) are grown in a small way on many farms and all of these products are sold to some extent, but there are few farms on which such crops constitute the principal products. Of the vegetables grown for market the Irish potato leads. Dairying and the fattening of beef cattle are the live-stock industries affording greatest income. Many farmers raise a few hogs for their own use, and occasionally sell some fresh pork and a few live hogs.

Wheat was one of the first grain crops grown in the county. It is at present the most important, and is a valuable money crop.

Spelt was grown in the early period of settlement and was not replaced by the common bread wheats until about a century after the first settlements were made. Fultz, Fulcaster, Poole, and "No. 10" are the most common varieties of bread wheats. The Fulcaster was developed in Lancaster County. Wheat is widely distributed through the county, being grown on all the soils, but most extensively on the Hagerstown, Manor, Chester, and Berks. In the rotation wheat follows corn and tobacco. The corn stubble is commonly plowed under and the ground rolled for wheat, but the land from which tobacco has been harvested is disked, affording a good, firm seed bed for the grain crop. Fertilizer analyzing about 2-8-2 is applied at the rate of 200 to 600 pounds per acre. The yields vary from about 15 bushels on the soils less well adapted to the crop to 40 or 45 bushels on the Hagerstown soils. The average for the county is about 23 bushels per acre. The Hessian fly does considerable damage to the wheat crop. This crop ranks next to tobacco in point of income received through direct sale.

The area in corn is about 35,000 acres less than the acreage devoted to wheat. Corn gives heavy yields on most of the soils and is widely distributed through the county. The yields range from 25 or 30 bushels per acre on the poorer soils to 125 bushels on the Hagerstown soils. The average yield for the county is something over 40 bushels per acre. The corn is principally of the yellow dent varieties. Practically all the corn is husked and fed on the farms. The stover is usually shredded.

Tobacco was introduced early in the history of the county and for many years has been an important source of income. This is the leading tobacco-producing county in Pennsylvania. The Pennsylvania Seedleaf and the Pennsylvania Havana are the varieties grown. It is said that imported seed soon develops plants having the broad leaves characteristic of the Seedleaf variety and will, in a few generations, assume the flavor and aroma of the Pennsylvania tobaccos. Tobacco is grown most extensively on the soils of the Hagerstown, Conestoga, Manor, Chester, and Elk series. The crop is widely distributed, being grown to some extent on practically all the soils in the county. The Hagerstown soils produce as high as 2,500 pounds per acre, while some of the other types used, those not derived from limestone, produce as low as 900 pounds. The average yield for the county is about 1,300 pounds per acre. The leaf is used almost entirely for cigar filler and binder. Formerly some wrapper leaf was grown. The tobacco fields range in size from 2 or 3 acres to about 20 acres. The tobacco transplanter is in general use, and considerable hand labor is also employed in the production of this crop.

Irish potatoes are grown on all farms for home use; on some farms they are grown on a commercial scale and have a definite place in the rotation. This crop has supplanted tobacco to a considerable extent on some farms, in the last few years, as a money crop. The Manor loam, Chester loam, Berks shale loam, and Hagerstown silt loam are the soils most used for potatoes. These types produce yields of 90 to 300 bushels per acre in favorable seasons. The average yield on all soils for a period of years is about 80 bushels per acre. The fields range in size from about 2 to 15 or 20 acres. The State of Maine, State of Washington, Sir Walter Raleigh, and Green Mountain are the favorite varieties.

The acreage in oats has gradually decreased. Oats do well on nearly all the soils, yielding from 30 to 60 bushels per acre, but this crop is considered less profitable than wheat. The fields are small, and the crop does not have a definite place in the rotation except on a few farms. The grain is grown for feed. The crop is less heavily fertilized than other grain crops.

Like oats, the acreage planted to rye has decreased, though this has never been an important crop. Rye is confined mainly to the lighter soils of the Penn series. The fields are small and scattered. The grain is used for feed on the farms.

Buckwheat is grown to a very small extent on the Manor and Chester loams in the southern part of the county. The fields are small and scattered. The average yield is about 14 bushels per acre. The grain is grown for home use.

Millet is sometimes sown after oats, the green forage being used for dairy stock to supplement pasturage in the latter part of the season.

Of the hay crops grown, mixed red clover and timothy constitutes about 90 per cent of the total. This mixture has been the most important hay crop since the early settlement of the county. More clover is grown than all other legumes combined. Under the present system of farm management clover gives good yields on nearly all the soils of the county, but the Hagerstown, Conestoga, Manor, and Chester soils give most satisfactory results. Practically all the soils need liming in preparation for clover. A good stand is usually obtained with little difficulty, except on some of the hillsides and in a few places where underdrainage is poor. Timothy is more successful than clover on thin and stony soils, as in areas of the Lehigh, Penn, and Montalto. The greater part of the hay is fed on the farms. Wild carrot and ragweed are rather serious weed pests.

Alfalfa was not introduced into the county until about 1900. The census of 1910 gives the number of acres in alfalfa as 544, with an average yield of less than 2 tons per acre.

Orcharding on a commercial scale was not taken up in the county until recently. A number of apple orchards have been set out on

areas of the Edgemont, Manor, and Montalto soils. Nearly all farms have small orchards of apples, pears, peaches, and cherries which supply the home demand and frequently small quantities of fruit for local markets. Seedling cherry trees occur on all the soils along roads and fence rows. The lighter and more stony soils of the Manor series seem to be particularly well adapted to peaches, and peach trees have been set out on some of the rough, hilly land along the Susquehanna River, where the elevation and air drainage are such as practically to eliminate the danger from late frosts in the spring. Successful peach orchards are located on the Manor loam near Refton and southeast of Columbia and on Bunker Hill. Peaches will succeed on all the soils in the county, except the bottom lands, but are more uncertain on other soils than on those of the Manor series. Elberta, Carman, and Belle of Georgia are the most common varieties of peaches grown. Land devoted to peaches sells at from \$10 to \$50 an acre.

The most common varieties of apples are the Smokehouse, Stayman Winesap, Grimes Golden, Fallawater, Jonathan, Baldwin, York Imperial, and Black Twig. Commercial orchards have recently been set out on the Edgemont stony loam at the top of Welsh Mountain and on the Montalto loam in the northwestern part of the county. Nearly all the farm orchards include a few pear trees.

Small fruit and vegetables are grown on many farms in conjunction with general farming, and in the aggregate are of some importance in the agriculture of the county. Strawberries are grown successfully on the lighter soils of the Penn series and on the Manor loam. Strawberry patches of 1 acre to 3 acres are common near Bunker Hill. The Lehigh soils are well suited to strawberries. Raspberries and blackberries do well on the stonier and lighter soils, which are not well adapted to the general farm crops. The small fruits are grown mainly to supply the local markets.

Sweet potatoes and broom corn are grown on nearly every farm. These are grown for home use, and a small surplus is sold in the local markets.

Dairying is confined to the more hilly soils, particularly to the Manor and Chester soils in the southern part of the county. There are a few large dairy herds in the county, and each farm has from 8 to 15 cows during a part of the year. The common practice is to buy the cows from drovers at the season when they can be pastured to best advantage, that is, immediately after the hay and wheat harvest. Grade Holsteins, Guernseys, Jerseys, and milking shorthorns predominate. The cows are fed through the winter and sold in the spring for beef. Very little stock is raised on the farms. Dairying is, in the main, carried on as an adjunct to general farming, and the manure is used on cultivated fields. The city of Lancaster is a

good local market for dairy products, and butter is shipped to Philadelphia and New York. In 1914 50 cooperative creameries were in operation in Lancaster County, producing from 40,000 to 60,000 pounds of butter during the summer months. Little winter milk is produced at present, but ensilage is coming into more general use and it is probable that more winter milk will be produced in the future.

Throughout the central part of the county, particularly on the Hagerstown soils, dairying receives less attention, but the fattening of beef stock through the winter to be sold in the spring is important. Although there seems to be little actual profit to be gained by this practice it seems to be a highly satisfactory method of using the roughage and other feedstuffs on the farms and producing manure. The greater part of the beef stock is purchased at the stockyards in Lancaster, where 100 to 400 cars per week of stockers and feeders are handled. The lean animals are shipped mainly from Buffalo, N. Y., and from Ohio, Maryland, and farther south.

Hog raising is not a special industry in any part of the county, but hogs for home butchering are kept on most of the farms having dairy herds. Sheep are pastured in the poorest and most hilly sections of the county. Practically all the horses are purchased from outside the county, only a few colts being raised.

Soil and topography have strongly influenced the agriculture of the area. The productive, smooth limestone soils of the valleys are all under cultivation, being devoted to a highly developed type of general farming. In the higher country to the north and south of the limestone valleys fields in cultivation are progressively more scattered as the surface becomes more rolling, and the rougher areas are either forested or used chiefly for pasture. The yields over this higher country, where the soils are derived from rocks such as sandstone, quartzite, shale, gneiss, and diabase (other rocks than limestone), are lighter and the type of farming prevailing is not so intensive.

In the use of the soils of this area much attention is paid to the character of the soil and other conditions in the matter of the crops grown. The rich, limestone-valley soils (Hagerstown and Conestoga) are used for the general farm crops, and also preference is given them for tobacco. On the other hand, the more rolling, thinner soils of the highlands are not so much sought for general farming. Here relatively more attention is given to live-stock industries and fruit production. The wet bottom lands are used for grass. A great many farmers, however, grow all crops on nearly all types of soil. In many instances this is done because soils that in other sections of the county are used with especially good results for certain crops do not occur, or occur only to a small extent, on the farm.

Near the larger towns market gardening is carried on to some extent.

In the manipulation of the soil the land is generally plowed deep and seasonably, while cultivation is performed at frequent intervals, usually with shallow-running implements. Good teams and efficient up-to-date farm machinery are in general use. The barns and out-buildings are prevaillingly large, providing plenty of storage room for feed and shelter for stock. Silos are coming into general use.

There is little doubt that the systems of crop rotation, which have been generally followed for many years, have been the chief means of maintaining the high state of productiveness of the soils. Generally a 4-year or 5-year rotation is practiced, and on some soils a 6-year rotation is used. Wheat, while a valuable money crop on many soils, is frequently grown mainly as a nurse crop. The grass land is plowed for corn, which is rarely grown more than one year. This is followed by tobacco one year, then wheat one year, seeded to timothy and clover. In the 5-year system the land is allowed to remain in sod two years, when it is again plowed for corn. In the 6-year rotation, which is rarely used, both wheat and grass are grown two years in succession. In a 3-year rotation, practiced on some of the smaller farms, the grass land is planted to corn and tobacco, or to corn alone, followed by wheat. This system is generally considered undesirable on account of the increased danger from cutworms when tobacco follows sod. Where potatoes have a regular place in the rotation they follow corn, and rarely sod, the fields sometimes being divided between tobacco and potatoes. Oats, when grown, follow corn.

The use of lime is general throughout the county. It is applied at the rate of 20 to 70 bushels per acre once in the course of a 4-year or 5-year rotation. The quantity of lime used depends mainly on the character of the soil, and partly on the distance it must be hauled. It is possible that smaller quantities of lime should be used on some soils and applied oftener. Ground limestone and pulverized lime are coming into more general use than formerly. The local limestone is, for the most part, suitable for burning, and lime kilns are scattered throughout the limestone regions. Many of the farmers burn their own lime.

In addition to lime and manure, commercial fertilizers are used for nearly all crops. The census of 1910 reports a total expenditure of \$552,468, or \$51 per farm, for commercial fertilizers. Corn and tobacco are manured in addition to receiving applications of commercial fertilizers. About 150 to 300 pounds per acre of fertilizer are applied to corn, and applications of 200 to 600 pounds of fertilizers of high potash content are made on tobacco land. A mixture which has proved successful for tobacco on the Hagerstown soils

consists of 1 ton of cottonseed meal to one-half ton of sulphate of potash and one-half ton of ground rock, applied at the rate of 1,000 pounds per acre. Fertilizers generally high in phosphates are applied to wheat land at the rate of 200 to 400 pounds per acre. The application is increased for the Manor soils. Some farmers buy the constituents and mix the fertilizers at home, but the common practice is to buy the commercial mixtures. The cost of hauling is a limiting factor in the use of fertilizers in the more remote parts of the county.

According to the census of 1910, 91.4 per cent of the area of the county is in farms, and 85.9 of the farm land is improved. Very little land has been cleared for farms in recent years, the tendency being to leave the rougher, stonier sections in forest. From such areas chestnut timber, cut for fence posts and rails, crossties, and telephone poles, is a source of considerable income.

According to the census of 1910 about 61 per cent of the farms are operated by the owners. The tenant farms are rented mainly on the share basis, the landowner furnishing one-half the seed and one-half or two-thirds the fertilizer, while the tenant furnishes the labor and work stock, the proceeds from the farm being divided equally.

Day laborers are paid an average of \$1 per day with board during harvest. Laborers hired for long periods receive \$15 to \$30 per month with board for 6 to 9 months in the year. Labor usually can be obtained without difficulty.

There is a wide range in the value of farm land, prices varying from \$10 an acre for some of the rough, uncleared land, to as much as \$400 an acre for some of the highly developed land in the limestone valleys. The average value of land throughout the county is about \$100 an acre.

#### SOILS.

The upland soils of Lancaster County, comprising about 92 per cent of the area, are residual in origin. There has been, however, some slight movement of the material by gravitation and erosion. Erosion has played an important part in influencing the thickness of the soil mantle, and, on steep slopes, in preventing the accumulation of mellow surface soils by washing away the surface material as it is formed. Some important changes in the residuum have been brought about by the rapid advance of oxidation under local conditions. The depth of the mantle of residual material over most of the county varies from about 2 to 12 or 15 feet. There are in places, however, rock outcrops and areas having a very thin soil covering, such places representing areas of sloping surfaces where erosion has kept pace with or followed closely upon rock decay.

The stream-bottom and terrace soils consist of material washed from the various upland soils and deposited over the flood plains of the streams during overflows. Except along the Susquehanna River this wash is from local soils, and there has been comparatively little definite assortment and stratification of the material. Along the Susquehanna there is some wash from distant soils, including sandstone and shale soils of the Appalachian Mountains and, to some extent, glacial soils to the north. There has been some stratification or assortment of material, especially on the terraces, where there are in many places beds of transported, waterworn gravel beneath fine material. The material in these terraces was deposited when the waters of the stream reached higher levels than at present. In the first bottoms, where overflows still occur, additional material is deposited during each overflow, and these are the most recently formed soils of the county.

Some changes take place in the alluvium after deposition through the influence of vegetation, drainage, and oxidation. In some of the bottoms which have very poor drainage, the material has a light-grayish color at the surface with mottling below, whereas material from the same source in bottoms having good drainage between overflows possesses a uniformly brownish color. In the poorly drained alluvium the saturated condition has caused the exclusion of air to such a degree that there has been little or no oxidation, but instead changes opposite to those resulting from oxidation are taking place.

The character of the soils is closely related to the character of the rocks from which they are derived, and to the topography of the region.

The principal soil-forming rocks of the area are limestone, sandstone, shale, and schist. The limestone, consisting mainly of the carbonates of lime and magnesium, has been decomposed chiefly by removal of the carbonates in solution, thus leaving a residuum consisting of the impurities which existed in the original rock. The sandstone rocks, on the other hand, with their large content of quartzitic material, have had comparatively little of their mass removed in solution, hence the resultant soils are of a quartzose nature, and the types principally sandy loams. The shales vary from argillaceous to arenaceous and the soils, which have been formed through their weathering, bear these characteristics. The highly metamorphosed rocks, such as the phyllites and mica schists, seem to contain considerable mineral of a quartzose character in addition to the micaceous components and in the material formed by their decay there is a relatively high content of quartzose particles. The micaceous particles from the parent rocks give the soil material a greasy feel. The quartzite rocks have weathered into soils resembling in color those derived from gneiss.

The metamorphosed limestone, of schistose character, impresses its micaceous features in the residuum formed upon its weathering, while the limestone imbedded with shale or other siliceous rocks has produced a residuum having a different character from that derived from pure limestone.

Other characteristics of the parent rock are present in the resultant residual material; for example, the Indian-red shale and sandstone has given rise to soils of Indian-red color, while the light-gray and bluish shale and sandstone have given rise to grayish and bluish soils.

The alluvium of the area, to some degree, shows the characteristics of the upland soils from which it is derived. The red alluvial material, for example, obviously owes its red color to the presence of wash from the associated red uplands. In the gravel underlying the old terrace alluvium there is present some material of a crystalline character, which undoubtedly represents wash from the distant soils of the glacial region. The alluvium, which contains considerable material washed from the micaceous soils, possesses a micaceous character.

Probably the oldest rocks in the county are those located in the Piedmont Plateau of the southern part, comprising chiefly the metamorphosed, crystalline schists, presumably pre-Cambrian in age. The limestone valleys, extending across the north-central part of the county, are underlain by rocks probably belonging to the Shenandoah group. Pure limestone predominates here, but there is some shale in places associated with limestone, and some metamorphosed limestone or schistose limestone. The ranges of hills jutting into the Lancaster Valley at each end are underlain principally by quartzite and gneiss, the latter appearing to be of Cambrian age. The belt of little metamorphosed shales bounding the limestone valley on the north, as hills and ridges, are probably of the same geologic age as the Martinsburg shale. These have been considered in older geologic work as the equivalent of the Hudson River slates. They are probably of Ordovician age. The northern part of the county, a plateau area, is underlain principally by rocks of Triassic age—shale, sandstone, mudstone, and conglomerate, only locally metamorphosed by intrusions. Dikes or intrusions of diabase occur throughout the Triassic region, and are probably of both Triassic and post-Triassic age. Dikes of the same material have cut through the older formations farther south in the county. The alluvial soils occurring as terraces along the Susquehanna River are of recent age. The narrow bottoms along the smaller streams of the county are still in process of formation.

The rocks of Lancaster County have been tilted so that the bedding plains are usually steeply inclined. The broader geologic divi-

sions occur in roughly parallel belts having a general east and west trend.

The greater part of southern Lancaster County, comprised in the Piedmont Plateau, is occupied by residual soils of a predominantly micaceous character, chiefly the Manor soils, which are derived mainly from mica schists and chlorite schists, with some gneiss. Through the limestone valleys, residual limestone soils, the Hagerstown and Conestoga, predominate. The hills and ridges adjoining the limestone valleys are occupied by argillaceous shale soils of a distinctive character. These are mapped as the Berks. Within the larger limestone valley there are some important quartzite soils, the Edgemont, on the hills and ridges, which owe their relatively high position to the resistant character of the rocks. Over the northern Piedmont occur the soils of the red, brownish, and bluish shales, sandstones, mudstones, and conglomerates of Triassic age, classed with the Penn, Lansdale, and Lehigh series, together with local developments of diabase soils, mapped as the Montalto.

The following table gives the name and actual and relative extent of each soil type mapped in Lancaster County:

*Areas of different soils.*

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Hagerstown silt loam.....	144,832	24.0	Montalto loam.....	8,192	1.4
Manor loam.....	123,840	20.6	Codorus silt loam.....	7,936	1.3
Conestoga silt loam.....	36,480	6.1	Lansdale sandy loam.....	4,928	.8
Berks shale loam.....	34,240	5.7	Bermudian silt loam.....	4,544	.8
Penn loam.....	27,712	4.6	Lehigh stony loam.....	4,096	.7
Hagerstown clay loam.....	26,880	4.5	Elk silt loam.....	3,392	.6
Chester loam.....	23,808	3.9	Penn gravelly sandy loam.....	2,240	.4
Penn stony loam.....	22,656	3.8	Lansdale gravelly sandy loam.....	1,664	.3
Huntington silt loam.....	18,368	3.0	Lehigh silt loam.....	1,664	.3
Edgemont stony loam.....	16,000	2.6	Chester fine sandy loam.....	1,408	.2
Lansdale loam.....	15,744	2.6	Conowingo silt loam.....	1,344	.2
Conestoga loam.....	14,592	2.4	Huntington fine sandy loam.....	1,216	.2
Manor slate loam.....	12,736	2.1	Elk fine sandy loam.....	1,152	.2
Edgemont loam.....	11,456	1.9	Elk gravelly loam.....	576	.1
Rough stony land.....	10,560	1.7			
Berks silt loam.....	9,600	1.6			
Meadow.....	8,384	1.4			
			Total.....	602,240	.....

HAGERSTOWN SERIES.

The soils of the Hagerstown series are prevailingly brown, with light-brown, reddish-brown, or dull-red subsoils. These soils are developed in the limestone valleys, and are residual from limestones of massive structure. Fragments of the limestone and of quartz locally are common in the soil, and rock outcrops occur on the steeper slopes. The topography is undulating or gently rolling, and the drainage is good.

## HAGERSTOWN SILT LOAM.

The surface soil of the Hagerstown silt loam is a brown or light-brown, mellow silt loam ranging from 8 to 12 inches in depth. This is underlain by yellowish-brown heavy silt loam or silty clay loam, grading, at about 2 feet, into a yellowish-red, reddish-brown, or dull-red moderately friable clay. The surface soil contains in places a noticeable quantity of fine sand and approaches the texture of a silty loam, but the type is dominantly a silt loam. Locally the soil varies from a loam to clay loam, the latter representing eroded areas. Where of sufficient size to warrant separation the clay loam is mapped as a distinct type. The areas of loam are so small and scattered that their separation from the silt loam is impracticable. The beds of limestone from which this type is derived are seamed and intersected by veins of quartz, fragments of which are scattered about, and in a few places, particularly on slopes, are so numerous as to give the immediate surface material a gravelly character. These fragments are not large enough to hinder tillage, the soil generally being free from stones.

The subsoil rests on the hard, unaltered rock at depths ranging from about 3 to 10 or 12 feet. There are occasional outcrops of this rock on the steeper slopes.

The Hagerstown silt loam is the most extensive soil type in Lancaster County, occupying 226.3 square miles. The principal area occurs as a broad belt stretching across the county in a general east-and-west direction from the Berks and Chester County lines to the Susquehanna River. This area is more than 40 miles long and has an average width of approximately 7 miles. It comprises the large limestone valley mentioned in preceding pages. A somewhat smaller area lies north of this. Small, isolated areas of soils included with this type lie to the south and southeast of Lancaster, and are associated with the soils of the Conestoga series.

The type occupies nearly level to undulating and rolling valley land, the elevations ranging from 300 to 500 feet above sea level. The drainage is generally good, but parts of the low-lying, more nearly level areas would be benefited by artificial drainage.

The Hagerstown silt loam is residual from limestone. Some of the limestone, notably that near Rheems, has been marmorized. In the vicinity of Kinzers and in other parts of Leacock, Paradise, and Salisbury Townships the parent rock contains some shaly material which gives a loam to very fine sandy loam of a friable structure and reddish-brown color. These areas are too small to be mapped separately. They are very productive. Also there are present in places areas of a weathered yellowish shale which may be derived from arenaceous shaly limestone. The presence of this rock does not seem

to have any important influence on the soil, as it is essentially the same, apparently, as the typical Hagerstown silt loam, both in physical characteristics and in agricultural value. Such shale material was seen over considerable areas near New Holland, Blue Ball, Mechanicsburg, Neffsville, East Petersburg, Salunga, and northwest of Marietta.

Practically all the Hagerstown silt loam is under cultivation, probably less than 2 per cent remaining in forest. The few remaining woodlots, usually of less than an acre each, are highly prized. The land originally was forested with oak, hickory, ash, elm, tulip, sycamore, walnut, maple, beach, birch, buckeye, and locust.

The Hagerstown silt loam is regarded as one of the most valuable soils in the county for general farming. All the farm land is highly improved and very productive. The soil does not clod badly, and can be maintained in good tilth with a reasonable expenditure of time and labor.

The principal crops grown are wheat, corn, hay, and tobacco. Irish potatoes are of some importance. Corn does particularly well. Yields of as much as 130 bushels per acre have been reported, but the average for all farms on the type for a number of years is between 60 and 75 bushels per acre. Wheat yields from 25 to 45 bushels, averaging about 28 bushels per acre. Tobacco of both the Pennsylvania Seedleaf or Broadleaf, and Havana varieties is grown. The former variety does best, yielding, where fertilized, from 1,300 to 2,500 pounds, with an average of about 1,500 per acre. The Havana tobacco yields from 1,000 to 1,500 pounds per acre. Potatoes are grown in fields of about 2 to 20 acres on many farms, and this crop has supplemented tobacco to a considerable extent in the last few years as a money crop. Potatoes yield about 90 to 200 bushels, averaging about 100 bushels per acre. Oats are not considered so profitable as wheat. They yield 50 to 60 bushels per acre. Hay, consisting mainly of mixed timothy and clover, yields from  $1\frac{1}{2}$  to  $4\frac{1}{2}$  tons per acre, the average being about 2 tons. Alfalfa is grown on some farms with success. On nearly all the farms there are some fruit trees, and truck crops are grown in a small way on farms near Lancaster. Neither fruit nor truck are grown on a large commercial scale.

Wheat, tobacco, and potatoes are the principal money crops. The other grain and forage crops are fed on the farms, and all the straw is returned to the soil. Dairying is not carried on to any important extent. Some farmers do not even keep enough cows to supply the home demand for milk. Practically all farms, however, keep fattening stock through the winter, using the grain and forage crops on the farms and producing manure.

Systematic crop rotations of 3, 4, 5, or 6 years duration are in general use. The 3-year rotation is corn and tobacco 1 year, wheat 1 year, and grass 1 year. In the 4-year rotation the field is devoted to corn and tobacco 1 year each. The land is allowed to remain in sod 2 years for the 5-year period, and in the 6-year rotation wheat is grown 2 years in succession. The 6-year rotation is not used on many farms, the 4-year and 5-year rotations generally being considered more satisfactory.

Lime, commercial fertilizers, and barnyard manure, as well as green manuring crops, are used to keep the soil in a high state of productiveness. Lime is applied in the form of slaked lime or ground limestone to the wheat land. Commercial fertilizers analyzing 4-8-4 or 4-8-6 are used at the rate of 200 to 500 pounds per acre for wheat and corn. A fertilizer mixture which has proved profitable, and which is, it seems, responsible for some of the high yields of tobacco, is made up of 1 ton of cottonseed meal, one-half ton of sulphate of potash, and one-half ton of phosphate rock applied at the rate of about 1,000 pounds per acre.

The nearly level topography is favorable for the use of modern machinery in seeding, cultivating, and harvesting all the crops. Grain binders are in common use, although corn binders and hay loaders are not used extensively. The number of silos is gradually increasing. The common practice is to shred the corn fodder. The corn is husked, and ground corn and cob meal is largely used as feed.

The farms are usually of small size, averaging about 50 acres. Improved farm land has a wide range in value. Small farms sell for as high as \$400 an acre, and even larger farms, favorably situated, have sold recently for \$350 an acre. The average price is probably between \$125 and \$175 an acre.

The average results of mechanical analyses of samples of the soil and subsoil of the Hagerstown silt loam are given in the table below:

*Mechanical analyses of Hagerstown silt loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
182185, 182195.....	Soil.....	1.4	2.2	0.9	3.6	13.9	65.8	12.0
182186, 182196.....	Subsoil.....	1.4	2.0	.9	3.6	13.6	50.5	28.0

HAGERSTOWN CLAY LOAM.

The surface soil of the Hagerstown clay loam is a brown or faintly reddish brown, silty clay loam to clay loam, which passes at about 10 inches into reddish-yellow clay loam, and this at about

15 to 20 inches into reddish-yellow or red clay. Some slopes from which the lighter surface material has been washed have a fairly heavy clay loam at the surface. The type, although prevailingly a clay loam, is not uniform in texture. The soil as a whole is much heavier than the Hagerstown silt loam. Considerable difficulty was experienced in separating the silt loam and clay loam types, and it is likely that the two overlap in some places. The surface of a plowed field within the area mapped as the clay loam has a spotted appearance, brown, reddish-brown, and even light-red colors being present. The soil is locally termed "red clay land." The subsoil, although heavy, is seldom plastic, except when very wet. When dry the material crumbles readily.

The soil, like the silt loam type, rests on solid limestone at a depth of about 3 to 8 or 10 feet. There are a few unimportant rock outcrops. The soil is usually free from stones, except for a scattering of small quartz fragments and occasional small fragments of limestone.

The largest and most important areas of the Hagerstown clay loam occur north and northwest of Lancaster, north of East Petersburg, around Witmer and Intercourse, and north of New Holland and Blue Ball. The type usually occurs in relatively small, irregular-shaped bodies, closely associated with the Hagerstown silt loam throughout the limestone-valley regions.

The Hagerstown clay loam occupies gently undulating valley lands. The surface is perhaps smoother in general than that of the silt loam. Considering the heavy texture of the subsoil the natural drainage is good. There are no continuously wet or swampy areas, although water stands for a short time after heavy rains on low-lying or depressed areas, which would be benefited by artificial drainage. Erosion of the soil is not serious. This type is residual from limestone of the same formation as those underlying the Hagerstown silt loam.

Practically all of the type is in cultivation. The preparation of the seed bed is not so easily accomplished as on the silt loam, as the soil is heavier and more inclined to clod. The few remaining scattered trees indicate that the original forest growth was the same as that of the silt loam type.

The staple crops of the limestone valley region, wheat, corn, tobacco, grass, oats, and potatoes, are grown. In general, the small-grain and grass crops do slightly better on the clay loam type than on the lighter Hagerstown soil. Corn yields 50 to 120 bushels, averaging about 70 bushels per acre. Wheat has been reported to yield 50 bushels per acre in a few instances, but the average yield is about 30 bushels per acre. Oats yield 40 to 60 bushels per acre and the quality of the grain is good, but this crop is not extensively

grown. The average yields of tobacco are about the same as those obtained on the silt loam, the Seedleaf being the prevailing type. Red clover does particularly well, and the average yields of mixed timothy and clover are between 2 and 3 tons per acre. Irish potatoes are not grown on so large a scale as on the lighter type, but yield 85 to 150 bushels of potatoes of good quality per acre.

Practically the same systems of rotation and general farming are employed on this soil as on the Hagerstown silt loam. There is a tendency to extend the rotation period somewhat, keeping the fields in grass a year longer. Greater care is required in plowing much of this soil on account of the more pronounced tendency to form in clods.

This land has the same range in value as the Hagerstown silt loam.

#### CONESTOGA SERIES.

The soils of the Conestoga series are light brown to brown, and the subsoils are yellow or yellowish brown to olive green. These soils are residual from highly schistose and thinly laminated limestone, in which micaceous particles have been developed. The micaceous particles impart a characteristically greasy or graphitic feel to the subsoils. Numerous small, flaky particles of the parent rock occur in some of the soils. Rock outcrops are common on the slopes. The topography is rolling, and drainage is good.

#### CONESTOGA LOAM.

The surface soil of the Conestoga loam consists of a brown, mellow silty loam with an average depth of 10 inches. The subsoil is a light-brown to slightly reddish or greenish-brown, highly micaceous, friable, silty loam or clay loam to a depth of about 20 or 24 inches, where it usually passes into a mass of yellow or olive-green partly decomposed rock particles giving the lower subsoil and substratum a loose, open structure. There is only sufficient fine-earth material in the lower subsoil to give the mass coherence. The soil is comparatively free from rock fragments of such size as to make it gravelly or to interfere with cultivation, but contains some fine, flaky particles which give it a mellow and friable structure. Quartz fragments are scattered over the surface and through the subsoil. The chief basis on which this soil is separated from the Conestoga silt loam is the presence of rock fragments in the soil and the more loose character of the subsoil. The principal variation from the typical loam is in the area southeast of Washingtonboro, where the subsoil in places has a reddish cast. It is probable that this reddish color is due in part to the oxidation of iron pyrite, crystals of which are encountered in the unweathered rock, and in part to a mixture of materials other than limestone. The rock is encountered at depths of 2 to 8 feet.

Small rock outcrops are common. The soil is residual from the same schistose limestone formation as that giving rise to the silt loam type of this series.

The Conestoga loam is closely associated with the silt loam type. The principal areas of the loam occur between Lancaster and Millersville, southeast of Washingtonboro and north of Safe Harbor. The most important detached area is situated around Martinsville.

This type occupies slopes and rolling land. In general, the topography is rougher than that of the Conestoga silt loam. Natural drainage is good. The soil is perhaps less retentive of moisture than the silt loam type on account of the more open, porous character of the subsoil.

Practically all of the land is in cultivation or devoted to permanent pasture, none of the original forest growth remaining.

A good tilth is maintained with a reasonable expenditure of labor, and the soil is considered well suited to general farming. Being closely associated with the Conestoga silt loam, the loam is often farmed in connection with that type. The agricultural practices on the two types are practically the same, and the yields of the staple crops on the loam type are equal to or only slightly inferior to those obtained on the silt loam.

Results of mechanical analyses of samples of soil and subsoil follow:

*Mechanical analyses of Conestoga loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
182179.....	Soil.....	0.3	1.8	1.2	13.4	25.0	46.3	11.9
182180.....	Subsoil.....	4.6	6.6	2.6	9.2	10.2	55.5	11.0

CONESTOGA SILT LOAM.

The Conestoga silt loam to a depth of 8 to 12 inches consists of a brown silt loam of mellow structure. The upper subsoil is a yellowish-brown or light-brown silt loam. This grades into more compact, brown or greenish-brown or slightly reddish brown silt loam or silty clay loam to clay at about 20 to 30 inches. A large quantity of very finely divided micaceous material is contained in both soil and subsoil, imparting a greasy feel. When the soil is rubbed between the fingers it has a polished luster. There are no large fragments of rock in the soil although small fragments of quartz are scattered over most of the type. Rock outcrops are common on the slopes, particularly in the banks along stream courses, where the soil has been removed by erosion. The depth of the soil covering ranges from about 2 to 8 feet, and the soil rests directly on the unaltered

rock except in a few instances where there is a 3 or 4 inch layer of small rock chips. The stratum of fine-earth material immediately overlying the rock is a dark-brown or olive-green, highly micaceous silt loam or loam, composed largely of flaky particles of mica, and having a still more pronounced greasy or graphitic feel than the soil or subsoil. This olive-green layer frequently is encountered within the 3-foot section.

In Manor and Pequea Townships and in the vicinity of Paradise there are some included patches where the soil is dark grayish brown to nearly black silt loam, underlain at about 8 to 12 inches by a black to bluish-black silt loam which becomes more compact and heavier in the lower subsoil. Often there is present in the soil section much partly decomposed graphitic or highly schistose limestone which gives the soil and subsoil a friable structure and greasy feel.

The Conestoga silt loam is not widely distributed, although it has a large total area and is regarded as one of the most important soil types in Lancaster County. Most of it lies within a radius of 8 miles of Lancaster, to the southeast, south, and southwest.

The topography of this type is more varied than that of the Hagerstown soils. As a whole it may be described as gently rolling to rolling. Excepting a few of the steeper slopes along stream courses, the topography is nowhere sufficiently rough to prohibit the use of modern farm machinery. The natural drainage usually is adequate for the general farm crops grown. In some places where seepage at the bases of slopes keeps the soil moist for long periods of time artificial drainage has proved advantageous. The type occupies valley land and lies at about the same elevation as the Hagerstown soils to the north and northeast.

This soil is residual from a gray or bluish-gray, highly schistose, thinly laminated limestone. The limestone was doubtless originally massive, but has assumed its present characteristic structure through intense mashing and shearing from regional metamorphism. The rock has been so severely folded and crumpled that the beds do not lie in the original horizontal position. The metamorphism developed, among other minerals, mica and iron pyrite, crystals of which commonly occur in the soil.

Practically all of the type has been cleared and is in cultivation to general farm crops or is in permanent pasture, many of the slopes occupied by a thinner soil mantle being devoted to the latter use. The original forest growth has been removed.

A good tilth is easily maintained, as a rule, although the soil has a tendency to clod when plowed too wet. Ordinarily the mellow condition of the surface soil makes it possible to work it under a fairly wide range of moisture conditions. The subsoil is fairly retentive of moisture, and crops rarely suffer from drought.

The principal crops grown are corn, wheat, tobacco, oats, potatoes, and grass. With the same fertilization the yields are equal to or only slightly inferior to those obtained on the Hagerstown soils. In its present state of improvement the soil is about intermediate in productiveness between the Hagerstown silt loam to the north and the Manor loam to the south. Corn yields 50 to 100 bushels, averaging about 70 bushels per acre. In favorable seasons wheat, on the better improved farms, yields as high as 40 bushels per acre, and the average yield of this crop is about 27 bushels per acre. Tobacco usually is not so heavily fertilized as on the Hagerstown soils, and consequently lower yields are obtained, ranging from 1,200 to 2,000 pounds per acre. Potatoes are not grown on a commercial scale, but yield 90 to 175 bushels per acre. Oats are not grown extensively, being considered less profitable than other crops. Yields of 40 to 50 bushels per acre are ordinarily obtained. Timothy and clover do well, yielding from 1½ to 3½ tons of hay per acre, the average being about 2 tons per acre. Bluegrass is indigenous, and affords good pasturage.

Tobacco and wheat are the principal money crops. The soil has been found suitable for producing nursery stock, and a small acreage is successfully devoted to that use. Berries, especially raspberries, do well. As on many of the soils in this region, some fattening stock is fed on most of the farms through the winter. The barnyard manure is used mainly on the corn and tobacco land. In addition a little commercial fertilizer, usually high in phosphoric acid, is used on corn and tobacco. The fertilizer is commonly about a 2-8-2 grade. A 4-year or 5-year rotation is in general use. Corn, 1 year, is followed by tobacco 1 year. Then wheat is grown 1 year, the land being seeded to mixed timothy and red clover, to remain in sod 1 or 2 years. Slaked lime is commonly applied once in the course of the rotation at the rate of 25 to 50 bushels per acre.

On the dark-colored soil about the same yields of corn, wheat, and tobacco are obtained as on the typical soil, but grass does not do so well. Some of the steeper slopes are used only for pasture.

This land sells for \$60 to \$250 an acre, depending on its location with respect to markets and shipping points.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

*Mechanical analyses of Conestoga silt loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
182143.....	Soil.....	2.1	2.4	0.9	3.4	10.5	58.8	21.6
182144.....	Subsoil.....	2.0	4.0	1.4	6.6	16.2	48.8	20.6

## MANOR SERIES.

The Manor soils have yellowish-brown to brown surface soils and yellowish-red or dull-red subsoils. The series is characterized by a high content of finely divided micaceous material in both soil and subsoil, which imparts a greasy feel. These soils are residual from metamorphic rocks such as phyllites, mica schists, and chlorite schists, fragments of which are common in some of the types. The topography is rolling to hilly, and the drainage is good.

## MANOR SLATE LOAM.

The Manor slate loam is a light-brown to faintly reddish brown silty or gritty loam, underlain at a depth of about 6 to 10 inches by light-brown or reddish loam to clay loam, which passes into yellowish-red or pale-red clay or clay loam at about 12 to 20 inches. Thinly laminated, highly schistose rock fragments are scattered over the surface and through the subsoil, constituting about 25 to 60 per cent of the soil mass. At a depth of about 30 inches the subsoil frequently rests on a loose mass of small schist fragments with little interstitial material. The rock fragments, which are 1 inch to 4 or 5 inches in diameter, and soft, do not interfere seriously with cultivation of intertilled crops. The mellow, friable character of the soil, which renders it cultivable under a wide range of moisture conditions is mainly due to the presence of these schist fragments. A rather high percentage of micaceous particles, principally chlorite, is left upon the decomposition of the parent rock, and these impart a peculiar greasy feel to the subsoil. This greasy feel is one of the distinguishing characteristics of the Manor soils. Locally, large quantities of vein quartz fragments are scattered over the surface. The material of colluvial origin at the bases of slopes frequently is of a lighter brownish or grayish-brown color, but it was not deemed advisable to make a further separation on this account. This land is called "slate land," though the rock is a schist.

The Manor slate loam is associated with the Manor loam, which occupies a large area in the Piedmont section of the southern part of Lancaster County. The largest areas occur around Truce, and east and southeast of Quarryville along the East and West Branches of Octoraro Creek.

This type occupies the tops and steeper slopes of hilly and rolling land and the steep slopes along stream courses, where, as in the case of the areas of the Manor stony loam, the streams have cut deep V-shaped valleys through the soft rock. The general level of the plateau is 700 to 900 feet above sea level, and Octoraro Creek has cut a gorgelike valley 100 to 250 feet deep. Some of the slopes along Octoraro Creek are too steep for successful cultivation. The

natural drainage is good, and in a few areas of shallow soil excessive. The steeper slopes are subject to erosion.

This soil is residual from the hydromica and chloritic schists, belonging to an extensive schist formation. The rock is fine grained, highly schistose, and of greenish, greenish-gray, or reddish color. This seems to have been originally a sedimentary rock, which has been greatly modified by metamorphism. In the metamorphism a number of minerals were developed, including chlorite, pyrite, mica, and quartz. Oxidation of the pyrite and chlorite produce the reddish color in the soil.

About 50 per cent of the type is in cultivation. The chief forest growth is chestnut. White oak, red oak, tulip, hickory, sycamore, maple, dogwood, and locust are less common.

Corn, wheat, tobacco, potatoes, and grass are the principal crops grown, producing yields somewhat inferior to those obtained on the Manor loam. A small acreage is devoted to peaches and apples, which do fairly well. Strawberries, bush fruits, and truck crops are grown in a small way to supply local markets.

The more arable portions of this type sell for \$50 to \$75 an acre. The value of uncleared land depends on the quantity and kind of timber.

#### MANOR LOAM.

The Manor loam is a light-brown to brown, mellow loam underlain at about 6 to 10 inches by yellowish-brown to reddish-brown loam or clay loam, which passes at about 15 to 24 inches into clay loam or clay of a reddish-yellow to dull-red color. The surface of a plowed field, when wet, gives the impression at a distance of being reddish, but on close inspection is distinctly brownish. Usually at a depth of about 30 inches or more the disintegrated parent rock is encountered, and the substratum is characterized by a large content of micaceous particles, which impart a fluffy structure to the light-reddish material. Micaceous particles are usually found in both soil and subsoil in sufficient quantity to give the material a greasy feel. The subsoil almost invariably is decidedly unctuous. Small, flat chips of the parent rock and angular fragments of quartz are found in the soil and subsoil, but these are too small and of too small quantity to interfere with cultivation. Rock outcrops are of rare occurrence. The bedrock lies at depths varying from about 4 to 8 or 10 feet. There are some included small areas of silt loam.

The Manor loam, which covers 20.6 per cent of the area of the county, occupies the greater part of what has been described in this report as the southern plateau of Lancaster County.

This type has a varied topography. In the vicinity of Fairmount the surface is nearly level to undulating. That part of the type lying within about 5 miles of the Susquehanna River and along Octoraro Creek is dissected by streams and is mainly hilly. The greater part of the type is rolling. Both the surface drainage and the subsoil drainage are good.

Nearly all of the typical Manor loam is in cultivation. A few patches of woodland support a growth of oak, chestnut, beech, soft maple, tulip, sycamore, locust, linden, birch, spruce, hemlock, scrub pine, walnut, and cherry. The undergrowth is mainly laurel and sassafras.

The Manor loam is cultivated with little difficulty, and is considered one of the most productive soils in Lancaster County for general farm crops. There is little waste land, and this fact, together with the ease of cultivation, makes the soil particularly desirable. The staple crops common to the region are grown. Corn yields as high as 125 bushels per acre occasionally are reported, but the average for a period of years and for the whole type is probably between 65 and 75 bushels per acre. As much as 40 bushels of wheat per acre has been produced, but the average yield for the type is about 25 bushels per acre. Oats yield 40 to 55 bushels per acre. The land is usually allowed to remain in sod for a number of years. Clover does well, and the average yield of timothy and clover mixed is about 2 tons per acre. It is probable that the first cutting after seeding yields considerably more than this average. Some of the most productive tobacco farms in Lancaster County are situated on this soil. The Pennsylvania Seedleaf is the most common variety, and yields of 1,200 to 2,100 pounds per acre are obtained, the average being about 1,500 pounds per acre. Irish potatoes yield 100 to 250 bushels per acre. Alfalfa does fairly well. If the soil is well inoculated, alfalfa should prove profitable. Peaches give heavy yields of fruit of good quality on this soil, notably on Bunker Hill. Their success indicates that many of the slopes could be profitably used for orchards.

Regular rotation systems are followed. A common method is to follow corn one year with oats, tobacco, or potatoes one year, followed by wheat one year, seeded to mixed timothy and clover, the land to remain in sod one year, two years, or even three years. Dairying in connection with general farming is carried on more extensively on the Manor loam than on any other type in the county. In addition to small dairy herds, many farms keep a few head of fattening stock. A few silos are in use, the ensilage being used for both dairy and fattening stock. The manure is used mainly on corn and tobacco. The latter crop receives the greater part, applications of 10 or 12 tons per acre being made. Hydrated lime is in common

use and is applied to wheat land in the fall at the rate of 30 to 40 bushels per acre once in the course of the rotation. Commercial fertilizers of 2-8-10 or 2-6-8 grade are applied to all crops, corn receiving 300 to 500 pounds per acre, wheat 400 to 500 pounds, tobacco 500 to 800 pounds, and potatoes about 500 to 800 pounds. Some ground rock phosphate also is used.

The yellow dent corn, locally known as Whiteside, is the common variety. Fultz and No. 10 are the varieties of wheat most extensively grown. The State of Washington, State of Maine, and Green Mountain are the most popular varieties of potatoes.

The wheat, potatoes, and some of the hay are sold. The milk is sold mainly at Lancaster. The Lancaster, Oxford & Southern Railroad, connecting with the Pennsylvania system at Oxford, Peach Bottom Station, and Quarryville, affords a ready means of shipping the farm products from the southern part of the county.

The average size of the farms within the area of the Manor loam is about 85 acres. There are a few farms of 200 to 225 acres, but smaller farms are more common. Land values vary widely and depend in a large measure on improvements, location with respect to shipping points, and topography, ranging from \$40 to \$125 or more an acre. A reasonable estimate of the average value is about \$65 an acre.

#### MANOR STONY LOAM.

The areas in Manor loam color and indicated by stone symbols differ from the Manor loam in depth of soil, topography, and agricultural value. These areas comprise the Manor stony loam. The surface soil consists of a yellowish-brown to brown, gritty loam from 5 to 8 inches deep. The subsoil is a yellowish or light-brownish to reddish-brown loam to clay loam, usually changing at about 10 to 20 inches into reddish-brown or dull-red clay loam to clay. Both the soil and subsoil contain flat and angular fragments of the parent rock, varying in diameter from 2 inches to 2 or 3 feet and probably averaging 6 or 8 inches. The substratum, at a depth of 5 to 8 feet, is a mass of rock fragments with little interstitial material. Rock outcrops are of uncommon occurrence except in the deeper cuts.

The largest single area of the stony loam is situated north of Rawlinsville, extending to the Susquehanna River. Other smaller areas occupy steep slopes occurring along stream courses, particularly along the larger creeks, as the West Branch of Octoraro Creek, and in the vicinity of the river, where the streams have cut deep, V-shaped valleys. Areas are encountered also on the tops and steeper slopes of hills rising to an elevation of 400 to 800 feet above sea level and 200 to 600 feet above the level of the Susquehanna River. The natural drainage is good. The surface run-off is rapid

on the steeper slopes and considerable erosion takes place where the land has been cleared. On the more gentle slopes the subsoil is fairly retentive of moisture.

Probably about 25 per cent of the area of the Manor stony loam is in cultivation. The less arable portions are forested mainly with chestnut, with a scattered growth of oak, tulip, beech, birch, sycamore, locust, dogwood, spruce, hemlock, and cedar, and usually there is a thick undergrowth of mountain laurel and berry bushes.

Where the more gentle slopes have been cleared the soil is devoted to general-farm crops and fruit. The yields of the staple crops—corn, wheat, oats, potatoes, tobacco, and grass—are about equal or slightly inferior to those obtained on the Manor loam. The soil is tilled with considerable difficulty on account of the slope and the stone content. Frequently the larger stones are removed.

Peaches, apples, and pears are successful, and conditions seem to favor the extension of the orchard industry. Much of the stony loam seems best suited to a combination of dairy and fruit farming. Strawberries produce good yields of fruit of excellent quality in the less stony areas. Lancaster is the chief market for the strawberries and peaches grown on this soil.

Some of the uncleared land has sold recently for as low as \$10 an acre. The improved land is valued at as high as \$65 an acre, but a reasonable estimate of the average value of the stony areas is about \$35 an acre.

#### BERKS SERIES.

The soils of the Berks series are yellowish brown to brown with yellowish subsoils. They are derived from yellowish, brownish, grayish, and reddish argillaceous shales of the Martinsburg (old Hudson River) type. The soils occupy ridges and hills, generally of smooth surface. Drainage is good. The soils are subject to erosion.

#### BERKS SILT LOAM.

The surface soil of the Berks silt loam, to a depth of 6 to 10 inches, consists of a light-brown silt loam. This is underlain by yellow, friable silty clay loam extending to a depth of about 15 to 20 inches and grading into yellow silty clay, showing some grayish in places. The undecomposed shale is frequently encountered at a depth of 2 to 3 feet, while the mass of fine earth may be 6 to 8 feet deep. The surface soil bakes and cracks in dry weather, and care in plowing is necessary to prevent the formation of hard clods. The subsoil in places varies in color from mottled yellow to gray or drab, and is sometimes even pink or light reddish. Small, flat chips of the underlying shale generally are present in both surface soil

and subsoil, but not in sufficient quantity to warrant including this soil with the Berks shale loam. The soil usually is compact in structure, differing from the shale loam in that respect as well as in the quantity of shale present.

The Berks silt loam occurs in a number of comparatively small areas in the north-central part of the county associated with the Berks shale loam. The greater part of the type occupies the lower and gentler slopes of hills and undulating, irregular-shaped areas, occurring as depressions within the area of the Berks shale loam. While the slope is usually sufficient to permit the surface water to run off rapidly, the subsoil drainage usually is poor on account of the compact structure of the material. The type is subject to erosion.

About 90 per cent of the Berks silt loam is in cultivation. In the few remaining small woodlots, white oak and hickory are the principal trees, with some chestnut and chestnut oak and a thick undergrowth of bushes and shrubs.

The type is devoted to general farming. Corn yields from 40 to 70 bushels; wheat, 15 to 30 bushels; tobacco (seed leaf), 1,200 to 1,800 pounds; and hay, timothy, and clover, 1½ to 2½ tons per acre. Oats and potatoes are not extensively grown, giving only fair yields.

The methods of farming employed on this type are similar to those on the adjoining Hagerstown soils. Lime is applied at the rate of 1,000 to 2,500 pounds per acre every 4 or 5 years. Commercial fertilizers, usually high in phosphorus, are quite extensively used. The rotations generally are of four-year and five-year periods.

This land has a wide range in value. The lower slopes of the silt loam are frequently sold with the Hagerstown soils, and the price is raised considerably on that account. Some of the type is held in connection with the Berks shale loam and has a correspondingly low value. The average value is probably between \$75 and \$125 an acre.

Mechanical analyses of samples of the soil and subsoil of this type gave the following results:

*Mechanical analyses of Berks silt loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
182111.....	Soil.....	1.5	3.1	1.3	3.6	3.9	63.6	23.4
182112.....	Subsoil.....	1.9	5.5	2.0	5.7	5.1	53.6	26.1

BERKS SHALE LOAM.

The Berks shale loam consists of a light-brown silty loam, underlain at about 6 to 10 inches by yellowish-brown silt loam, having a

buff to pinkish cast in places. The type is characterized by a large percentage of small, flat shale fragments, constituting about 30 to 70 per cent of the soil mass. In the typical areas the shale content increases with depth, and the substratum, at a depth of 3 to 4 feet, consists of a mass of shale fragments with insufficient fine-earth material to completely fill the interstices. In some places on steep hill-sides this mass of shale fragments is encountered at a depth of 18 inches, or even less. The hard bedrock is reached at about 6 to 12 feet. In some places the subsoil is distinctly reddish in color. This variation is probably due to the oxidation of pyrite occurring in small quantities in the unaltered rock. Differences in the depth of soil material are due in a large measure to the topography, the surface soil being deeper on the level tops of hills and at the bases of slopes than on the slopes.

The Berks shale loam occurs in the northern part of the county, covering an area of 53.5 square miles. The principal body of the soil extends from a point near Milton Grove nearly to Manheim where it divides into two ranges of hills, bordering the Ephrata Valley on the north and south. Small areas of the type occur in East Hempfield and Manheim Townships and in a few other places in the county.

The Berks shale loam occupies rolling uplands and hills of smooth, regular outline. The hills rise to an elevation of 400 to 600 feet above sea level, and 100 to 200 feet above the adjoining limestone valley floors. The soil is everywhere well drained. On some of the steeper slopes sheet erosion is serious, and great care must be exercised to prevent the surface soil from being washed away by heavy rains. The soil on the slopes is subject to excessive leaching. While many of the slopes are steep, they are so smooth that the use of farm machinery in harvesting is feasible.

At least 90 per cent of this type is in cultivation, only the steeper and less accessible slopes remaining in timber. The few forested areas show a predominance of white oak, hickory, and chestnut, with a scattered growth of chestnut oak, red oak, pin oak, and cedar. The low, moist slopes support a thick growth of underbrush, which becomes thinner toward the tops of the hills.

The soil is utilized almost entirely for general farming; on some farms dairying is an important adjunct. Corn, wheat, tobacco, potatoes, and grass are the principal crops. On some of the better farms yields of the staple crops equal to those on the adjoining Hagerstown soils are obtained in favorable seasons, but the average yields are considerably lower. On the more improved farms, in seasons of favorable rainfall, corn yields as much as 85 bushels per acre, but the average for the type for a number of years is about 50 bushels. Wheat yields average about 20 bushels, ranging from 15 to 30 bushels. The Seedleaf or Broadleaf tobacco yields from 1,000

to 1,800 pounds of leaf of fair quality with fertilization. The soil seems well adapted to Irish potatoes, producing 100 to 225 bushels per acre, and even higher yields with the liberal use of barnyard manure and commercial fertilizers. Potato growing might be profitably extended as a special industry. The average yield of mixed timothy and clover hay is about  $1\frac{1}{2}$  tons per acre, ranging from 1 ton to  $2\frac{1}{2}$  tons. A small acreage is devoted to oats, which yield 30 to 40 bushels per acre with fertilization.

Crop rotation usually is practiced, the same general system being employed as elsewhere in the county. The soil responds readily to the use of commercial fertilizers, which are commonly used on nearly all crops. Lime ordinarily is applied once in the course of a rotation. The importance of maintaining a good supply of organic matter in the soil is recognized, and the manure from dairy and fattening stock is utilized to advantage. Very little of the hay or corn is sold.

In cultivating this soil it would seem that, where practicable, the plow furrows and corn rows should follow the contours of the hills, in order to check erosion. After the soil is in sod there is no danger of excessive erosion, and for that reason some of the slopes are largely kept in pasture. In the arrangement of fields, sod above and below corn fields on the slopes would prevent erosion to a considerable degree.

The selling price of this land varies with the improvements and topography. Practically no part of the type is less than 5 miles from markets or shipping points. Farms of average size sell at \$50 to \$100 an acre.

#### CARDIFF SERIES.

The Cardiff series is characterized by the yellowish-brown color of the soil, the yellow color of the subsoil, and by a substratum of shale. Fragments of the parent rock are of common occurrence throughout the soil section. These soils are most typically developed in the northern Piedmont near the Maryland-Pennsylvania line.

#### CARDIFF SLATE LOAM.

Mapped in Berks shale loam color is a small area of the Cardiff slate loam, which is indicated on the soil map by inclusion symbol. In this area the surface soil is a dull-brown to grayish-brown silty loam to silt loam, 6 to 10 inches deep. The subsoil is light brown to yellow and ranges in texture from a heavy silty loam to silty clay. Scattered over the surface and throughout the soil mass are small fragments of black slate from one-half inch to 5 or 6 inches in thickness. The presence of the rock fragments is responsible for a fairly open structure in what would otherwise be a rather compact soil.

The soil mass rests on a substratum of broken slate at a depth of about 3 to 6 feet, decomposition having proceeded only to that depth. This soil adjoins the Manor types and there is a considerable admixture of schist fragments with the slate along the boundaries. The slate outcrops on the steeper slopes, particularly along the Susquehanna River bluff, where areas of the outcrop are classed with Rough stony land. Veins of quartz are present in the beds of slate.

The Cardiff slate loam occurs in the vicinity of Peach Bottom Station and occupies an area of less than 1 square mile. It has an elevation of about 300 to 400 feet and is about 200 to 300 feet above the Susquehanna River. The natural surface drainage is good.

The Cardiff slate loam is residual from slate belonging to the Peach Bottom slate formation. The unmodified rock is quarried for roofing slate, but much of it is folded and broken. The rock is uniformly black, or bluish-black, fine-grained, and jointed.

Of the native trees, on this soil chestnut predominates, with some chestnut oak, white oak, black oak, hickory, and locust, and in places cedar and sassafras. About one-half the area is in cultivation, the remainder, including the steeper slopes and the more stony portions, being in forest or permanent pasture. The land is used for the production of the staple crops of the region, with some dairying in connection with general farming. In favorable seasons corn yields about 50 bushels per acre, wheat 14 to 25 bushels, averaging about 18 bushels, oats 30 bushels, and hay, mixed timothy and clover, 1½ tons per acre. Tomatoes are grown for the canning factory at Peach Bottom Station, giving good yields. Commercial fertilizers are used on practically all crops. Manure is used mainly on corn. Liming is commonly practiced.

This land sells for \$30 to \$50 an acre, the average price being about \$35.

#### CHESTER SERIES.

The soils of the Chester series have grayish-brown to brown soils and yellow or reddish-brown subsoils. Varying quantities of mica are present in the soils and subsoils. These soils are residual mainly from gneisses, although other metamorphic and igneous rocks enter into the composition to some extent. The topography is rolling to hilly and the drainage good.

#### CHESTER FINE SANDY LOAM.

The Chester fine sandy loam, to a depth of about 6 inches, consists of a yellowish-brown or grayish-yellow, rather heavy fine sandy loam. This is underlain by yellow fine sandy loam to clay loam. In some included areas a reddish sandy clay or clay is encountered in the

deep subsoil. Fragments of the parent rock are scattered over the surface, not, however, in sufficient quantity to interfere with cultivation. In places the subsoil contains small quantities of mica. The soil can be cultivated under a wide range of moisture conditions.

This type is confined to Paradise, Eden, Bart, and Sadsbury Townships, in the southeastern part of the county. The largest area, about 3 miles long and half a mile wide, is situated on Mine Ridge. Other areas of less importance occur south and west of Christiana.

The Chester fine sandy loam occupies the tops and slopes of ridges and hills, and is associated with the Chester and Manor loams. The ridges rise from 20 to 100 feet above the Chester loam. Natural drainage is good to sometimes excessive in the higher areas. The type is residual from fine-grained banded gneiss and schist.

About three-fourths of this type is in cultivation. The native timber is mainly chestnut, white oak, red oak, and chestnut oak.

The soil responds readily to applications of commercial fertilizers and manure, but wears out rapidly with continuous cropping. The soil needs to be supplied frequently with organic matter in order to maintain its productiveness. Lime is used rather sparingly. The staple crops of the region, corn, wheat, tobacco, potatoes, and timothy and clover are grown with fair success. Corn, where planted early, produces about as good yields as are obtained on much of the Chester loam. The soil seems best adapted to small fruits and vegetables.

Land of this type is valued at \$20 to \$60 an acre, depending on the improvements.

Results of mechanical analyses of samples of the soil and subsoil are given in the following table:

*Mechanical analyses of Chester fine sandy loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
182165.....	Soil.....	1.6	3.8	2.7	39.6	20.3	24.4	7.5
182166.....	Subsoil.....	2.4	4.0	2.6	38.8	18.0	22.3	11.7

CHESTER LOAM.

The surface soil of the typical Chester loam consists of a light-brown to brown, mellow, friable loam 8 to 10 inches deep. The subsoil is a pale-yellow to yellowish-brown loam, which becomes heavier with depth and grades, at about 16 to 20 inches, into gritty clay loam to clay of yellowish to reddish-yellow or orange color. The subsoil, although of heavy texture, is rarely compact or plastic, but characteristically is granular in structure. In places the subsoil

contains a high percentage of mica, but as a whole it does not possess the distinctively greasy feel of the Manor soils. Very small quantities of rock fragments and small, angular pieces of quartz are scattered over the surface and through the soil mass. The absence of rock outcrops on hillsides and in cuts indicates that the soil mantle is of considerable depth, probably 5 to 12 feet or more. Small quartz fragments in the surface soil sometimes give it a coarse sandy character, but the greater part of the fine earth is silt and clay. If plowed when moderately moist, the soil works up into a good seed bed and is easily maintained in good tilth throughout the season. It does not form in clods like the Hagerstown soils and no great difficulty is experienced in tillage. Some included patches have a red color in the deep subsoil. These would be classed with the Manor soils if of sufficient size to warrant separation.

The typical Chester loam occurs in the Piedmont section of the county, associated with the Edgemont and Manor soils. The largest and most important area is situated on and south of Mine Ridge, extending from near Quarryville to the Chester County line. A smaller but important area, in which Cambridge is located, occurs to the south of Welsh Mountain. It is roughly wedge-shaped and extends into Chester County. A narrow strip, composed of the colluvial wash from the hills occupied by the Chester stony loam is mapped in the extreme northern part of the county, and another, similar body west of Gap. Two small, isolated areas occur near Fairmount in the southern part of the county.

The surface of the Chester loam for the most part is uniformly rolling, with gentle slopes and hills of smooth, regular outline. This type is not so deeply dissected by streams as the Manor soils, and the drainage is more mature. The land slopes enough to give it adequate natural drainage, but the slopes are not so steep as to cause erosion or to interfere with cultivation.

At least 95 per cent of this soil is in cultivation, and of the original forest land only a few woodlots remain. Chestnut, chestnut oak, white oak, walnut, hickory, and dogwood are the principal native trees.

The Chester loam is an excellent soil for general farming. The subsoil is not so compact as to retard drainage, but is so retentive of moisture that crops seldom suffer from the short periods of drought which commonly occur. The soil warms up comparatively early in the spring and does not heave with frost. The land is utilized for as great a variety of crops as the Hagerstown silt loam, but is less productive. Corn, wheat, oats, potatoes, tobacco, and grass are the staple crops grown. Tobacco and potatoes are the principal money crops. Corn yields from 40 to 75 bushels, the average yield being about 65 bushels of grain and 10 tons of ensilage per acre.

Wheat yields 20 to 35 bushels, averaging 25 bushels; oats, 30 to 40 bushels, averaging 35 bushels; potatoes, 85 to 150 bushels, averaging 100 bushels; tobacco (Seedleaf), 1,200 to 1,600 pounds, averaging 1,300 pounds; and hay, 1 ton to 2½ tons, averaging 1½ tons of mixed timothy and medium red clover. Higher yields of all crops, particularly of potatoes and tobacco, occasionally are reported.

Regular systems of crop rotation are practiced, a five-year rotation being in general use. Corn one year, followed by oats, tobacco, or potatoes one year, then wheat one year seeded to mixed timothy and clover, to remain in sod two years, is a popular rotation. Dairying is carried on to some extent, and apparently could be profitably extended. On those farms where dairy herds are kept the silo is coming into general use. The feeding of stock is commonly practiced, utilizing the roughage from the farm, and producing manure which is used to advantage, together with the commercial fertilizers and lime. Hydrated lime has been in common use for sometime, but is being supplanted by ground limestone. The manure is used mainly on sod for corn and potatoes. Lime is applied to the wheat land. Commercial fertilizers of a 2-8-2 or 2-10-3 grade are used on all crops at the rate of 300 to 500 pounds per acre for corn, 200 to 400 pounds for oats, 500 to 1,000 pounds for potatoes, 300 to 500 pounds for wheat, and 400 to 600 pounds per acre for tobacco. Considerable hay and all the wheat are sold.

The farms range in size from 30 to 200 acres. The small farms are most common, however, and the average area is about 75 acres. Farms of this size, well improved and favorably situated, are valued at as high as \$200 an acre. The average of this land is about \$70 an acre.

A number of rather small areas of a poorly drained variation of this type are indicated on the soil map with inclusion symbols. This poorly drained soil consists of a dark-gray to nearly black silty clay loam, containing considerable organic matter, underlain at about 8 to 12 inches by a light-gray silty clay loam or clay which grades into white, mottled yellow or drab silty clay. Large quantities of very finely divided mica in the subsoil give it a greasy feel. In the third foot of the soil section a mass of broken, angular quartz fragments embedded in a highly micaceous silty clay frequently is encountered. The soil is usually free from stones, though in a few areas scattered bowlders are encountered.

This soil occurs in small, flat, and relatively unimportant areas. It occupies depressions, and low-lying spots at the heads of small streams, and the poor drainage has favored the accumulation of organic matter. The soil is colluvial, and represents the accumulations of wash material from the slopes of the adjoining Manor and Chester soils. It receives fresh additions of material yearly.

These poorly drained areas are cultivated to a small extent, but mainly are occupied by a growth of willow, swamp white oak, alder, and other trees and shrubs which are suited to the wet conditions. The cleared areas support a good growth of native pasture grasses. The soil is of little value in its present condition except for pasturage and the hay which is sometimes cut.

The greater part of this soil could be drained and converted into good farm land. There is little doubt that the soil would prove as productive as, if not superior to, the adjoining uplands with proper drainage. Tile drainage should prove profitable.

#### CHESTER STONY LOAM.

The areas in Chester loam color, indicated on the soil map by stone symbols comprise the Chester stony loam. In these areas the soil is a light-brown loam or sandy loam, varying locally to a silty loam. The subsoil is a yellow to reddish-yellow loam to clay loam grading into reddish clay loam at a depth of about 24 inches. The subsoil, while frequently of heavy texture, is rather brittle or moderately friable. Mica is frequently noticeable in the subsoil. Stones, varying in size from gravel to boulders 2 or more feet in thickness, are scattered over the surface and disseminated through the soil, constituting 25 to 60 per cent of the soil mass. In some places many of the stones have been removed. The stone content is not usually large enough to prevent cultivation of the land, except on the steeper slopes. Rock outcrops are of rare occurrence. Accumulations of colluvial material at the bases of slopes are less stony than the typical soil, and where practicable such material is classed with the Chester loam.

A considerable area of the Chester stony loam is encountered in the extreme northern part of the county; another important area occupies the northern slope of Mine Ridge west of Gap. Other smaller areas are scattered throughout the Chester loam.

The stony loam areas are hilly to rough, and the natural drainage is good. The soil on the steeper slopes is subject to considerable damage from erosion, and care in the cultivation of such areas is required.

The Chester stony loam, like the loam, is residual, mainly from fine-grained banded gneiss and coarse-grained foliated gneiss. A few fragments of granite are present, but granite does not seem to have entered into the composition of the soil. In some places the soil has a slightly higher content of mica than usual, resulting, apparently, from the presence of mica in the parent rock.

Farm land has been extended into areas of this soil in places, but the greater part of it is forested, mainly with chestnut and chestnut

oak. Mountain laurel and huckleberry are conspicuous in the undergrowth. Where cultivated, this soil produces yields of the staple crops of the region nearly equal to those obtained on the Chester loam. In order to maintain its productiveness it is necessary to apply large quantities of manure and to build up in other ways the organic-matter content. A few apple orchards on this soil indicate that an extension of the fruit industry would prove profitable. Improved land on the stony loam is valued at \$40 to \$80 an acre and the forested land at \$15 to \$35 an acre.

#### PENN SERIES.

The soils of the Penn series are characterized by the reddish-brown or Indian-red color of the soils and the Indian-red color of the subsoils, the color having been imparted to the material by the red Triassic shales, sandstones, and conglomerates from which the series is derived. The drainage is good and, in case of the more shaly areas, excessive. The surface is undulating to rolling or hilly.

#### PENN GRAVELLY SANDY LOAM.

The Penn gravelly sandy loam is a dark reddish brown to light Indian-red sandy loam 8 to 10 inches deep, underlain by Indian-red sandy loam, grading at about 20 to 24 inches into Indian-red loam, clay loam, or gritty clay. Both soil and subsoil contain large quantities of rounded or waterworn quartz and quartzite gravel. The proportion of gravel in the surface foot of the soil is often as great as 60 per cent, but decreases 10 or 20 per cent in the subsoil. Angular and subangular fragments of sandstone frequently make up a part of the gravel content. There are some included patches of sandy loam, and in a few small areas the surface soil is grayish and very similar to that of the Lansdale gravelly sandy loam. This condition is due in part to the greater content of light-colored quartz gravel on the surface, and probably to some extent to leaching. Owing to the loose, friable nature of the soil it can be cultivated under a wide range of moisture conditions.

In the vicinity of Bainbridge, Blainsport, and Schoeneck several areas of Penn gravelly loam are encountered. These are included with the gravelly sandy loam on account of their small extent.

The total area of the Penn gravelly sandy loam is small, only 3.5 square miles being mapped. The largest single area is on Laurel Ridge north of Blainsport. It extends into Berks County. A number of less important, roughly oval-shaped bodies of this soil are located in Clay and West Cocalico Townships at the base of South Mountain. Other small areas occur near the top of South Mountain along the Lebanon County boundary.

The Penn gravelly sandy loam occupies the tops of ridges and steep slopes, ranging in elevation from 500 to 900 feet above sea level, and 100 to 300 feet above the adjoining Penn loam type. The drainage frequently is excessive, although the more gentle slopes having a heavy soil are sufficiently retentive of moisture in ordinary seasons for crop production.

The soil is residual in origin, and derived principally from red conglomerates and partly from sandstones of Triassic age. The sandstone and conglomerate are interbedded, the former predominating, but strata of the conglomerate having a thickness of 12 or 15 feet are observed in outcrops. The conglomerate is made up of pebbles and cobbles derived from the older Paleozoic formations, embedded in a matrix of red sand and clay.

Probably about one-fourth of the type is in cultivation; the remainder is in forest, the principal tree growth being chestnut, with a scattering of white oak and chestnut oak. The undergrowth is mainly mountain laurel and sassafras.

This type is cultivated to the general farm crops with fair results, corn, wheat, tobacco, potatoes, and grass being the staple crops, with a very small acreage of oats and rye. Corn yields about 40 to 50 bushels, wheat 15 to 20 bushels, tobacco 900 to 1,400 pounds, potatoes 75 to 100 bushels, and hay about 1 ton per acre. The soil responds readily to the use of commercial fertilizers. Apples and peaches of good quality give fair yields, and it would seem that the acreage in fruit might well be extended.

The average value of this land is estimated to be between \$35 and \$50 an acre.

#### PENN STONY LOAM.

The surface soil of the Penn stony loam, to a depth of about 8 to 10 inches, is a brownish-red or dark Indian-red, medium gritty loam to sandy loam. The subsoil is an Indian-red heavy loam or clay loam grading into clay at a depth of 20 inches to 3 feet. Angular sandstone and conglomerate fragments are present in both surface soil and subsoil in such quantity as seriously to interfere with cultivation. The stones on the surface are usually small. They vary, however, from small rounded gravel to angular blocks a foot or more in diameter. The stones of the subsoil, being protected to a certain extent from weathering, are larger. The mass frequently rests on a substratum of broken sandstone. In the forested areas the surface is covered with an inch or two of rich, dark leaf mold, but under cultivation this has disappeared and the surface has assumed a light brownish-red to red color.

In preparing the land for cultivation many of the stones have been removed. As in the case of other stony areas in Lancaster

County, the stones removed from the land are used in constructing fences or are piled in the fields. The soil, when free from stones, is easily cultivable and can be worked under a wide range of moisture conditions.

The Penn stony loam is confined to the northern part of the county and is typically developed on South Mountain along the Lebanon-Lancaster County line, extending in an almost unbroken ridge from northwest of Mount Hope to Adamstown. Detached areas occur on the ridge east of Ephrata, and on Wolf Hill north of Churchtown.

This soil is derived from thick-bedded sandstone and conglomerate of Triassic age. The sandstone is usually brownish-red, varying to gray, while the conglomerate usually is lighter in color. The stony character of the soil is due in part to the thick-bedded structure of the original rock and partly to the topography, some of the fine earth material having been carried down the slopes. The rock seems to be composed essentially of angular particles of quartz cemented by iron oxide and rarely by silica. Some of the rock has an arkosic character.

This soil type has a hilly to mountainous topography, and is well drained. The subsoil, however, is retentive of moisture. Some seepage takes place on the lower slopes. There is very little erosion of the soil. Streams flowing through it have cut deep channels. The elevation ranges from 400 feet to 1,200 feet above sea level, the highest point being on South Mountain north of Penryn.

It is estimated that about 25 per cent of the area of Penn stony loam has been cleared and put under cultivation. The native forest growth consists principally of chestnut, with some white, black, red, and chestnut oak, hickory, tulip, mountain maple, dogwood, locust, cedar, butternut, beech, and sassafras. Mountain laurel is the chief undergrowth.

Forest products furnish the chief income. The ruggedness of the surface configuration and the stony character of the soil make the clearing of the land very expensive. The size of the cleared farms ranges from 30 to 50 acres.

The type is farmed mainly to the general crops, although it is better suited to truck and fruit, particularly small fruits. Apples, peaches, pears, plums, and cherries are grown to some extent. The soil is friable, easily maintained in good tilth, and responds readily to good management. Yields of corn and wheat are probably equal to those obtained on the Penn loam, but the expense of tilling and harvesting the crops is much greater. Oats and rye occasionally are grown, but the acreage is small and the results often unsatisfactory. The yields of hay are small, and natural pasture is poor. Much of

this type is situated at a considerable distance from markets and this fact retards its development.

The uncleared land sells for \$10 to \$25 an acre, depending on the timber. The selling price of improved land ranges from \$20 to \$40 an acre.

#### PENN LOAM.

The surface soil of the Penn loam consists of a reddish-brown or Indian-red mellow loam, with an average depth of about 10 inches. The subsoil is almost invariably Indian-red heavy clay loam, grading into deeper Indian-red clay in the third foot of the soil section. The line of demarcation between soil and subsoil is rather indistinct. Generally the type is free enough from stones to permit fairly easy cultivation. Where this type adjoins the Penn stony loam areas, and in the general region of Terre Hill and Bowmansville, blocks of the underlying rocks are scattered over the surface or have been removed.

There are local variations in the texture and color of the surface soil, but these are of little importance. Patches of clay loam, silt loam, shale loam, and fine sandy loam, too small to be shown separately on the map, are encountered throughout the area of the type. The heavy subsoil is often exposed in spots on hillsides, from which the original covering of lighter soil has been washed. Narrow belts of silt loam occur at the bases of slopes or in slightly depressed areas, these representing material accumulated through wash from adjoining contiguous higher land. The tops of small, rounded knolls or hillocks are frequently occupied by material of coarser texture than the typical loam. Where areas of the Penn loam are associated with the soils of the Lansdale series, the color of the soil is frequently lighter than the typical, and the boundary line between the two in the northwestern part of the county is more or less arbitrary. The separation is mainly based on the color of the subsoil.

A large area in this county is occupied by the Penn loam. The soil is typically developed in the northeastern plateau region of Lancaster County. The largest and most important area extends to the east from Ephrata, expanding as the Berks County line is approached. The flat or level tops of hills in this dissected country are all that indicate that the region was once a level plateau. These hilltops rise to a height of 50 to 200 feet above the nearby limestone valleys. The Penn loam in the northern part of the county, occurring in Clay and East and West Cocalico Townships, occupies a valley between ridges of South Mountain.

The topography of the Penn loam is that of an undulating to rolling plain. The surface is nowhere very rough or hilly. In the main the natural drainage is good. A comparatively small part of

the type, including depressions and the more nearly level areas, would be benefited by tile drainage, although there is no land in a continuously wet condition. Soil erosion is not a serious problem on this type, except in very small areas.

This soil is residual from red sandstones, conglomerates, and shales of Triassic age. The soil is closely related to the underlying rock in color and texture, variations in the soil being directly traceable to differences in the character of the rock. The sandstone is medium to coarse grained. The red or reddish-brown color of the rock is probably due to a coating of iron oxide over the sand grains.

Nearly all the area occupied by the Penn loam has been cleared and put in cultivation. In a few remaining woodlots white oak and hickory constitute the chief tree growth, with some chestnut, walnut, red oak, cedar, hemlock, elm, beech, and tulip.

The Penn loam is considered one of the most productive soils in the county for general farm crops. Where reasonable care is exercised in tillage the soil does not form in clods or bake hard in dry weather. The soil is fairly rich in organic matter and the supply usually is maintained. The soil can be kept in good tilth with little difficulty and an effective dust mulch maintained. The subsoil is fairly retentive of moisture and crops do not suffer from drought. The included areas of clay loam are inclined to bake and become compact.

There is little waste land in this type. Corn, wheat, tobacco, potatoes, oats, and grass are the staple crops. Some rye is grown, but the acreage is very small. Corn yields from 35 to 80 bushels, the average being about 45 bushels per acre. Wheat yields 15 to 30 bushels, averaging 20 bushels per acre; tobacco (Seedleaf) 1,000 to 1,800 pounds, averaging 1,200 pounds per acre; potatoes, 90 to 125 bushels per acre; oats, 30 to 40 bushels; and hay, mixed timothy and clover, 1 ton to 2 tons per acre. The quality of the tobacco is usually very good. The Sumatra leaf type formerly was grown to a small extent on the lighter variations of this soil, but has been abandoned. Havana leaf is still grown, but the acreage is small as compared with the acreage in the Pennsylvania Seedleaf. While many farms have small orchards, fruit is not produced on a commercial scale.

The system of crop rotation common to this region is in general use. Corn one year, followed by tobacco one year; then wheat, seeded to timothy and clover, to remain in sod one year or two years, is a common rotation. Wheat is sometimes grown in the same field two years in succession and grass is sometimes allowed to remain only one year. Dairying in a small way is carried on in connection with general farming on some farms. The value of barnyard manure is generally recognized. A few steers are fattened on nearly all farms.

Lime is generally applied and has proved very beneficial. Slaked lump lime is most commonly used, but ground limestone is becoming more popular. Commercial fertilizers are used on nearly all crops.

The farms range in size from 30 to 200 acres, the average size being about 75 or 80 acres. The selling price of farm land depends largely on the improvements and its location with respect to markets and shipping points. Improved land sells for \$75 to \$125 an acre. The average value of land of this type is about \$55 an acre.

#### LANSDALE SERIES.

The soils of the Lansdale series are characterized by grayish-yellow or grayish-brown soils and pale-yellow subsoils. The chief difference between these soils and the soils of the Penn series is in color. The Lansdale soils are residual from yellowish and grayish sandstones and conglomerates of Triassic age. They have about the same topography and drainage as the Penn soils.

#### LANSDALE GRAVELLY SANDY LOAM.

The Lansdale gravelly sandy loam consists of a grayish-brown light gravelly sandy loam, underlain at about 5 to 10 inches by pale-yellow or yellow light gravelly loam or sandy loam, grading into light gravelly sandy loam at a depth of about 16 to 24 inches. Sandy clay occasionally is encountered in the lower part of the 3-foot section. Stones, varying in size from fine gravel to cobbles 4 to 6 inches in diameter, constitute from 20 to 60 per cent of the soil mass. The gravel usually is most abundant in the surface 12 or 18 inches. It consists of angular and subangular fragments of fine to coarse-grained sandstone and waterworn quartzite and chert pebbles and cobbles. There are so many spots of Penn gravelly sandy loam in the areas of this soil that the characteristic red of the Penn series often appears in the areas mapped as Lansdale. Where the soils are associated the separation is based on the predominating color. In the northwestern part of the county there are some included areas of Lansdale gravelly loam.

The Lansdale gravelly sandy loam is of small extent and is scattered through the northwestern and northern parts of the county, associated with the other soils of the Lansdale series and with the Penn soils. It is confined mainly to Conoy, West Donegal, Mount Joy, and Rapho Townships, while some minor areas occur in the vicinity of Terre Hill.

The surface configuration of the Lansdale gravelly sandy loam is varied. The type occupies small, rounded hills, long, narrow ridges with abrupt slopes, and undulating to rolling land. The drainage is well established, and excessive where the topography

is roughest. The loose, porous nature of the subsoil in some areas permits rapid downward percolation of rain water.

This soil is derived from the underlying grayish or yellow, fine-grained to coarse-grained sandstones and conglomerates of Triassic age. The sandstones and conglomerates are interbedded, enough gravel being liberated by the disintegration of the conglomerate to give the soil its gravelly character.

At least 80 per cent of the type is in cultivation. The original forest apparently consisted mainly of chestnut, with a scattered growth of white and red oak, locust, and a number of shrubs.

The soil is easily cultivated under a wide range of moisture conditions. The gravel particles usually are not large enough to interfere seriously with cultivation. The type is devoted mainly to the general farm crops, including corn, wheat, tobacco, potatoes, and grass, and a small acreage each of oats and rye. The farm practice is about the same on this soil as on the Lansdale sandy loam, but crop yields are usually inferior except in seasons of abundant rainfall. The soil responds quickly to the use of commercial fertilizers. Alfalfa is grown in a few small fields, and apparently does well.

The type seems best adapted to small bush fruits, which, with an early growth, can be harvested before the summer droughts. This soil would be improved by the liberal use of manures to increase the organic-matter content. The included Lansdale gravelly loam is somewhat more productive than the typical gravelly sandy loam.

There are few, if any, farms entirely within this type. It has about the same agricultural value as the Penn gravelly sandy loam.

#### LANSDALE SANDY LOAM.

The Lansdale sandy loam consists of a yellowish-gray to grayish-brown sandy loam 6 to 10 inches deep, underlain by a pale-yellow sandy loam, or light sandy loam containing enough of the finer material to render it coherent and moderately compact. Sandy clay loam is frequently encountered at a depth of about 30 inches. Toward the lower slopes the surface soil is somewhat modified by colluvial wash, and in such instances the soil on the slopes is free from stones, while the tops of the hills contain considerable small angular fragments and rounded gravel, not in sufficient quantity, however, to interfere with cultivation. The similarity in color of the sandy loam and the loam renders it difficult to determine the line of separation between the two types.

This type is associated with the Lansdale loam and Penn loam in the northwestern and northern parts of the county. It occurs mainly in small, detached areas, but in the aggregate is of considerable importance. The largest areas are located north and northeast of Bainbridge and in the vicinity of Milton Grove.

The Lansdale sandy loam occupies the tops and steeper slopes of low, rounded hills and broad gently, undulating slopes. It has a more varied topography than the Lansdale loam. The drainage is good, it is seldom excessive, and surface erosion is never serious. Artificial drainage is not necessary except in a few small areas.

This soil is residual and is derived from the weathering of medium and coarse grained, grayish and yellowish sandstones and conglomerates of Triassic age, differing only in color from the material giving rise to the sandier members of the Penn series. The sandstone is soft and is composed mainly of cemented grains of quartz. The cementing material seems to be clay, together with silica. The slight color of the soil is traceable to the underlying strata of sandstone and conglomerates.

The land is practically all under cultivation, only a few small woodlots remaining. The native trees are white and red oak, hickory, chestnut, tulip, locust, and cherry.

The soil is easily cultivated, and a good tilth is maintained without difficulty. By keeping a dust mulch in cultivated fields crops are protected from drought. Agricultural practices are the same as on the Lansdale loam, but crop yields are on the whole slightly lower. Corn yields 50 to 65 bushels per acre, wheat, 15 to 18 bushels; oats, 25 to 35 bushels; tobacco, 900 to 1,400 pounds per acre; and hay, mixed timothy and clover, 1 to 1½ tons per acre. Some areas seem to be well adapted to potatoes, and yields of 100 to 150 bushels per acre are obtained.

This land is valued at \$45 to \$90 an acre. A reasonable average is about \$70 an acre.

#### LANSDALE LOAM.

The soil of the Lansdale loam is a light-brown, mellow silty loam about 10 inches deep. The subsoil is a yellow or yellowish-brown friable loam to silty clay loam, which frequently is lighter in texture and more open in structure at about 30 inches. Lemon-yellow streakings often occur in the third foot of the section. The soil, for the most part, is free from large rock fragments, but a scattering of small, angular fragments from 1 inch to 4 inches in diameter is characteristic of a large part of the type. When plowed in a very wet condition the soil tends to form in clods and bake, but if worked when moderately moist it is easily maintained in good tilth.

The Lansdale loam is distributed through the northwestern and northern parts of the county, from the Susquehanna River nearly to the Berks-Lancaster County line. It is closely associated with the Lansdale sandy loam type and the soils of the Penn series. It is so closely associated with the soils of the Penn series, particularly the Penn loam, that the intermingling of materials has given a reddish cast to the subsoil and the boundary between the two types

necessarily is rather arbitrary. The type occurs in small irregular areas, but in the aggregate is an important soil.

The areas of this type vary from undulating to rolling, the slopes, although short, sometimes being quite steep. Natural drainage is good, except in the more nearly level areas, which are in need of tile drainage.

This soil is residual from pale-yellowish or grayish sandstones of Triassic age, resembling the sandstones from which the Penn loam is derived in every particular except color. The rock has not been modified by heat metamorphism, as in the case of the rocks underlying the Lehigh soils. The soil derives its color from the original sedimentary material.

The native forest growth consisted of white oak, red oak, black oak, hickory, chestnut, and other hardwoods. The greater part of the type is in cultivation and devoted to the production of general farm crops. Corn gives an average yield of about 50 bushels per acre, wheat yields 20 to 25 bushels, oats 30 to 40 bushels, tobacco 1,000 to 1,500 pounds, and mixed hay  $1\frac{1}{4}$  to  $1\frac{3}{4}$  tons per acre. Potatoes are not extensively grown, but yield an average of about 100 bushels per acre. Oats are grown only to a small extent.

Crop rotation is generally practiced, the system being about the same as that employed throughout the county. Corn is followed by tobacco; after tobacco wheat is grown, seeded with red clover and timothy, followed by grass land two years or more. Dairying on a small scale and the fattening of cattle are practiced. The use of manure and commercial fertilizers is general. Lime in the form of slaked lime or ground limestone is applied on the wheat land. Commercial fertilizer of about a 2-8-2 grade is applied to most of the crops. The manure is used mainly on the corn and tobacco land. The type seems better adapted to general farming than to the production of special crops.

The buildings on the Lansdale loam are usually good and are kept in good repair. Farms with good improvements are valued at \$100 to \$115 an acre. The average selling price of farms of 50 or more acres is probably about \$80 an acre.

Below are given the results of mechanical analyses of samples of soil and subsoil of the Lansdale loam:

*Mechanical analyses of Lansdale loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
182125.....	Soil.....	1.8	4.8	2.8	8.4	13.6	51.6	17.0
182126.....	Subsoil.....	1.0	4.2	2.4	8.4	19.1	46.3	18.4

## LEHIGH SERIES.

The soils of the Lehigh series are characterized by drab or bluish-gray soils and bluish compact subsoils. These soils are residual from shale and other rocks of Triassic age which have been modified by metamorphism from intrusions. They are associated with the soils of the Montalto series. The surface drainage is good, but the subsoil drainage appears to be deficient in places.

## LEHIGH STONY LOAM.

The surface soil of the Lehigh stony loam is a yellowish-gray or dull slaty gray silty loam or silt loam, underlain at 4 to 6 inches by a pale-yellow or drab, very compact silty clay loam or clay which extends to a depth of 20 to 24 inches. At this depth a substratum of broken rock usually is encountered. Angular fragments of the rock, though small, occur in such quantity in the upper 2 feet of the soil mass as to interfere seriously with cultivation and to lessen the agricultural value of the land. Local variations in color result from differences in the underlying material.

This type is confined to the northwestern and northern parts of the county, occurring principally in West Donegal, Mount Joy, Caernarvon, and Brecknock Townships. It usually is closely associated with the Montalto soils and is developed as narrow bands and ridges following the outlines of the dikes of intrusive material.

The type occupies the tops of narrow ridges and the steeper slopes of larger hills. The stone content gives stability to the soil, which, if free from stones, would gully badly like the silt loam type of this series. Drainage is good and in places excessive.

The soil is residual from fine-grained sandstones and mudstones which have been modified apparently by contact metamorphism from intrusions of diabase. The beds in close proximity to the dikes have been so modified that the original character of the rock is not easily determined.

More than two-thirds of the Lehigh stony loam is forested with white oak, hickory, chestnut, chestnut oak, tulip, cedar, sassafras, and locust. Cedar is a characteristic growth on the thinner and stonier parts of the type.

This soil is one of the poorest, agriculturally, in the county. Its tillage is difficult, and it is naturally of low productiveness. The soil often becomes soggy in the spring and fall, and upon drying has a tendency to harden.

A small part of the type is utilized for general farm crops, with uncertain results. The pomaceous fruits do well on the Lehigh stony loam, and the indications are that the acreage in fruit might be extended with profit. A part of the type is best adapted to for-

estry. This soil occurs in comparatively small, narrow areas, and is sold only in connection with other soils.

#### LEHIGH SILT LOAM.

The Lehigh silt loam, to a depth of 5 to 8 inches, consists of an ashy-gray or bluish-gray heavy silt loam. The color of the soil varies locally to brownish, depending on moisture content and the character of material from which it is derived. The subsoil is typically bluish or gray, being somewhat lighter in color than the surface soil. The subsoil is a silty clay loam grading into clay at about 24 to 30 inches, and is very compact. When dry the soil gives evidence of a large content of silt, and has a flourlike feel. The disintegrated rock is encountered at depths ranging from 3 to 5 feet.

Like the stony loam type of this series the Lehigh silt loam is closely associated with the Montalto soils. It occurs in long strips along narrow ridges and in broad sheets on the longer slopes. The type is confined largely to the northwestern part of the county. The total acreage is small.

The surface is sloping and surface drainage is rapid. Many of the steeper slopes are badly eroded and gullied, while the gentler slopes require careful treatment to prevent erosion. While the surface drainage is good, subsoil drainage is slow, owing to the compact nature of the material. The soil is very retentive of moisture. In rainy seasons crops are often seeded late and fail to mature. When plowed wet the soil tends to form into clods which are broken down only with great difficulty.

The soil is residual from Triassic sandstone and mudstones metamorphosed apparently by igneous agencies. This type represents a later stage than the stony loam in the decomposition of the rock. A relatively small proportion of the soil is colluvial in origin, consisting of wash from the stony loam type.

About half the type is under cultivation. The native timber includes white oak, hickory, and chestnut. The growth is similar to that on the stony loam except that cedar is less common.

The soil generally has a low agricultural value, but with careful plowing and the judicious use of lime and manure fair yields of the general farm crops are obtained. Corn yields 30 to 40 bushels per acre, wheat 15 to 20 bushels, and oats 30 to 35 bushels. The soil is not well adapted to grass, but produces an average of about 1 ton per acre of mixed timothy and clover hay. The type is probably best adapted to fruits, particularly the small bush fruits, and to strawberries, when drained. Many fields are in need of tiling.

There are but few farms located entirely on this type. Land with best improvements is valued at \$50 to \$65 an acre. The average value for the type is about \$35 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

*Mechanical analyses of Lehigh silt loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
182123.....	Soil.....	1.6	5.0	2.6	9.1	8.8	56.5	16.4
182124.....	Subsoil.....	1.4	3.6	2.1	8.0	8.5	45.7	30.5

EDGEMONT SERIES.

The soils of the Edgemont series have grayish-yellow surface soils and pale-yellowish subsoils of compact structure. They are residual from quartz schist and quartzite, with some fine-grained sandstone. These soils occupy ridges and hills rising to a considerable height above the near-by limestone valleys. The surface drainage is usually good, but the compact nature of the subsoil causes the soil to be wet and soggy at times.

EDGEMONT STONY LOAM.

The surface soil of the Edgemont stony loam is prevaillingly a grayish loam, underlain at an average depth of about 6 inches by a pale-yellow silty loam which extends to a depth of about 16 to 20 inches, where a compact silty clay loam is encountered. While there are enough fine to coarse angular particles of sand to give the soil a sandy or gritty feel, probably 40 to 50 per cent of the fine earth is silt and clay. Enough angular fragments of rock are present in both soil and subsoil to give it a predominantly stony character and seriously to interfere with, if not prevent, satisfactory cultivation and to retard farm development on account of the expense of clearing the land. Rock outcrops rarely occur, except on the steeper slopes. The bedrock usually is found at a considerable depth below the surface, ranging from 4 or 5 feet on the tops of ridges to 8 or 12 feet on the lower slopes, where some colluvial material has accumulated. Some of the rock in the vicinity of Gap, near the Chester County line, seems to have been sufficiently metamorphosed to take on a schistose character. The type here contains some mica in the subsoil and has a slightly reddish tinge. The rock content of the Edgemont stony loam consists of angular fragments of quartzite, hard, fine-grained gray sandstone, quartz schist, and in places a small quantity of siliceous shale. In size the stones range from gravel to blocks 4 or 5 feet in thickness, but the average diameter is about 10 or 12 inches.

The Edgemont stony loam includes a few small patches having gray fine sandy loam and sandy loam surface soils and yellow, gritty loam subsoils, but these are not of sufficient importance to warrant separation.

The largest and most important area of this type occurs on Welsh Mountain, extending in an unbroken body from a point south of New Holland eastward to the Chester County line. The small ridges and hills in the vicinity of Intercourse are occupied by the Edgemont stony loam. The hills east of Gap and north of Christiana, extending from the county line into Lancaster County, are separated from the main body of the type by a narrow limestone valley. Several smaller areas of this soil extend in a broken line from Landis Valley to the Susquehanna River north of Columbia. The type has an elevation above sea level of 400 feet to more than 900 feet and lies 100 to 400 feet above the surrounding country.

The surface configuration is rough and irregular in places, and some of the slopes are so steep that cultivation of the ordinary crops is extremely difficult or impossible. In general the topography is hilly to mountainous. The surface run-off is usually rapid, but the stone content prevents serious erosion. The compact nature of the subsoil causes some of the type to be soggy in rainy seasons. As a whole, the soil is fairly well drained.

The Edgemont stony loam is derived principally from quartzite and quartz schist, the formation being known as the Chickies quartzite. The rocks are highly siliceous, consisting of gray arkosic quartzite and hard, fine-grained gray sandstones. A small quantity of argillaceous schist or shale is encountered in the hills north of Columbia.

Only about 10 per cent of the type is in cultivation, the remainder being in dense forest, consisting principally of chestnut, particularly in the higher positions, with some white oak, chestnut oak, tulip, maple, hickory, dogwood, locust, hemlock, spruce, and a thick undergrowth of huckleberry, mountain laurel, and sassafras.

The Edgemont stony loam is not, as a whole, well suited to general farming on account of the steep slopes and the stony character of the soil. The expense and labor of clearing the land of timber and stones has retarded its development, and the area of improved land in farms is small, ranging from 10 to 40 acres on each farm. Some of the less hilly and stony soil has been cleared of the timber and stones, and good yields of the staple crops are obtained. Corn yields 35 to 65 bushels, wheat 15 to 25 bushels, oats 30 to 40 bushels, tobacco 1,000 to 1,500 pounds, and hay 1 ton to 2 tons per acre. Timothy is a good hay crop, but clover seems to make a poor stand. Tobacco (Pennsylvania Seedleaf) of good quality is grown, but the yields are low.

Some of the new land, notably on Welsh Mountain and near Rohrerstown, has been used for orchards of apples, pears, peaches, and cherries, and the results seem to justify an extension of this industry. Grapes on the slopes exposed to the south do fairly well. A good form of agriculture for this soil seems to be a combination of fruit and poultry farming.

The forested land is valued at \$10 to \$35 an acre, according to the quantity and variety of the standing timber. Improved farms of 20 to 40 acres are held at \$30 to \$65 or more an acre, depending on the distance to markets, character of roads, and topography.

#### EDGEMONT LOAM.

The Edgemont loam, to a depth of 6 to 8 inches, is a pale-yellow or yellowish-gray, mellow silty loam containing a sufficient quantity of sand to give it a distinctly gritty feel. The upper subsoil is a lemon-yellow or pale-yellow, flourlike silty loam, grading into silt loam or silty clay loam at about 30 inches. The soil is sufficiently free from stones to permit cultural operations, but there is a scattering of small, angular blocks of quartzite, and small, flat, slaty rock fragments. The bedrock is encountered at a depth of 3 to 6 feet, except on the lower slopes where some colluvial material has added to the depth of the soil mass. The soil is inclined to form clods when worked too wet but under moderately moist conditions it works up into a mellow tilth with less labor than some of the other soils of the county having the same texture.

The typical Edgemont loam is located around Columbia, associated with the stony loam of the same series. A small area occurs at the foot of the slope on the north side of Welsh Mountain, and others are associated with the Edgemont stony loam to the south, near the Chester County line. The type has a small total area.

The Edgemont loam occupies mainly the lower undulating slopes and tops of hills and stream divides. The topography is mainly rolling to hilly. The natural drainage is usually good, although small local areas have a compact subsoil, and in wet seasons a wet, soggy condition prevails until late in the spring. Few of the slopes are steep enough to prohibit the use of modern farm machinery.

About half of the type is under cultivation, and of the remainder nearly all is forested with chestnut, oak, hickory, dogwood, and tulip, with an undergrowth of mountain laurel. This land is utilized for general farming, and the crops common to the region are grown. Corn yields 45 to 70 bushels per acre, wheat 18 to 25 bushels, oats 30 to 40 bushels, tobacco 1,000 to 1,500 pounds, and hay, mixed timothy and clover,  $1\frac{1}{2}$  to  $2\frac{1}{4}$  tons. Fruits, such as apples, pears, peaches, and cherries, should do well on this soil, and the steeper slopes seem well suited to orcharding.

The land has a wide range in value. It sells for \$50 to \$100 an acre depending on its improvement and location with respect to markets.

Results of mechanical analyses of samples of soil and subsoil are given in the table below :

*Mechanical analyses of Edgemont loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
182135.....	Soil.....	1.5	3.4	1.7	10.5	22.3	44.6	15.4
182136.....	Subsoil.....	1.7	4.1	1.9	9.0	20.0	46.8	16.1

MONTALTO SERIES.

The soils of the Montalto series are rusty brown, reddish brown, or yellowish red, and are underlain by yellowish-red to dull-red subsoils. They generally can be worked only under a narrow range of moisture conditions, but are considered well drained. These soils are derived from the weathering of intrusive dikes consisting chiefly of diabase. They occupy slopes and hills.

MONTALTO LOAM.

The Montalto loam, to a depth of 8 to 10 inches, is a light-brown or yellowish-brown, heavy, gritty loam to silty loam. This is underlain by an ochereous to light reddish brown heavy loam or clay loam, grading at about 2 feet into red clay loam to clay. The subsoil is crumbly and gritty, and has the appearance and feel of a much lighter soil. On some of the eroded slopes the soil is reddish brown in color and a clay loam in texture, but the variation is not of sufficient importance to warrant separation on the soil map. With a reasonable expenditure of labor the soil can be maintained in good tilth.

This type is residual from diabase, or trap rock, and occurs in the northeastern and northern parts of the county, where the Triassic rocks are encountered. Some of the principal areas are near Adamstown, near the Berks County line. In such areas the underlying rock resembles granite and the soil is more yellowish than typical.

The topography of the typical areas is sloping and rolling. Where the steeper slopes occur the fine earth has been washed away, exposing stones, and such areas comprise the Montalto stony loam. Such areas are subject to serious washing and gullyng. The slopes are seldom steep enough seriously to hinder the use of modern farm machinery.

About one-half of the typical Montalto loam is cleared and cultivated. The remainder is forested with oak and some hickory, chest-

nut, tulip, dogwood, beech, cedar, ash, walnut, sycamore, locust, and birch. The cultivated land is devoted to the general farm crops. The farm practices are the same as on the adjoining soils. The areas of the type usually are so small that only small fields occur on this soil. The type is naturally strong, and with proper attention to manuring and liming produces good yields of the staple crops. Corn yields 45 to 55 bushels, wheat 20 to 30 bushels, oats about 40 bushels, tobacco 1,200 to 1,500 pounds, and mixed clover and timothy hay 1½ to 2 tons per acre. Light applications of commercial fertilizers, 150 to 300 pounds per acre, are employed on all crops. The fertilizers usually are high in potash.

Farms on this type with good improvements sell for \$60 to \$100 an acre, but areas remote from markets sell for as low as \$35 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Montalto loam:

*Mechanical analyses of Montalto loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
182133.....	Soil.....	0.6	2.9	2.2	11.3	23.6	44.6	14.8
182134.....	Subsoil.....	.4	2.9	3.0	15.0	19.0	39.4	20.3

MONTALTO STONY LOAM.

The Montalto loam as mapped includes several areas of the Montalto stony loam, which are indicated on the soil map by stone symbols.

To an average depth of about 10 inches the Montalto stony loam is a light reddish brown to rusty-brown heavy loam or silty loam. This is underlain by reddish-yellow heavy loam to clay loam, grading into red clay loam to gritty clay at about 20 to 24 inches. The subsoil generally has a granular structure, though small areas have a very heavy, plastic clay subsoil and moderately heavy clay surface soils. The surface is strewn with angular rock fragments, varying in size from small gravel to boulders 2 feet or more in diameter, and rock fragments are found throughout the 3-foot section. Areas in which the stones are of such size and occur in such quantities as to prohibit cultivation are shown on the soil map as rough stony land. Many of the larger stones have been removed from the fields and the less stony areas converted into good farm land.

Long, narrow dikes, consisting chiefly of diabase, have given rise to this soil in several parts of the county. One of these dikes, extending from Salunga southward through the limestone valley land is particularly noticeable. A small part of the rock from which this soil is derived is grayish, and coarse grained, giving rise to a more

yellowish soil, and a lighter brown or reddish-brown subsoil. These rocks occur in the northeastern part of the county.

The stony loam areas are hilly and rough or sloping. Some of the smaller areas are undulating. The natural drainage is good, and the subsoil is retentive of moisture. The abundance of stones prevents serious erosion, though the surface soil is sometimes washed from the ridges and steeper slopes.

About one-fourth of the Montalto stony loam is in cultivation, the remainder being in pasture and woodland. The land devoted to farming is used mainly for the staple farm crops, with some dairying. The methods of farming common to the county usually are employed. Corn yields 40 to 65 bushels, wheat 20 to 25 bushels, with occasional yields of 30 bushels, tobacco 1,000 to 1,700 pounds, the average being about 1,200 pounds, and mixed timothy and red clover  $1\frac{1}{2}$  to  $2\frac{1}{2}$  tons of hay per acre. The soil is well suited to the production of fruit, but there are only a few orchards, mainly near Elizabethtown. The arable land is valued at \$40 to \$75 and in some cases \$100 an acre.

#### CONOWINGO SERIES.

The Conowingo soils are grayish yellow to brownish, and the subsoils yellowish, varying to reddish. These soils are derived mainly from serpentine and associated rocks, and the subsoils have a decidedly greasy feel. The drainage is not well developed, at least locally, although the surface is rolling to hilly. The soils of the better class are fairly well suited to general farming, but some areas are stony and practically worthless for agriculture.

#### CONOWINGO SILT LOAM.

To depths ranging from 4 to 8 inches the Conowingo silt loam consists of a grayish-yellow silt loam. This is underlain by a yellowish, more compact, heavy silt loam. At a depth of about 18 inches the color changes to yellowish brown, and the texture to clay or silty clay loam. The subsoil has a very compact structure and a decidedly greasy feel. Below a depth of about 18 inches the material almost invariably is mottled with light gray, and frequently mottlings appear in the surface foot. Included patches vary to a brownish-red silty loam, underlain by red or yellowish-red clay or clay loam. The soil mass rests on bedrock at depths of about 2 to 6 feet. In a few places fragments of the rock occur in such quantity as to prohibit cultivation. Rock outcrops occur on the steeper slopes and bluffs, and are included with the Rough stony land.

This type has a small total area. The largest single body lies along the Maryland State line.

The topography is generally rolling, but a part of the type occupies long, gentle slopes. The surface water runs off rapidly, but sub-

soil drainage is invariably poor on account of the heavy texture and compact structure of the material. Crops are subject to injury by drought.

About one-half of the type is under cultivation. The native forest growth consists of cedar, particularly near areas of rock outcrop, stunted white pine, and scrub oak. The better areas support a larger and more sturdy growth of the various oaks native to this section.

By plowing the soil when moderately moist and repeated harrowing the soil can be worked up into good tilth. When plowed too wet or too dry hard clods are formed, and these are broken down only with great difficulty. Proper drainage, the liberal use of lime and manure, and a gradual deepening of the plowed section are the essential requisites for the improvement of this soil. General farming is carried on over most of the type with fair results. Much of the wild land affords only meager pasturage, as native grasses do not do well. Corn yields 30 to 40 bushels per acre, wheat 12 to 15 bushels per acre, and timothy hay about 1 ton per acre. The land has a selling price of \$5 to \$15 an acre.

Results of mechanical analyses of samples of the soil and subsoil are given below:

*Mechanical analyses of Conowingo silt loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
182115.....	Soil.....	1.0	3.0	1.0	2.6	5.7	76.6	9.9
182116.....	Subsoil.....	2.8	4.0	1.4	3.2	8.4	64.6	15.6

#### ELK SERIES.

The Elk series is characterized by the brown color of the soils and the light-brown color of the subsoils, with a substratum of rounded, waterworn gravel. These soils occupy terraces along the Susquehanna River, which are composed of transported material laid down by overflows when the streams reached higher levels. The gravel consists mainly of sandstone, with small quantities of shale, limestone, and crystalline rocks. The surface is undulating to level, and the drainage is well established.

#### ELK GRAVELLY LOAM.

The soil of the Elk gravelly loam is a brown or light-brown silt loam, usually containing 30 or 40 per cent of waterworn gravel varying in size from fine gravel to stones 3 or 4 inches in diameter. The subsoil, beginning at about 8 to 10 inches, has the same texture as the soil, but usually is of a lighter brown to yellowish color. This is underlain at 2 to 4 feet by a stratum of gravel containing a small

quantity of fine earth. The fine earth varies throughout the type from silt loam to fine sandy loam, but for the most part it is a silty loam. The gravel content ranges from 25 to 60 per cent in both soil and subsoil. The gravel consists mainly of granite, quartzite, sandstone, and limestone.

The Elk gravelly loam is associated with the other soils of the Elk series on the terraces along the Susquehanna River. The largest single area of the type is situated near Bainbridge; another area of considerable size occurs south of Washingtonboro. Smaller areas are encountered between these places.

The topography of the type is level to gently rolling. The natural drainage is good and in some places excessive. However, the substratum usually contains enough fine earth to be fairly retentive of moisture.

This soil has the same origin as the other Elk soils. The presence of rounded gravel indicates that the material has been reworked by stream action.

All of the Elk gravelly loam is in cultivation, and is used for general farming. Of the staple crops of the region this soil seems best suited to corn and Havana tobacco. The methods of farming and the crop yields are about the same as on the other Elk soils. This land sells for \$75 to \$200 an acre.

#### ELK FINE SANDY LOAM.

The Elk fine sandy loam is a brown fine sandy loam, underlain at about 8 to 12 inches by yellowish-brown or light-brown fine sandy loam, which passes at about 12 to 24 inches into sandy clay loam or sandy clay of rather compact structure and light-brown color. A few waterworn gravel particles and cobbles occur on the surface and through the soil section, but not in such quantities as to give the soil a gravelly character. At depths of 3 to 6 feet, however, a stratum of gravel embedded in fine earth material is encountered, the gravel constituting about 50 to 75 per cent of the mass. This type can be worked under a wide range of moisture conditions and is easily maintained in good tilth. Occasional cultivation in the growing season is sufficient to develop an effective mulch, and crops seldom suffer from the short periods of drought.

The Elk fine sandy loam is associated with the other soils of the Elk series. It occurs on the lowest bench (terrace or second bottom) of the Susquehanna River. The largest area occurs between Bainbridge and Marietta. The topography is billowy or undulating. Natural drainage is good but, notwithstanding the gravelly nature of the substratum and the comparatively light texture of the upper layers of the soil, is seldom excessive.

This type is of alluvial origin and consists of material transported from the various soils of the drainage basin of the Susque-

hanna River, including wash from glacial soils and residual limestone, sandstone, and shale soils. This material was deposited when the waters of the Susquehanna River reached higher levels.

All the type is in cultivation. The original growth consisted of oak, hickory, elm, tulip, and other hardwoods. The type is devoted to general farming and trucking, the principal crops being corn, wheat, wrapper-leaf tobacco, potatoes, and grass, with some oats. Corn yields 60 to 80 bushels, wheat 20 to 30 bushels, Pennsylvania Seedleaf tobacco 1,500 to 2,000 pounds, Cuban Seedleaf tobacco 1,200 to 1,600 pounds, potatoes 90 to 125 bushels, oats 30 to 40 bushels, and hay, mixed clover and timothy, 3 to 4 tons per acre. Good yields of melons, strawberries, early sweet corn, early potatoes, and the small bush fruits are obtained. The results indicate that the soil is well suited to the production of truck crops. Some peaches are grown, with fair results.

Practically the same methods are practiced on this soil as on the Elk silt loam. Nearly all crops are fertilized, a 2-8-10 grade of fertilizer being in common use. Lime is used, but in smaller quantities than on the Elk silt loam. The soil is kept in a high state of productiveness. Some cattle are fed on nearly all the farms, and the manure is used to advantage.

The farms average about 80 acres in size, and are valued at \$100 to \$250 an acre, the average value being about \$150 an acre.

#### ELK SILT LOAM.

The Elk silt loam to a depth of 8 to 12 inches is a brown, mellow silt loam. The subsoil is a light-brown silt loam, and is usually rather compact. The lower subsoil, below a depth of about 2 feet, often becomes yellowish brown as the structure becomes more compact. Where exposed in cuts, at a depth of 5 to 8 feet, the substratum is seen to be reddish. Both the soil and subsoil contain varying quantities of rounded, waterworn gravel and cobbles, but not in sufficient quantity to give the soil the character of a gravelly loam. The type seems to be underlain at depths of 3 to 12 feet by strata of gravel. The gravel probably rests on residual material at still greater depth. It consists of rounded fragments of a variety of rocks including sandstone, granite, gneiss, and quartzite. The soil is mellow, loose, and easily cultivated, and can be worked under a wide range of moisture conditions. Local and relatively insignificant variations occur in the texture of the surface soil and in the depth of the water-deposited material over the residual material.

The Elk silt loam occurs along the Susquehanna River as terraces, which usually are well preserved but in places are more eroded remnants. This belt of terraces is from a few rods to barely a mile wide. The towns of Bainbridge, Marietta, Columbia, and Washing-

tonboro are situated wholly or in part on this soil type. The silt loam has a greater area than both the other soils of the Elk series. It is one of the most valuable and important soils of Lancaster County.

The surface varies from nearly level or gently sloping to rolling. The terraces usually represent a series of steps or benches approaching the river by successive lower levels. The drainage is good. The soil is retentive of moisture, and crops seldom suffer from the short periods of drought. The type has an elevation of 20 to 100 feet above the river.

The waterworn gravel in the Elk silt loam indicates its alluvial origin. The material represents wash from the various glacial soils and limestone, sandstone, and shale soils occurring in the drainage basins of the Susquehanna River. It was deposited by overflows when the waters reached higher levels than at present.

Practically all the Elk silt loam is in cultivation. It is probable that the type originally was occupied mainly by a growth of heavy oaks and other hardwoods.

The land is devoted to general farming, and corn, tobacco, wheat, potatoes, oats, and grass are the staple crops. Corn yields an average of 60 bushels, with occasional yields of 100 bushels per acre. Wheat averages 30 bushels, oats 35 to 40 bushels, and potatoes 100 bushels per acre. Mixed red clover and timothy yields from 3 to 5 tons of hay per acre. Both the Pennsylvania Seedleaf and Cuban Seedleaf tobacco are grown on this soil, but the latter usually is considered more profitable. The former yields 1,800 to 2,000 pounds per acre and the latter about 1,500 to 1,700 pounds.

A regular 4-year or 5-year rotation commonly is practiced, consisting of corn one year, tobacco, oats or potatoes one year, wheat one year, and grass one year or two years. Commercial fertilizers of about 2-8-10 grade are applied at the rate of 1,000 to 1,500 pounds per acre for tobacco or potatoes and 500 or 600 pounds per acre for wheat. Barnyard manure is applied to the tobacco fields at the rate of 12 to 15 tons per acre. Lime, in the form of burned lime or ground limestone, is harrowed in before the corn is planted, being applied at the rate of 1½ to 2 tons per acre. There is very little dairying on this soil, but some beef cattle are fattened on nearly all the farms, more for the production of manure than for cash profit. Silos are coming into general use.

The farms on the Elk silt loam vary in size from 50 to 90 acres. The soil is thought to be about two weeks earlier in maturing crops than the upland soils. Land sells for \$100 to \$300 an acre, according to location.

#### HUNTINGTON SERIES.

The surface soils of the Huntington series are brown to dark brown, and the subsoils range from yellowish brown to somewhat

grayish in the more poorly drained places. The soils are of recent alluvial origin, occurring along streams carrying material washed from limestone and associated soils. They usually are subject to frequent overflow, but generally are well drained between overflows.

#### HUNTINGTON FINE SANDY LOAM.

The surface soil of the Huntington fine sandy loam is characteristically a brown to dark-brown fine sandy loam, underlain at about 8 to 12 inches by light-brown fine sandy loam. Below a depth of about 2 feet the material varies considerably, ranging from clay loam to loam. Small, waterworn gravel often is scattered over the surface and throughout the soil section. Gravel frequently occurs in beds in the deeper subsoil, but nowhere in sufficient quantity to make this soil gravelly loam. Some sorting of the soil material, due to stream action, always is noticeable. In some places there is very little difference in color or texture within the 3-foot section.

This type is of small extent and is confined to the Susquehanna River bottoms and islands. A narrow band of Huntington fine sandy loam occurs along the river between Columbia and Bainbridge. The type is best developed on Haldeman and Wise Islands.

The elevation ranges from 2 or 3 feet to about 15 feet above the normal level of the river. The low-lying areas are subject to inundation at every period of high water, while the higher areas are overflowed only at 4-year or 5-year intervals. The natural drainage is poor over the greater part of the type.

The Huntington fine sandy loam is of recent alluvial origin, the material being derived largely from limestone, shale, and sandstone soils of the upper reaches of the Susquehanna River. There probably is also some wash from glacial soils. Some coal dust is present in places, in quantities sufficient to darken the soil.

Only a small part of the type is cultivated. Since the dam below McCalls Ferry was constructed several of the islands have been rendered unfit for cultivation by the raising of the water level. Haldeman and other islands in the vicinity of Bainbridge are farmed with rather uncertain results, their cultivation being greatly hindered by the difficulty of access to the islands. Corn, grass, and truck crops, particularly melons, do well on this soil. Uncleared areas support a rank growth of wild grasses, vines, and shrubs, with some pin oak, hickory, black walnut, locust, sassafras, and sumac. Willows and alder fringe the shores, and it is probably due to these that more destructive erosion does not take place.

In the higher areas the Huntington fine sandy loam is valued at about \$30 to \$50 an acre. The low-lying areas are practically worthless for farming but afford meager pasturage for cattle.

## HUNTINGTON SILT LOAM.

The surface soil of the Huntington silt loam is a brown or grayish-brown, mellow, heavy silt loam, having an average depth of about 10 inches. The subsoil consists of a yellowish-brown to dark-gray, rather compact silty clay loam to silty clay. Rusty-brown mottlings of iron oxide almost invariably occur in the third foot. In the more poorly drained areas the subsoil frequently is mottled with bluish gray or drab. The subsoil varies considerably, frequently grading into sandy clay or beds of gravel at depths of 30 to 36 inches.

This type occurs in narrow strips along streams draining the soils of the Hagerstown, Berks, Conestoga, and other series, widely distributed over the central part of the county. No single area of the type is extensive, but in the aggregate it covers 28.7 square miles.

The surface of the type usually is not more than about 6 to 10 feet above the normal level of the streams, and more frequently the elevation is less. The surface is flat or very gently sloping, and the natural drainage poor. Most of the land is subject to frequent overflow. The material consists of recent alluvium.

Most of the bottom land originally was forested. The few remaining patches of timber include white oak, shagbark hickory, ash, elm, sycamore, willow, and alder. The type supports a good growth of grasses which flourish under conditions of poor drainage.

Probably less than one-half the area of the type is under cultivation, and the remainder in permanent pasture. The more arable land is sometimes plowed and reseeded, the grass being cut for hay for 1 year or 2 years, and returned to pasture for long periods. Bluegrass makes a natural growth on the areas of the type which have better drainage. Corn, wheat, grass, and occasionally tobacco are grown, and in dry seasons give yields almost equal to those obtained on the adjoining upland soils. On account of the poor drainage and danger of inundation, however, this type has a much lower agricultural value than the residual soils. No separate value can be given for this soil, as it is sold with adjoining soils.

## WEHADKEE SERIES.

The Wehadkee soils are of gray color, compact structure, and pre-vaillingly silty texture, the subsoils of mottled grayish and yellowish to white color, compact structure, and prevaillingly clay to silty clay texture. These soils are developed in the first bottoms of streams, where they represent alluvial material derived from Piedmont soils. They are of low agricultural value and are best suited to grasses.

## WEHADKEE SILT LOAM.

The inclusion symbol within areas in Huntington silt loam color indicate areas of Wehadkee silt loam. This soil has a gray or dull

grayish brown, compact silt loam to silty clay loam surface soil, about 8 to 12 inches deep, often faintly mottled with rusty brown. This is underlain by a somewhat lighter gray, drab, bluish or mottled, compact silty clay loam or silty clay. Sandy clay frequently is encountered at a depth of 20 inches to 2 feet, and, rarely, beds of gravel occur at about 3 feet. In the more poorly drained areas where the moist condition has favored the accumulation of organic matter the soil is dark gray to nearly black.

This soil occurs as flat or nearly level strips along the streams which drain the Montalto and Lansdale soils in the northwestern part of the county. It has a small area and is unimportant, but is typically developed along Conoy and Little Chickies Creeks in West Donegal, Mount Joy, and Rapho Townships. It is mainly alluvial in origin, although modified to some extent along the outer edges by colluvial wash. It occurs along streams within the Piedmont section and largely represents wash from the Lansdale and Montalto soils. It is practically free from stones.

Uncleared areas support a growth of hickory, white oak, pin oak, ash, willow, cedar, and alder.

The land is deficient in drainage and much of it is kept wet the greater part of the year by flood waters. Overflows are frequent and the soil is in poor physical condition. It affords good natural pasturage. If properly tile drained this soil might produce as good yields of corn, wheat, and hay as the adjoining uplands. Protection from overflow would necessitate diking or enlarging the stream channels. No separate value can be placed on the Wehadkee soil, as it is sold in connection with adjoining soils.

Results of mechanical analyses of samples of the soil and subsoil of the Wehadkee silt loam follow:

*Mechanical analyses of Wehadkee silt loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
182131.....	Soil.....	0.1	0.9	1.0	4.7	5.7	69.0	18.5
182132.....	Subsoil.....	1.8	6.4	4.8	16.0	11.3	44.4	15.1

#### BERMUDIAN SERIES.

The soils of the Bermudian series are dark reddish brown to Indian-red in color, and the subsoils are lighter reddish to yellowish or mottled. These soils are of recent alluvial origin, subject to frequent overflow, and are poorly drained between overflows. They contain enough wash material from the Penn soils to give the characteristic red color.

## BERMUDIAN SILT LOAM.

The surface of the Bermudian silt loam to a depth of about 12 to 16 inches is a dark reddish brown or dark Indian-red silt loam containing considerable organic matter. The subsoil is a silt loam to silty clay loam of a lighter color, tending toward grayish in the lower part of the 3-foot section. Considerable variation occurs in this type as mapped, particularly in the subsoil. The surface soil of some included patches is a loam or fine sandy loam, while layers or lenses of sand of the various grades and even gravel frequently are encountered in the subsoil. In the main, however, the silt loam predominates and the loam and fine sandy loam spots are not of sufficient size or importance to be shown separately on the map. The type includes some strips of the lower, very gentle slopes, which are partly of colluvial origin. The lower and more poorly drained areas frequently are mottled yellowish or grayish in the lower subsoil.

The Bermudian silt loam is associated with the soils of the Penn series throughout the northern and northwestern parts of the county, occurring as narrow strips along the creeks and branches. The material, to a considerable degree, is recent alluvial wash from the soils of the Penn series. The bottoms are not more than about 5 to 10 feet above the normal level of the streams and frequently less than 4 feet. The topography is flat or very gently sloping, and the drainage is poor.

Only a small part of this type is cultivated. At least 90 per cent of the total area is subject to frequent inundation, and for that reason is kept in sod to prevent the washing away of the surface soil in times of overflow. The soil supports a luxuriant growth of pasture grasses, including bluegrass, fescue, and white clover. This is one of the most valuable types for pasture in the county. It supports a scattered growth of pin oak, shagbark hickory, elm, ash, sycamore, and alder.

The small areas of the type in cultivation are devoted to the general farm crops, including corn, wheat, oats, and grass, and the yields are good but rather uncertain on account of the floods. Ordinarily, when it is found necessary to plow the land it is seeded as soon as possible and allowed to remain in sod for long periods. Where it is possible to drain this soil and put it under cultivation the yields of the staple crops are greater than on the adjoining uplands.

No value can be placed on the land separately, as it is always sold with other soils.

Results of mechanical analyses of samples of the soil and subsoil of this type follow :

*Mechanical analyses of Bermudian silt loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
182161.....	Soil.....	0.1	0.7	1.8	13.6	14.6	50.1	19.2
182162.....	Subsoil.....	1.0	7.7	10.6	32.6	10.7	25.3	12.0

CODORUS SERIES.

The Codorus soils are brown or grayish brown at the surface, passing through light-brown into grayish or yellowish material in the lower subsoil. These are recently deposited alluvial soils, occurring along streams draining the areas of the Manor and Chester soils. A high percentage of micaceous particles is present, giving a somewhat greasy feel to the material. Although subject to overflow, the drainage is, as a rule, fair between overflows.

CODORUS SILT LOAM.

The surface soil of the typical Codorus silt loam is a brown or grayish-brown, mellow silt loam, with a depth of about 12 to 14 inches. This is underlain by light-brown or yellowish-brown, heavy, compact silt loam to silty clay loam. The soil is characterized by a large percentage of fine micaceous particles which give the material a greasy feel and a peculiar structure, the soil being somewhat fluffy when dry and compact when moist. This soil, as mapped, varies considerably in texture, ranging from a loam to silty clay loam, but it is prevailingly a silt loam. The color varies toward gray in the subsoil. The variation is most marked in the area along West Branch of Octoraro Creek.

In its distribution the Codorus silt loam is confined to narrow strips, not exceeding one-fourth mile in width, along the streams draining the soils of the Manor and Chester series in the southern part of the county. The typical material is recent alluvium. The type generally is elevated not more than about 6 to 10 feet above the normal level of streams, and frequently not more than 2 feet. It includes some of the very gentle slopes adjoining the flat bottoms where the soil, although partly colluvial, is practically the same as the true alluvium. The type is composed of material washed from soils derived from chloritic and mica schists. Along some of the smaller streams, particularly within areas of the Chester soils, the first bottoms are particularly variable in texture, and are very poorly drained. Such areas are classed with Meadow.

The Codorus silt loam is not in cultivation. It supports a sparse growth of white oak, pin oak, hickory, sycamore, willow, and alder. The soil supports a rich growth of good pasture grasses, including bluegrass, fescue, and white clover. It is devoted entirely to pasture and this constitutes its best use. The native grasses are sometimes cut for hay. On some of the type the water table is within a few inches or a foot of the surface, and on all of it the danger of inundation prohibits the production of cultivated crops.

This land, though valuable as pasture, can not be given a separate value, as it is always sold in connection with adjoining upland soils.

In the following table are given the results of mechanical analyses of samples of the soil and subsoil of this type:

*Mechanical analyses of Codorus silt loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
182189.....	Soil.....	0.2	0.4	0.6	16.4	17.0	54.1	11.3
182190.....	Subsoil. ...	.3	.7	.7	15.4	13.9	53.4	15.4

MISCELLANEOUS MATERIAL.

ROUGH STONY LAND.

Rough stony land includes areas which, on account of their rugged or steep surface and stony character are nonagricultural. Rock fragments and rock outcrops are so abundant as to preclude agricultural development. These rough, stony areas do not differ in point of soil material from the types with which they are associated. The largest areas are situated in the northern and northwestern parts of the county, in association with the soils of the Penn, Montalto, and Lansdale series. The surface is strewn with large bowlders of intrusive rocks. The slopes are not particularly steep, but disintegration of the hard rock has taken place so slowly that no great depth of soil has accumulated. Small areas occur through the more hilly or mountainous sections of the county. The steep, rocky bluffs along the Susquehanna River, while narrow, represent in the aggregate a considerable area of nonarable land. Land of this character is encountered also on South Mountain in association with the Penn stony loam. Here the land is rendered unfit for any kind of agricultural occupation by benchlike rock outcrops and scattered large blocks of Triassic sandstone and conglomerate, with but little soil.

In the area of Rough stony land northeast of Churchtown, and in other areas in that part of the county, blocks of granite occur in

association with diabase and other rocks of igneous or intrusive origin.

Many of the islands in the Susquehanna River, notably those in the vicinity of McCalls Ferry and Columbia, are very rocky and are included in this classification. In places on these islands some soil is held in the spaces between the rocks, and supports a thick growth of alder, sumac, and other shrubs, willow, and occasionally sycamore.

The scanty soil covering supports a good growth of a wide variety of trees and shrubs. Chestnut is the predominating timber growth throughout the region of South Mountain, with a less extensive growth of various oaks, hickory, cedar, sassafras, and many shrubs. A scattered growth of pine, spruce, and hemlock occurs on the steep slopes and rocky islands of the Susquehanna River between Pequea Creek and the southern county line.

No separate value can be placed on Rough stony land. The value depends on the variety and quantity of timber and with proper management the land can be made a source of some income from the timber. A few patches have been cleared, and support meager pasturage.

#### MEADOW.

The term Meadow is applied to low-lying, poorly drained alluvium occurring in narrow strips along many of the smaller streams in the northern, eastern, and southern parts of the county. The material is extremely variable in texture and can not be separated into definite soil types. The soil material usually is a silt loam or light clay loam. Some stony bottoms along swiftly flowing streams, where only the coarser material is deposited, are included in this classification. The color varies widely within small areas, particularly in the subsoil. The surface usually is dark, owing to the presence of organic matter, and the subsoil in most cases is gray or mottled drab and yellow.

The principal areas of Meadow occur in the more hilly parts of the county where the narrow bottoms and lower slopes are continually wet from seepage. The land is subject to frequent overflow and additional deposits of alluvium are made annually. The material comes mainly from the Penn, Chester, and Manor soils. Meadow supports a growth of native grasses where not too wet, and water-loving grasses and flags, with a sparse growth of swamp white oak, sycamore, and pin oak, and a fringe of alder and willow along the streams.

The land is poorly drained and subject to frequent overflow, and has no value for cultivated crops. The land is utilized largely for pasture, although some of the areas with better drainage support a heavy growth of grasses which make nutritious hay.

## SUMMARY.

Lancaster County is situated in the southeastern part of Pennsylvania and comprises an area of 941 square miles or 602,240 acres. Four physiographic divisions are represented in the county, the Piedmont Plateau, Limestone Valley, Appalachian Mountain, and River Flood Plain provinces. The topography is undulating in the limestone valleys, varying to hilly and mountainous over a small part of the county. The elevation ranges from 100 to 1,200 feet above sea level. The greater part of the county lies at elevations of from 350 to 700 feet. The regional drainage is mature and complete. The county is entirely within the drainage basin of the Susquehanna River, and the general slope is toward the southwest.

The county is thickly settled and had a population of 167,029 in 1910, about 62 per cent of which was reported as rural.

The mean annual temperature is about 51° F. The average length of the growing season is about 195 days near the Susquehanna River and 165 days in the interior of the county. The average annual precipitation is reported as about 41 inches at Ephrata and about 37 inches at Harrisburg, Dauphin County.

The land is rather intensively farmed throughout the county. Crops are systematically rotated, and the use of lime, barnyard manure, and commercial fertilizer is general. Corn, wheat, oats, and hay are the staple crops; tobacco and Irish potatoes are the principal special crops. There are only a few commercial orchards, although peaches and apples do well on a number of the soils. Dairying is an important adjunct to general farming, and some beef cattle are fattened. Railroads and trolley lines reach nearly all parts of the county. Lancaster is a good local market for farm products, and Philadelphia and New York City are important outside markets.

In classifying the soils of Lancaster County 36 types, including Rough stony land and Meadow, representing 17 series, are recognized. Among the various soils the loams and silt loams predominate.

The Hagerstown soils, occupying a large area in the north-central part of the county, are the most important in the county. These soils are brown with light-brown to reddish subsoils. They are derived from limestone, and are well suited to the production of general farm crops and tobacco.

The Conestoga soils are associated with the Hagerstown. They are derived from highly schistose limestone, are generally darker colored than the Hagerstown, and are micaceous.

The Manor soils occupy a large area in the southern part of the county. These are light brown to reddish, highly micaceous soils,

derived from chlorite and mica schists. The more hilly and stonier areas of these soils seem best suited to combined fruit and dairy farming.

The Berks series includes soils of light-brown color derived from shales. These soils occur in the northern part of the county, bordering the limestone valleys, at a considerably higher elevation.

The Chester soils are brown or reddish, and are derived from gneisses and schists of great age. These are valuable soils for dairy-farming and general farming.

The soils of the Penn series are extensively developed in the northern and northeastern parts of the county. The Penn soils characteristically have an Indian-red color, and are derived from Triassic sandstones, shales, and conglomerates. They are undulating and rolling to mountainous.

The Lansdale soils mapped in the northern part of the county are associated with the Penn soils and are similar to them except in color. They are yellow, grayish yellow or light brownish, and are derived from yellowish and grayish sandstones and conglomerates of Triassic age.

The Lehigh soils are of small extent. They are associated with the Montalto soils and are derived largely from mudstones, modified by contact metamorphism.

The Edgemont soils are derived from quartzite, quartz schist, fine-grained sandstones, and shales, and are of yellow color and compact structure. In general the stony loam type, which is the most extensive, seems best suited to fruit growing, while the loam type is fairly productive of the general farm crops.

The Montalto soil is reddish or reddish brown, and usually of heavy texture. It is derived from intrusive rocks. It is fairly productive of the general farm crops, but the stony areas are best suited to fruit.

The Conowingo silt loam is a minor type occurring in the extreme southern part of the county. It is residual from serpentine and talcose rocks.

The Elk soils are of small extent, but are important agriculturally. These are brown soils with a gravel substratum, occurring in terraces built up of material transported from the glacial regions.

The recent alluvial soils are classed with the Huntington, Bermudian, and Codorus series. These soils are inextensive, are subject to frequent inundation, and are not cultivated, but generally afford good pasturage.

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