Soil Survey

Series 1932, No. 35. Issued March 1939

Armstrong County Pennsylvania

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SOIL SURVEY OF ARMSTRONG COUNTY, PENNSYLVANIA

By R. T. AVON BURKE, in Charge, and S. O. PERKINS, Bureau of Chemistry and Soils, and L. J. YOHN, O. C. LEWIS, C. H. ATKINSON, and L. A. BROWN, Pennsylvania State College

COUNTY SURVEYED

Armstrong County is in the west-central part of Pennsylvania (fig. 1). Kittanning, the county seat, is 44 miles northeast of Pittsburgh, 20 miles east of Butler, and 29 miles northeast of Indiana, Pa. The county is irregular in shape. The western, eastern, and southeastern boundaries are straight lines, and the northern and southwestern boundaries follow the meanderings of Allegheny River, Redbank Creek, and Kiskiminetas River. It is somewhat longer north and south than east and west. The total area is 653 square miles, or 417,920 acres.

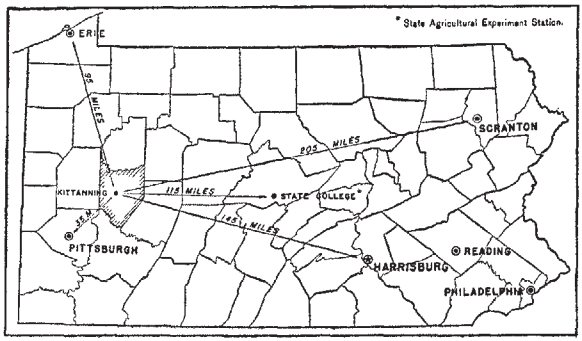

FIGURE 1.—Sketch map showing location of Armstrong County, Pa.

Armstrong County is a part of the Appalachian Plateaus Province, which in turn is a major physiographic subdivision of the Appalachian Highlands. It includes parts of two subdivisions of the Appalachian Plateaus, that is, the Allegheny Mountain and the Kanawha sections. The Allegheny Mountain section is described[1] as a "maturely dissected plateau of strong relief with a few mountains formed by erosion of open folds," and the Kanawha section is "a maturely dissected plateau of fine texture and of moderate to strong relief." In both sections, smooth areas of valleys and ridge tops are narrow, and the slopes between range from very steep to moderate. A few well-developed ridges extend in a general north-south direction in the eastern part of the county, but these grade into the general plateau levels toward the west.

A dendritic system of streams has dissected the country into a rolling and hilly relief, with the smoothest areas on the higher

[1] FENNEMAN, N. M., and JOHNSON, D. W., PHYSICAL DIVISIONS OF THE UNITED STATES (map). U. S. Geol. Survey. (n. d.)

uplands and the rougher sections along the valleys. The hills of the northern half of the county are generally more broad and rolling than those of the southern half, and as a result the soil pattern of the northern part is less intricate than that of the southern part.

The highest parts of the county, where elevations above sea level range from 1,300 feet to more than 1,600 feet, are for the most part in the northern half and belong to the Allegheny Mountain section of the Appalachian Plateaus Province. A line drawn through Worthington and Cowansville to Frenchs Corner, southeastward from there to include Blanket Hill and a wedge-shaped section extending to Kiskiminetas River near Edmon, and thence northeastward to Dayton, roughly separates the higher northern and eastern parts from lower areas. A hill three-fourths mile north of Mount Tabor in the northeastern part of the county has an elevation of 1,740 feet above sea level—the highest point in the county.

The rest of the dissected plateau, ranging roughly from 1,200 to 1,300 feet above sea level, comprises the Kanawha section of the Appalachian Plateaus Province. It is more closely dissected, as a rule, than the higher plateau.

Both divisions are dissected plains with an even skyline and nearly concordant altitude of the hilltops in each division. The relief might be described as hilly, but it includes flat, rolling, and ridgy country, characterized by trailing divides, flat saddles, and rounded hills, with a general slope to the south and west.

Another outstanding feature of the relief of Armstrong County is a high somewhat dissected shelf which occurs above Allegheny River and some of its tributaries. This shelf lies about 300 feet above the water level of the river and is characterized by flat terrace-like features and in places is more than a mile wide. It is not continuous but occurs in places along the river and tributary streams at an elevation ranging from 900 to 1,145 feet above sea level. It is well developed near Ford City, Parker City, and other places, and its smooth even surface is very conspicuous.

Many of the present watercourses have not developed large bottoms, but some of them are one-half mile or more wide. Most of the valleys are narrow and their walls steep near the outlets of streams, but the slopes are more gentle and smoother near the streamheads. Allegheny River flows through the west-central part of the county. This stream has cut deeply, and the valley walls in places are precipitous. It leaves the county at an elevation of about 760 feet above sea level, and its valley ranges from 440 to 700 feet below the surrounding upland. Redbank and Mahoning Creeks, in the northern part of the county, also flow through steep-walled valleys with precipitous slopes in places and have developed comparatively narrow flood plains lying from 500 to 700 feet below the nearby uplands. Similar conditions occur along Buffalo Creek below Worthington, where this stream, in places, has cut a gorge ranging from 300 to 500 feet in depth, and similar conditions exist along Crooked Creek below South Bend. Steep and precipitous valley walls are also along Kiskiminetas River, which flows into the Allegheny at an elevation of about 783 feet above sea level. This stream has cut a valley ranging from 300 to 500 feet below the adjacent uplands.

In general, Armstrong County might be described as open country, with the exception of a few scattered wood lots, as most of the forest

and brushland is restricted to the rougher and more inaccessible parts, to steep hillsides, and to the more shallow and stony land. The original forest growth consisted largely of white, black, red, and chestnut oaks, maple, chestnut, walnut, butternut, locust, hickory, dogwood, poplar, mountain birch, sycamore, willow, ironwood, hemlock, white pine, spruce, and ash. Nearly all the present forest cover consists of second-growth trees of the same species. The chestnut trees have been almost exterminated by blight.

Lumbering in the early days was a dominant industry, but at present little merchantable timber is left and lumbering is carried on to a small extent by portable mills. When the mines are in operation, there is a demand for mine timbers and props. The planting of white pine and other evergreen seedlings has been undertaken in a large way and promises to provide timber for the future. Most of the forests are open, but the land supports some undergrowth near streams and watercourses. On the uplands, the undergrowth consists of young shoots of the original trees, together with sassafras and dogwood, and with ferns, blackberries, dewberries, sweet myrrh, timothy, redtop, quackgrass, bluegrass, and poverty grass near the edges. At present, hemlock and white pine are more plentiful on the uplands of the northeastern part of the county along the banks of Mahoning and Redbank Creeks, near the outlets of Pine and Cowanshannock Creeks in the central part, and in a similar position in the gorge of Buffalo Creek in the southwestern part. Oaks and other hardwoods, however, constitute the principal tree growth in all sections.

Allegheny River, which forms part of the northern boundary and crosses the county in a general north-south direction, receives practically all the drainage. This is effected chiefly by Kiskiminetas River and by Crooked, Cowanshannock, Pine, Mahoning, Redbank, and Buffalo Creeks, in addition to numerous small streams and branches. The county in general is well or excessively drained, although in a few places run-off is not well established. The drainage may be described as mature or dendritic, and branches and intermittent drainageways extend to all parts and to almost every farm.

Armstrong County was formed from parts of Westmoreland, Allegheny, and Lycoming Counties by an act of assembly March 12, 1800, and was named after one of the pioneers. The early settlers were chiefly of Scotch-Irish and German descent, the former coming from Westmoreland County and the latter from Lehigh and Northampton Counties. Their descendants constitute the greater part of the population. In recent years, many persons of foreign birth, principally Italians, Poles, and Slovaks, have come into the county to engage in coal mining. The total population, as given by the 1930 Federal census, is 79,298. The principal towns are Kittanning, the county seat, Ford City, Leechburg, and Apollo. Besides these, numerous small villages and hamlets are scattered over the county.

Armstrong County has excellent transportation facilities—over three lines of railroad. A branch of the Pennsylvania Railroad follows the east bank of Allegheny River and connects Ford City, Kittanning, and Templeton with many smaller places; another branch follows Kiskiminetas River and connects Leechburg, North Vandergrift, and Apollo; and another connects Boggsville and Free-

port. The Pittsburgh & Shawmut Railroad follows the west side of Allegheny River and part of Mahoning Creek and serves Freeport, Cadogan, West Kittanning, Mahoning, Colwell, Nitro, Eddyville, McWilliams, and other places. The Baltimore & Ohio Railroad connects Dayton, Mosgrove, Craigsville, and Nichola and has a short branch to Worthington and Buffalo Creek and another branch to Yatesboro and Rural Valley. A spur of the Baltimore & Ohio serves Parker City, and a spur of the Buffalo & Susquehanna Railroad serves Sagamore. Freight and passenger auto lines also add greatly to the convenience of transportation.

Armstrong County has good markets in a number of towns within its boundaries. With the excellent transportation facilities afforded by the railroads and freight truck lines, excess produce can be easily dispatched to Pittsburgh and other more remote markets.

The county has a very good system of concrete and macadamized highways which penetrate all sections and add greatly to the comfort and convenience of the people. Practically all farms are connected by telephone and have the advantage of rural free delivery of mail. Churches and schoolhouses are conveniently located. Recently some schools have been consolidated, and many children are now transported to centralized schools by bus.

The mining of bituminous coal is the principal industry. The 1930 Federal census reports 60 active mines in the county, which produced 4,474,255 short tons in 1929, valued at $7,202,931. It is estimated that about one-third of the original coal reserves have been removed. At present no byproducts from coal are made in the county, although in the past some coke was produced.

Since the discovery of gas and oil in this county, the field has expanded considerably, but no figures are available as to the number of producing wells. This is said to be more of a gas than an oil field.

The quarrying of limestone is also an important industry. Large quarries are in operation on both sides of Allegheny River at Templeton and Kittanning, near Bradys Bend, and at Buffalo Creek. In addition to these large quarries, smaller hillside quarries are operated in many places throughout the county. The limestone is used for flux in steel manufacturing, for road material, for concrete work, and for agricultural purposes.

The removal of large quantities of sand and gravel from the bed of Allegheny River by dredges is also important. Each year the supply is renewed by deposition in the river.

The supply of potable water is plentiful in all sections. The water is obtained from wells, springs, and streams. Many wells and springs have failed since the opening of the coal mines.

CLIMATE

The climate of Armstrong County is continental in character. The approach of the different seasons is generally gradual and is marked by a difference of about 20° F. in the mean temperature between winter and spring and spring and summer and by a difference of 17.2° between summer and fall.

The winters in this section are not continuously cold, but the temperature fluctuates between a maximum of 75° and a minimum

of −22° with a seasonal mean temperature of 29.2°. The summers are usually pleasant and mild, although occasional hot spells occur when the weather is rather oppressive, but they are generally of short duration and the nights are generally cool. The fall season usually approaches gradually and is one of the most agreeable seasons of the year. The spring season is more often characterized by extremes of temperature than the fall months and is generally colder.

The greater part of the average annual rainfall of 46.63 inches occurs during the months when it is most needed by growing crops. Most of the summer rains are accompanied by southerly and westerly winds and generally occur as thundershowers. The rainfall is less during the fall than during other seasons of the year. The average depth of snowfall is 54.7 inches.

The average dates of the earliest and latest killing frosts are May 8 and October 2. This gives an average frost-free period of 147 days, which is ample for the production of a wide range of crops. Frost has been recorded as late as June 10 and as early as September 11.

The data given in table 1 were compiled from the records of the United States Weather Bureau Station at Indiana, Pa., which has an elevation of 1,350 feet above sea level and is only a short distance east of Armstrong County. The data are probably fairly representative of the conditions in Armstrong County, as the altitude of the county ranges from about 800 to 1,720 feet above sea level.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Indiana, Indiana County, Pa.*

[Elevation, 1,350 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1922)	Total amount for the wettest year (1888)	Snow, average depth
	° F.	*° F.*	*° F.*	*Inches*	*Inches*	*Inches*	*Inches*
December	30.5	72	−17	3.49	3.62	2.52	12.7
January	28.9	75	−21	4.07	2.03	6.75	15.5
February	28.3	70	−22	2.97	2.49	1.84	11.1
Winter	29.2	75	−22	10.53	8.14	11.11	39.3
March	38.5	84	−8	4.07	4.96	3.34	8.9
April	49.8	94	13	4.02	4.30	2.98	3.7
May	60.4	98	26	4.27	4.53	5.30	.1
Spring	49.6	98	−8	12.36	13.79	11.62	12.7
June	67.2	98	32	4.74	3.91	4.60	.0
July	71.3	103	40	4.45	4.47	7.04	.0
August	70.2	105	39	4.35	3.62	10.65	.0
Summer	69.6	105	32	13.54	12.00	22.29	.0
September	64.1	96	27	3.88	.62	2.82	.0
October	52.2	89	21	3.62	2.56	5.48	.1
November	41.0	79	7	2.70	2.34	2.75	2.6
Fall	52.4	96	7	10.20	5.52	11.05	2.7
Year	50.2	105	−22	46.63	39.45	56.07	54.7

AGRICULTURAL HISTORY AND STATISTICS

The present area of Armstrong County was occupied by the Delaware Indians until the year 1730. Kittanning, the county seat, was the site of an old Indian village of the same name.

In the early days, lumbering was the principal industry, and farming was more or less a side line. The early agriculture consisted of patch farming, and the crops grown—corn, wheat, rye, oats, vegetables, and fruits—were for subsistence. The shortage of equipment and tools was a serious factor; the tools used were of a very primitive type, and the first plows and harrows were made entirely of wood without iron points.

With the increase in population and the establishment of towns and villages, the acreage in crops was extended, and a greater variety of crops and fruits was grown. These crops became the means of trade and barter. The introduction of the threshing machine in 1849 and of the mower and reaper about 1860 added greatly to the ease of harvesting crops and led to an extension of the acreage in grains. The ranging and feeding of sheep and beef cattle developed in importance.

The agriculture has been influenced by the industrial development, which began early. In 1830, three iron furnaces were in operation, followed by steel mills at Bradys Bend where the first railroad rails were made. The Pittsburgh, Kittanning & Warren Railroad was completed in 1856. Following its completion, industry in the county made great advancement. The mining of bituminous coal was developed on a large scale, and discovery of oil at Parker City and of natural gas in other sections, with the building of other railroads and branch lines, resulted in great industrial activity and contributed very largely to the prosperity of the county. Coal and natural gas are found in all parts of the county, and many farmers have received enough income from gas- and coal-land rentals to pay the taxes on their farm land and in some instances a great deal more. The area on the western side of Allegheny River, including Sugar Creek, Washington, Bradys Bend, and Perry Townships, were much affected by the early iron furnaces at Bradys Bend where a town of about 15,000 persons was concentrated at the peak of the industry. This drew many persons from the farms to the mills. With the development of oil fields around Parker City many farmers spent much time on the road hauling supplies. During these periods of industrial activity, farmers operated their farms part time or short-handed and obtained employment with the industries; and some even stopped farming altogether but continued to live on the farm.

With the markets for hay, straw, and grain developed by the industries, those farmers nearest the industrial centers abandoned livestock farming for hay and grain farming. Hay became an especially important crop, and was cut from 4 to 5 years consecutively, or as long as the soils produced fair yields, as the demand for hay in the whole southwestern section of the State was unusual. Before the mines were electrified, much hay and grain were sold to the mines for feed for mules and other work animals, and this type of farming during this period is said to be responsible for the unproductiveness of many fields. With the electrification of the mines and the more general use of the gasoline motor, the market for hay has almost disappeared,

and most of the hay grown at present includes little timothy and consists largely of clovers. With the increase in the size and number of towns within the county, the demand for dairy products, eggs, poultry, dressed meat, truck crops, and fruit increased to such an extent that a gradual change has taken place toward dairying and general farming or to the production of those crops that best meet the needs of the dairy interests.

The population of the county, as given by the census report of 1880, was 47,641, all classed as rural. In 1890 the population was 46,747, of which 3,095 were classed as urban. From that time until the present the population has slowly but steadily increased until, in 1930, it reached a maximum of 79,298, of which 24,602 were classed as urban. Whereas the entire population in 1880 was classed as rural, only 68.9 percent were so classed in 1930.

The number of farms listed by the census in 1880 was 4,026, but in 1935 the number had decreased to 3,351. The average size of farms was 94 acres in 1880 and, with slight fluctuations in intervening census years, was 83.1 acres in 1935. The farms at present range in size from a few acres to more than 500, but most of them are between 10 and 175 acres. The average acre value of land, including buildings, as given by the census was $23.22 in 1900, $32.34 in 1910, $41.23 in 1920, $56.56 in 1930, and $35.81 in 1935; the range in value at present, however, is from a few dollars to more than $100.

The 1880 census reports that of the land in farms, 72.1 percent, or 67.8 acres a farm, was classed as improved land; in 1935 this had decreased slightly to 68.6 percent, or 57 acres, indicating that 31.4 percent of the land in farms is unimproved. This represents land not tillable and land covered with brush and woods. The 1935 census reports the total acreage in farms as 278,349, of which 198,848 acres is classed as improved, including cropland and plowable pasture.

Hay, oats, corn, wheat, potatoes, rye, barley, buckwheat, and vegetables are the most important crops, listed in order of their acreage as given by the 1935 Federal census report. Hay occupied the largest acreage in 1934, being cut from 37,710 acres. It reached its maximum of 49,391 acres in 1889, but was reduced to 37,509 acres in 1929. Oats occupied 31,270 acres in 1879, declined to 15,781 acres in 1929, and increased slightly to 18,020 acres in 1934. Somewhat similar conditions prevail with corn, which was grown on 24,684 acres in 1879, on 13,132 acres in 1929, and on 18,180 acres in 1934. Wheat also has declined greatly in acreage. In 1879 it was grown on 27,967 acres, in 1929 on 8,805 acres, and in 1934 on 13,347 acres. Buckwheat was grown on 7,713 acres in 1879 and on 4,920 acres in 1929. Rye was grown on 9,535 acres in 1879, on 3,476 acres in 1929, and on 2,256 acres in 1934. Potatoes occupied 7,713 acres in 1879, only 1,788 acres in 1929, and 2,735 acres in 1934. Vegetables, other than potatoes, attained their greatest acreage in 1909, when they were grown on 1,506 acres, and in 1929 were grown on only 428 acres. The acreage of barley was not reported in 1880 or 1910, but was given as 21 acres in 1889, 168 acres in 1919, 119 acres in 1929, and 132 acres in 1934. The estimated acreage of farm crops, as listed by the Pennsylvania Department of Agriculture [2] for the year 1931, indicates that the acre-

[2] GASTEIGER, E. L., and WILAND, L. H. AGRICULTURAL STATISTICS, 1930–1931. Pa. Dept. Agr. Gen. Bull. 511, 77 pp. 1932.

age of hay and of buckwheat decreased slightly, and that of oats, wheat, corn, rye, and potatoes showed a slight increase.

The United States census report of 1935 lists the number of bearing fruit trees in 1934 as follows: Apples, 78,664; peaches, 61,378; pears, 14,129; plums, 16,554; cherries, 24,416. It lists also 59 acres of strawberries, 55 acres of raspberries, and 14 acres of blackberries and dewberries. Farmers are reported planting an increased acreage of strawberries and cane fruits. The Howard 17, or Premier, is the more common variety of strawberry, and the Cumberland is the favorite among the raspberries. These berries are marketed in the local towns or trucked to Pittsburgh and New Kensington.

During the last 10 years, a definite change in the character of livestock farming has taken place, as dairying has largely replaced the ranging and feeding of beef cattle and sheep. This is attributed in part to the building of concrete and macadamized roads which have made markets for dairy products available the year round. At present, dairying is of major importance. Great interest is taken in the quality of the livestock, and during 1932 more than 10,000 head of cattle were tested for tuberculosis, and the county qualified as a modified accredited area. Most of the milk is marketed in Pittsburgh and the surrounding territory. The census report for 1930 lists the total number of cattle in the county as 18,010, of which 847 are beef or dual-purpose cattle. The 1935 farm census reports the number of cows and heifers 2 years old and over, as 11,131 and the milk produced in 1934 as 4,896,545 gallons. The dairy cattle are predominately Holstein-Friesians, Guernseys, and Jerseys, and grades of these breeds. The feeding of steers was of some importance until about 1925, but since that time it has given way largely to dairying, although some beef cattle are still fed. Many farmers buy feeders in the fall, feed them through the winter, and sell them during the spring. Most of the beef cattle now are of the Shorthorn breed.

According to the 1935 census report, 4,057 sheep and lambs were on the farms in the county on January 1 of that year. Purebred rams are used in most flocks. This practice has tended to improve the stock and also the quality of the wool. Hampshire, Shropshire, Southdown, and Oxford rams are most commonly used. Most of the lambs are sold in Pittsburgh, as the local demand is small. The wool is marketed through cooperative wool associations. The 1935 census reports 24,013 pounds of wool shorn in 1934. The same authority reports 7,907 hogs in the county on January 1, 1935. Hogs are not important as a source of revenue, but enough are raised for home consumption. Most farmers keep from one to three brood sows. Most of the hogs raised for market are sold locally as pork products, but a few are fed with steers and marketed at Pittsburgh. The principal breeds are Poland China, Chester White, and Duroc-Jersey.

Poultry raising has increased greatly in recent years, and a number of large flocks are kept. Many farmers keep about 300 hens, but there are many larger flocks in practically every township. The 1935 census reports the total number of chickens as 209,890, which produced 1,363,797 dozens of eggs in 1934. White Leghorns predominate, although many flocks are composed of Plymouth Rocks,

Rhode Island Reds, and Wyandottes. The nearness to good markets has helped develop poultry raising, and those farmers who have given it attention have found it profitable. The demand for live and dressed poultry is good. Most of the poultry and poultry products are sold in Pittsburgh and New Kensington. The grading of eggs for market is not common, but the practice is growing, as graded eggs are more profitable. Turkey raising is on the increase since the practice of keeping the birds more or less confined has been introduced. The local demand is good, and New Kensington, Tarentum, and Pittsburgh are good outlets for the surplus.

Most of the farm power for working the land is provided by horses, although a few farmers prefer mules, and some tractors are used, particularly where the relief is such that they can be handled advantageously. In addition, tractors are used for belt power. The number of horses, as reported by the 1935 census, is 4,960, and the number of mules is 220. Interest in the breeding of horses of the draft type, particularly Belgian and Percheron, is increasing, as the supply for farm work does not meet the demand. In 1931, 15 carloads of horses were shipped in and distributed throughout the county. For all-round purposes, horses are said to be more suitable in a section of such hilly relief.

In 1929, 44.6 percent of the farms used hired labor, and the total amount expended for this purpose was $188,533. The average yearly cost per farm is $158.56. Most of the labor on the farms is done by the owners and their families. Where extra labor is employed, the common monthly pay ranges from $25 to $60, with board, and day labor is paid from $1.50 to $2. Some groups of farmers exchange labor during harvesting and threshing periods.

The 1935 census reports the number of farms operated by owners and part owners as 2,725, by tenants as 617, and by managers as 9. The common system of tenure is worked out on a share basis and consists of a share of the crops or a share of the income from livestock, on the basis of share and share alike, with both income and expenses. Some farmers rent for cash; the price is governed largely by location and ranges from 50 cents to $3 an acre for farm land.

The farm buildings generally consist of a dwelling; barns for housing livestock and for storing grain, hay, straw, and other farm products; hogpens; chicken houses; corncribs; and sheds for sheltering machinery and implements. The dwellings present a wide range in character and structure; some are imposing and pretentious structures of stone, wood, and brick, and, at the other extreme, some are not much more than a roof and walls. In general, however, the dwellings are homelike and the outbuildings good. Most of the older homes are located near springs.

Most of the farms require considerable equipment, and, although tractors are used by many farmers, they have not replaced horses to a great extent. Automobiles and trucks are used for marketing and hauling. Threshing is done largely by custom machines, although some groups of three or four farmers own a machine cooperatively. Binders are used in all parts of the county, and a few drop reapers are still in use. Grain drills are used almost exclusively for seeding. Two farmers are using crawler-type tractors with deep-tillage tools for potatoes. Combination power sprayers are used by many

farmers for spraying orchards and potatoes. The two-row corn planter is common. Corn huskers are used by a few groups of farmers, but most of the corn is cut and husked in the field by hand. Corn binders are generally used for cutting silage corn and some of the husking corn. The side-delivery rake has practically replaced the dump rake. Hay loaders are used on some farms, particularly where the land is not steep. The four- to six-row weeder is used to some extent but is largely restricted to the potato crop.

An expenditure of $108,638 was reported by the 1930 census for fertilizer in 1929 on 1,754 farms. The fertilizer included commercial fertilizer, manure, marl, lime, and other soil amendments.

The same census reported 2,314 automobiles on farms, 407 motor-trucks, 69 electric motors for farm work, and 396 stationary gas engines. Telephones were used on 1,262 farms, 1,153 farms reported water piped to the dwelling house, and 174 dwellings were lighted by electricity.

SOIL-SURVEY METHODS AND DEFINITIONS

In soil-survey procedure, soils are classified according to those characteristics, both physical and chemical, which can be determined by observation, examination, and simple tests in the field.

Excavations or borings are made at frequent intervals, and the nature of the soil is carefully observed. It will be noted that an excavation exposes a series of layers or "horizons", and the entire section from the surface down is known as the "soil profile." The classification is based largely on the character of the horizons of the soil profile, together with such external characteristics as drainage, relief, and stoniness. The vegetation—either native vegetation or crops—is observed, and its correlation with the soils is studied. In this way the natural productivity of the soil and its adaptation to various crops can be determined or estimated with a fair degree of accuracy. In classifying virgin lands which may be brought under cultivation, the observation of like soils now cultivated is an important part of the work.

Three units are commonly used in the field mapping of soils—series, type, and phase.

Most important of these is the series, which is a group of soils having certain features in common, including color, structure, thickness, and chemical composition of the horizons of the soil profile; essentially the same parent material and natural drainage conditions; and in most instances similar relief. The series are given geographic names taken from locations near which they are first identified. Rayne, Gilpin, and Chenango are names of soil series in Armstrong County.

The soil texture—the size of the soil particles and the relative amounts of the particles of different sizes—may differ within a series. As texture is a characteristic that has importance in determining the use to which a soil is put and the ease with which it can be tilled, it is taken into consideration in soil classification. Soil types are determined according to the texture of the surface soil. Thus the class name of the soil texture, such as sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam, and clay, is added to the series

name to give the complete name of the soil type. For example, Chenango loam and Chenango silt loam are types within the Chenango series. Except for the texture of the surface soils, these soils have approximately the same general characteristics.

A phase of a soil type is a soil which differs from the type in some minor characteristic that may have special practical significance. Differences in relief, depth of soil material, and content of gravel or stone are frequently the bases for the separations of phases. These differences may not materially influence soil character but may be of great significance in land use.

SOILS AND CROPS

The soils of Armstrong County are characteristic of a region included in the physiographic division known as the Allegheny Plateaus, or Allegheny Mountain section, particularly the southwestern part of it. They occupy a landscape that at present bears little resemblance to a plateau, as the county consists, in general, of rolling to hilly lands which have been greatly altered and modified by erosion.

The soils are variable and represent a considerable range in character. They have been developed from the products of the disintegration of the underlying rocks, chiefly sandstone and shale, modified by the vegetation and the influence of climate for long periods of time; or from similar material removed and deposited at lower levels as a result of soil wash; or the soil material may consist of alluvium deposited on the flood plains of rivers and smaller streams and branches. In general the upland soils of this county are thin, as most of the land surface has a pronounced relief and has undergone much natural erosion. The shallow soils occur on the tops of knolls and hills and on the valley slopes. Deeper soils occur on the lower benches, along the streams and on stream terraces, and on the tops of ridges, upland flats, and saddles. The soils on first bottoms, or land subject to frequent overflow, are more shallow along the small streams and branches and deeper along the larger streams and rivers, except where the latter flow in gorgelike channels. The deep soils, as a rule, have good surface features but in places are imperfectly drained, although they include some of the best land in the county.

The principal crops are hay, oats, corn, wheat, potatoes, rye, barley, buckwheat, and clovers, supplemented by fruit and garden vegetables. All the crops named, with the exception of buckwheat, potatoes, truck crops, and fruit, are classed as subsistence crops and the others as cash crops. The subsistence crops are those used for feed for livestock or food for home use, and they have been produced in this county since the early days of settlement. The geographical position and the climate are suited to their growth, and they fit well in systems of crop production. Changes in economic conditions are usually reflected only in an expansion or reduction of the acreage of these crops.

More land is utilized for the production of hay than any other crop. The hay consists largely of clovers and alfalfa and includes little timothy. It is used mainly as roughage for cattle. Oats are the basis of all livestock rations. Corn is produced largely for grain, although each year more silos are built and more silage corn is produced.

Wheat is grown largely for its value as feed for poultry and livestock and because it fits well in the crop rotations. Formerly much of the wheat was sold to the local mills where wheat flour and blended flour were made, but very little wheat is sold today. Rye is an important feed for livestock, and at times rye straw is in considerable demand at the brick plants where it is utilized to pack bricks for shipment.

Gardens and orchards are generally an important part of each farm, and, where the acreages are large, the surplus is sold to local and more remote markets. Some of the buckwheat, potatoes, fruit, and truck crops are consumed on the farm, but most of these products are sold. Buckwheat is used as a catch crop and is sometimes included in the crop rotation. Some of the local mills make buckwheat flour. The Japanese varieties of buckwheat seem to be the most popular. The acreage of potatoes seems to be increasing. Potatoes are grown on all farms and are an essential garden product. Commercial production has been stimulated by unusual local demands.

Practically the same crops are produced in all parts of the county, but a grouping of the soils can be made on the basis of their characteristic color, texture, structure, and drainage, and their relationship to crops can be more clearly defined. A broad grouping based on drainage has marked significance in land use. The soils of the county may be grouped as follows: (1) Well-drained soils, (2) imperfectly drained soils, and (3) poorly drained soils.

In the following pages the different soils are described in detail, and their agricultural relationships are discussed; their location and distribution are shown on the accompanying soil map; and their acreage and proportionate extent are given in table 2.

TABLE 2.—*Acreage and proportionate extent of the soils mapped in Armstrong County, Pa.*

Soil type	Acres	Percent	Soil type	Acres	Percent
Rayne gravelly silt loam	66,176	15.8	Westmoreland silt loam	7,872	1.9
Rayne shaly silt loam	57,920	13.9	Upshur clay loam	896	.2
Rayne silt loam	17,984	4.3	Belmont silt loam	1,920	.5
Rayne gravelly loam	13,824	3.3	Cavode silt loam	9,472	2.3
Gilpin gravelly silt loam	6,400	1.5	Ernest silt loam	37,312	8.9
Gilpin gravelly silt loam, steep phase	55,552	13.3	Ernest gravelly silt loam	14,272	3.4
Gilpin shaly silt loam	10,432	2.5	Monongahela silt loam	9,280	2.2
Gilpin shaly silt loam, steep phase	16,192	3.9	Philo silt loam	11,008	2.6
Chenango silt loam	3,456	.8	Robertsville silt loam	1,792	.4
Holston loam	3,584	.9	Atkins silt loam	6,912	1.7
Westmoreland gravelly silt loam	13,696	3.3	Alluvial soils (undifferentiated)	7,744	1.9
Westmoreland gravelly silt loam, steep phase	18,048	4.3	Rough stony land	15,104	3.6
Westmoreland shaly silt loam	11,072	2.6	Total	417,920	

WELL-DRAINED SOILS

The well-drained soils form the dominant group and occupy more than three-fourths of the total area of the county. Included in this group are soils with adequate to extreme run-off, which occupy favorable to unfavorable relief. Where run-off is excessively rapid or the soils are shallow, the parent rock material may be exposed. Not all the steep land, however, is subject to excessive erosion. Where the parent material is not consolidated rock, but disintegrated and unconsolidated material, the chippy and flaggy nature of the

surface soils seems to allow more ready absorption of rain water, and the subsoils, with some exceptions, though generally shallow, allow free movement of soil moisture and retain sufficient for crops in seasons of normal rainfall. The relief of the soils of this group might be described as nearly level to rolling or hilly. On the tops of ridges and on gentle slopes, improved labor-saving machinery can be operated and crops more economically grown than on the steeper slopes where much of the grain is harvested by hand with a cradle.

The color of the surface soil in cultivated fields ranges from grayish brown to dark chocolate brown. In forested areas the color of the thin surface layer ranges from grayish brown to nearly black, with some variation in the character of the organic matter; but where the soil is subjected to tillage operations for any length of time, the dark color soon disappears.

The well-drained soils may be separated into two subgroups on the basis of color, particularly the color of the soil in cultivated fields. The first subgroup includes the grayish-brown soils which have yellowish-brown or light-brown subsoils; and the second, the brown soils which are underlain by brown or light-brown subsoils.

GRAYISH-BROWN WELL-DRAINED SOILS

The grayish-brown well-drained soils include all the members of the Rayne, Gilpin, Chenango, and Holston series. These soils are well distributed over nearly all parts of the county. Although some large areas of the individual soils of this group occur in the northeastern and northwestern parts, in general the areas are small and interrupted in distribution by other members of this group and by members of other groups. The aggregate area occupied by the soils of this subgroup is 393 square miles, or 60.2 percent of the total area of the county. For the most part, these soils occupy rolling to hilly country with small areas of nearly flat to steeply inclined relief. Drainage is well established for the removal of surface and subsurface waters. In fact, run-off is generally excessive on the Gilpin soils, which are the most shallow. All the surface soils have a silty or loamy texture, are only slightly compact, are comparatively easy to work, and do not bake or run together, as seems to be the tendency of the brown soils. The soils of this group, in general, have a good supply of organic matter in the surface soil. In virgin areas the surface is covered with leaves and forest debris, beneath which is a more compacted layer of leaves, and this rests on partly or completely decomposed forest litter. This last layer grades into material which is intimately mixed with mineral surface soil. The organic matter on the soils of the northeastern and east-central parts of the county has a definite matlike character. The forest growth on the Rayne soils is dominantly hardwoods and consists largely of various oaks, maple, walnut, butternut, hickory, wild apple, and dogwood.

Nearly all the soils of this group are naturally acid or very acid in reaction, particularly in places where they have not been disturbed. Cultivated fields in places have been rendered slightly acid or almost alkaline by frequent applications of lime, which are considered necessary in order to obtain a stand of clover and legumes.

The soils of this group warm early in the spring, and the many different crops adapted to them usually get an early start. They are successfully used for general farming, dairying, and fruit and truck crops. The pastures are not generally so good or so persistent as those on the reddish-brown soils, but excellent pastures have been developed on some of these soils and are much better than pastures that have been neglected on the Westmoreland soils.

Rayne gravelly silt loam.—The surface soil of Rayne gravelly silt loam consists of grayish-brown or dark grayish-brown mellow silt loam, from 8 to 12 inches thick. This passes gradually into slightly compact silty clay loam which is more yellow than the surface soil and which generally becomes heavier in texture with depth; between depths of 18 and 24 inches it is heavy silty clay of a uniform buff color. The lower part of the subsoil, between depths of 24 and 36 inches, is not everywhere uniform in color or texture, but is made up of alternately heavy and light lenticular layers that change in texture and color from one extreme to the other within short distances. This soil, in most places, exceeds a total depth of 3 feet and rests on sandstone, sandy shale, or shale. Over the surface is a conspicuous amount of flaggy shale and sandstone fragments ranging from 2 to 6 inches in diameter. Rock fragments, most of which are more than 1 inch thick, also occur throughout the soil mass.

Rayne gravelly silt loam occurs in all parts of the county, in large well-developed areas in the northern part north of Cowanshannock Creek, and northwest of Kittanning, and in smaller and more widely scattered areas in the southern part. It is the most extensive soil in the county, covering 103.4 square miles, or 15.8 percent of the entire area. This soil occupies ridges and the more gentle slopes in the rolling to hilly country. Both surface drainage and underdrainage are well established, and crops rarely suffer during protracted dry spells. Farmers state that the stone fragments on the surface afford some protection against evaporation of moisture.

About 45 percent of this soil is used for crops, and the remainder supports a mixed growth of trees and brush, consisting principally of various oaks and, less commonly, maple, hickory, elm, dogwood, and wild apple. Of the cropland, corn occupies about 12 percent, wheat 9 percent, oats 14 percent, rye 3 percent, buckwheat 4 percent, and hay and pasture the remainder. Acre yields of corn range from 35 to 50 bushels, wheat from 20 to 30 bushels, oats from 20 to 50 bushels, buckwheat from 15 to 20 bushels, rye from 12 to 25 bushels, and hay from 1 to 1½ tons. This soil does not support such good pastures as Rayne silt loam, but it is recognized as a productive soil. Its use has been more or less restricted by fragmentary rock on the surface. The fragments, however, do not interfere seriously with cultivation but are wearing and destructive to farm tools.

Rayne shaly silt loam.—The surface soil of Rayne shaly silt loam consists of grayish-brown or dark grayish-brown silt loam 8 or 10 inches thick. This passes rather abruptly into buff or yellowish-brown light silty clay which, in a few places, extends below a depth of 20 inches. Below this layer, unconsolidated shale fragments are more abundant than the fine soil, which consists of yellowish-brown silt loam. This layer is underlain by bedrock composed largely of

shale or sandy shale, which, in most places, is within 3 feet of the surface. Over the surface and throughout the soil mass is a conspicuous quantity of shale chips which are not so abundant in the B horizon as in the other horizons.

Rayne shaly silt loam occurs mostly across the central part of the county, although small areas are in all parts. It is well developed in the vicinities of Sagamore, Blanco, and Shay; west of Ford City; around Worthington; and at other places.

This soil occupies rolling to hilly country, especially the tops of ridges, hills, and more gentle slopes. Both surface drainage and subsurface drainage are well established. The soil warms early in the spring, and crops get an early start and mature somewhat earlier than on the other Rayne soils, with the exception of Rayne gravelly loam. About 60 percent of this soil is under cultivation, and the rest supports a mixed growth of such trees as oaks, maple, hickory, wild cherry, and dogwood, and an undergrowth of sassafras, grapevines, and blackberry bushes. The cultivated land is used for the production of corn, wheat, oats, buckwheat, rye, potatoes, truck crops, and fruit. Hay occupies about 25 percent, oats 12 percent, corn 14 percent, wheat 7 percent, buckwheat 12 percent, and rye 8 percent of the cropland. Acre yields of corn range from 25 to 45 bushels, oats 20 to 45 bushels, wheat 10 to 25 bushels, buckwheat 8 to 20 bushels, rye 15 to 25 bushels, potatoes 100 to 250 bushels, and hay 1 to 2 tons. Most of the truck crops grown on this soil are of good quality and mature earlier than on the other Rayne soils. Apples, pears, plums, and cherries do well, but peaches are a little uncertain on account of late spring frosts. This is considered an easy soil to work, the relief in most places allows the use of labor-saving equipment, and crops can be economically produced.

Rayne silt loam.—The surface soil and subsurface materials of Rayne silt loam are similar to those of Rayne gravelly silt loam, with the exception that they contain little gravel. The underlying rocks are much the same and consist of sandstone, sandy shale, or a mixture of shale and sandstone.

Rayne silt loam occurs mostly in the northeastern and central-western parts of the county, but small areas are in all parts. Some of the larger areas are in the vicinity of Oakland, northeast of Worthington, north of Freeport, and in the southern part near Brickchurch and Spring Church.

Rayne gravelly loam.—The surface soil and subsoil materials of Rayne gravelly loam are similar to those of Rayne gravelly silt loam, with the exception that the soil in general is more shallow, and the surface soil and subsoil are lighter in texture and more uniform in color. Most of this soil has been derived exclusively from sandstone, and the lower part of the subsoil is very sandy. Scattered over the surface and throughout the soil mass is a conspicuous quantity of flaggy sandstone fragments which range from about 2 to 6 inches in diameter and from one-half to about 1½ inches in thickness.

Included with this soil, as mapped, are a few small areas of Rayne loam. These are essentially different from Rayne gravelly loam in that the surface soil is practically free of sandstone fragments. The largest areas are west and northwest of Deanville, southeast of Tidal, and 2¼ miles southwest of Blanco.

Rayne gravelly loam is one of the less extensive soils of this group. The larger areas are in the vicinity of Fredericksburg, south of Tidal, southeast of Belknap, west of McGregor, in the vicinity of Frenchs Corner, and at other places throughout the western and northern parts of the county.

This soil occupies relief favorable to agricultural operations, on the tops of ridges and more gentle slopes. It has good surface and subsurface drainage; in fact, the subsurface movement of moisture is too rapid in places, and crops suffer during protracted dry spells. About 70 percent of the land is cleared, and the rest supports a mixed growth of various oaks, maple, dogwood, poplar, and sassafras. Of the cropland, corn occupies 14 percent, wheat 7 percent, oats 15 percent, rye 8 percent, buckwheat 10 percent, and potatoes 3 percent, and the remainder is in hay or forage and pasture. Acre yields of corn range from 25 to 40 bushels, wheat 10 to 20 bushels, oats 20 to 40 bushels, buckwheat 15 to 30 bushels, rye 10 to 25 bushels, potatoes 60 to 200 bushels, and hay 1 to 1½ tons. This soil warms early in the spring. Crops mature earlier than on any other of the Rayne soils, but pastures are not quite so good or so persistent. Rayne gravelly loam can be worked sooner after rains than the other Rayne soils and is better adapted to light farming and the production of truck crops and fruit.

Gilpin gravelly silt loam.—The surface soil of Gilpin gravelly silt loam, which ranges from 6 to 10 inches in thickness, is grayish-brown mellow silt loam mixed with numerous flat shale fragments. It is underlain by a layer of yellowish-brown shaly silt loam slightly heavier in texture, which is variable in thickness and may extend to a depth of 20 inches. This rests upon loose fragmentary shale or shaly sandstone. Intermixed with these unconsolidated shale or sandstone fragments is a conspicuous amount of mellow brown silt loam. In places the unconsolidated shaly layer is missing, and the soil rests directly on consolidated bedrock of sandy shale or shale. On the surface and throughout the soil mass is an abundance of flat shale fragments ranging from 2 to 6 inches in diameter and from one-fourth to 1 inch in thickness.

Gilpin gravelly silt loam occurs in widely scattered small areas in all parts of the county. Some of the larger bodies are near Oakland, in the vicinity of Belknap, southwest of Yatesboro, near Brickchurch, east of Apollo, and between Worthington and Freeport.

This soil occupies moderate slopes and the tops of ridges and knolls, and its relief in general is comparatively favorable to agricultural use. Both surface drainage and subsurface drainage are good, but crops are said to do best in wet seasons and to suffer during protracted dry spells. About 65 percent of this soil is cleared, and the rest supports a mixed growth of various oaks, maple, hickory, dogwood, and sassafras. In general the trees on this soil are not so large as those on the Rayne and Westmoreland soils. The cultivated land is used for the production of corn, wheat, rye, oats, buckwheat, potatoes, hay, pasture, vegetables, and fruit. Corn occupies about 14 percent, wheat 8 percent, buckwheat 13 percent, rye 7 percent, oats 10 percent, and potatoes 3 percent of the cropland. Acre yields of corn range from 35 to 50 bushels, wheat 10 to 20 bushels,

oats 15 to 30 bushels, rye 15 to 25 bushels, buckwheat 20 to 30 bushels, potatoes 70 to 150 bushels, and forage or hay one-half to 1½ tons. All kinds of garden vegetables do well on this soil, and some success is had with such fruits as apples, plums, and cherries. This is an easy soil to work, and rock fragments on the surface do not interfere seriously with cultivation, although they are wearing on tools.

Gilpin gravelly silt loam, steep phase.—The steep phase of Gilpin gravelly silt loam is similar to the typical soil, but it is more variable in thickness and includes more local variations. It occupies steep positions on valley slopes and hills and is subject to serious wash and erosion. The wash in many small areas that have been poorly managed has been so severe as to expose the underlying bedrock or reduce the soil material to a mere cover of disintegrated rock.

Most of the soil of this phase occurs in the central and northeastern parts of the county, although it is not restricted to these sections. The more extensive areas are between Kittanning and the northeastern corner of the county, northwest of East Brady, and in the southern part east of Apollo.

About 30 percent of this land is cleared, and the remainder is in forest and brush similar to that on the typical soil. Some fields of buckwheat and other small grains were noted in the more favorable locations during the survey, but the greater part of this land is turned out of use for crops or pasture. Most of the land is too steep for agricultural use, and where it is cultivated nearly all the grain is harvested by hand, as machines cannot be used. The pastures are generally poor unless given some protection against wash and erosion. Where the land has been abandoned and eroded, so that vegetation has difficulty in getting a start, some success has been attained with reforestation.

Gilpin shaly silt loam.—The 6- to 10-inch surface soil of Gilpin shaly silt loam consists of grayish-brown silt loam containing a conspicuous quantity of small thin shale chips on the surface and through the soil. This material rests on unconsolidated shale fragments intermixed with brown silt loam which, below a depth of 24 inches, in most places passes into consolidated bedrock of gray, yellowish-brown, or, in places, reddish-brown shale.

This is one of the less extensive soils. The larger areas are northwest and southeast of East Brady, northeast of Yatesboro, and north of New Salem, and small bodies are scattered throughout the southern part of the county.

This soil occupies the tops of ridges and the more gentle slopes. It has good surface and subsurface drainage, but it is so light textured that crops are apt to suffer during prolonged dry spells. About 60 percent of the land is cleared, and the rest supports a mixed growth of various oaks, maple, hickory, and dogwood. Corn, wheat, oats, rye, buckwheat, potatoes, and hay or forage are the principal crops. Corn occupies about 14 percent, wheat 7 percent, oats 10 percent, rye 9 percent, buckwheat 14 percent, and potatoes 8 percent of the cropland. Acre yields of corn range from 25 to 40 bushels, wheat 10 to 20 bushels, rye 10 to 20 bushels, potatoes 60 to 200 bushels, and hay or forage 1 to 1½ tons. This is an easy soil to work, as small shale chips on the surface and through the soil do not inter-

fere with cultivation. It warms early, and crops mature early. It is considered a good soil for potatoes, truck crops, and fruit.

Gilpin shaly silt loam, steep phase.—The steep phase of Gilpin shaly silt loam has the same general characteristics as the typical soil, with the exception that it is more shallow and occupies steeper relief. The larger areas are in the eastern and central parts of the county on both sides of Cowanshannock Creek, west of Allegheny River at Ford City, in the southern part northeast of Vandergrift, and in the northeastern part north of New Salem. Smaller bodies occur in other parts.

Drainage on this soil in most places is excessive, and although more than 40 percent of the land is cleared, little of it is used for crops. Where it is used, small fields are devoted to rye and buckwheat, which are harvested by hand, as improved machinery cannot be used.

Chenango silt loam.—The surface soil of Chenango silt loam consists of grayish-brown light silt loam and ranges from 6 to 10 inches in thickness. This passes into yellowish-brown friable silty clay loam which becomes slightly heavier and more compact between depths of 20 and 30 inches and is underlain by yellowish-brown silt, sand, and gravel, which may extend below a depth of 70 inches. The gravel, which are rounded and very much stained, consist principally of quartzite, sandstone, and quartz, and they range from one-half inch to about 4 inches in diameter.

Included with Chenango silt loam are a few areas or spots of Chenango sandy loam. The most important of these is in the vicinity of Parker City, and an area is southwest of Mahoning. The aggregate area of these spots of sandy loam did not warrant their separation on the soil map.

Chenango silt loam is one of the less extensive soils. The largest areas are around Parker City, near Hillville, east of Ewing, northeast of Ford City, near Clinton, and in places along Mahoning Creek. The areas of this soil in the vicinity of Eddyville have a conspicuous quantity of gravel on the surface, and this condition obtains in other areas, particularly where the soil occurs on slopes and is more shallow.

Chenango silt loam occupies high terraces along Allegheny River and the larger streams, and in places it is more than 300 feet above the normal water level of the stream. The relief ranges from flat to slightly undulating, and the land has good surface and subsurface drainage.

About 80 percent of the land is cleared, and the rest supports a cover of trees and brush, consisting largely of white, red, and black oaks, maple, cherry, beech, and dogwood. Of the cultivated land devoted to field crops, corn occupies about 15 percent, wheat 10 percent, oats 12 percent, buckwheat 8 percent, rye 7 percent, and potatoes 4 percent, and the remainder is in hay or forage and pasture. Acre yields of corn range from 30 to 50 bushels, wheat 15 to 25 bushels, oats 20 to 60 bushels, buckwheat 15 to 20 bushels, rye 12 to 25 bushels, potatoes 100 to 250 bushels, and hay or forage 1 to 2 tons. In addition to the field crops, some vegetables and fruit are produced. Chenango silt loam is an easy soil to work. It warms early in the spring, and crops mature early. In some places the subsurface drainage is excessive, and crops sometimes suffer during protracted dry

spells. All kinds of vegetables and fruits adapted to the general region do well, and the relief is such that labor-saving machinery can be used.

Holston loam.—The 6- to 10-inch surface soil of Holston loam consists of brown rather light loam. This passes rather abruptly into yellowish-brown light silty clay which becomes more compact with depth and about 30 inches below the surface rests on brown sand and gravel or a partly cemented gravel bed of variable thickness. In places on the surface are scattered some small rounded gravel which consists mostly of sandstone and shale. Small included areas of Holston sandy loam occur in places near the breaks of the terrace, where the soil is more shallow as it approaches the slopes.

Holston loam is a soil of minor importance. It occupies the second bottoms along the larger streams. The larger areas are near Oak Ridge, west of Mahoning, in the vicinities of Kittanning, Ford City, Freeport, Leechburg, Apollo, and other places along the streams.

Probably 50 percent of the land is cleared, and the remainder supports a cover of trees and brush, which consist largely of red oaks and black oaks, and some elm, cherry, black walnut, and beech. The cultivated land is used for the production of corn, wheat, oats, rye, potatoes, hay, and some garden vegetables and fruit. Acre yields of corn range from 25 to 50 bushels, oats 20 to 60 bushels, wheat 20 to 30 bushels, rye 15 to 30 bushels, potatoes 100 to 150 bushels, and hay or forage 1 to 2 tons. Holston loam is an easy soil to work, and, as the relief ranges from flat to gently undulating, all kinds of labor-saving machinery can be used and crops economically produced. This is considered an excellent soil for general farm crops.

BROWN WELL-DRAINED SOILS

The brown well-drained soils, which have brown or reddish-brown surface soils and brown or light-brown subsoils, include all the types of the Westmoreland, Upshur, and Belmont series. These soils are largely developed in the southeastern, southern, and west-central parts of the county. In the southern part they are separated by a ridge extending north from the river near Edmon.

This subgroup occupies an aggregate area of 83.6 square miles, or 12.8 percent of the county. The different soils do not occur in large areas but rather in streaks and spots interrupted by bodies of other soils. Most of the soils of this subgroup, particularly in the southeastern and southern parts of the county, occupy country that has been greatly dissected, but in the west-central part the relief is more favorable and might be described as comparatively low and rolling.

Both surface and subsurface drainage are generally good, but in a few areas where the subsoils are heavy, the free movement of internal moisture is more or less obstructed. On much of this land, where poorly managed, sheet erosion is active, and, where the slopes are steep, trenching and gullying are not uncommon.

This subgroup includes most of the heavy soils of the county. The subsoils are close in structure, plastic and sticky in consistence, and decidedly heavy. The group includes soils that have been influenced directly or indirectly in their development by the presence of limestone, and they range from slightly acid to alkaline in reaction. Lime is used less frequently and in smaller quantities than is

ordinarily necessary on the soils of other groups. The soils of this subgroup are regarded as comparatively fertile, as most of them have a high content of plant nutrients, although the range in the content of plant nutrients is considerable. They are difficult to work and to put into good physical condition. Crops get a late start on some of these soils which do not warm so early as the Rayne soils.

The agriculture on the brown well-drained soils consists of general and dairy farming, although some cattle and sheep are fed and ranged. The principal crops grown are corn, wheat, oats, and hay or forage. Comparatively little buckwheat and rye are grown, as the heavier soils are not so well adapted to these crops as are the lighter soils. The soils of this subgroup constitute some of the best grazing land in the county, but pastures were seriously impaired while this part of the county contributed large quantities of hay and grain to the industries in nearby towns. As the development of dairying has demanded better and more permanent pastures, these soils are being put into good condition again.

Westmoreland gravelly silt loam.—The surface soil of Westmoreland gravelly silt loam consists of brown silt loam to a depth of about 10 inches. Below this depth the material becomes heavier and grades into brownish-yellow silty clay which continues to a depth of about 24 inches, where it rests on sandstone and shale with interbedded clay, coal, and limestone. The surface soil, in general, is not quite so loose and friable as that of the Rayne soils. Over the surface and throughout the soil mass is a conspicuous quantity of angular flaggy sandstone or shale fragments ranging from 2 to 5 inches in diameter and from one-half to 1 inch in thickness.

Included with this soil are a few small spots of Westmoreland gravelly sandy loam, near the Indiana County line southeast of Long Run. The total area of this gravelly sandy loam soil was too small to justify separation; it was included therefore, with Westmoreland gravelly silt loam on the map.

Westmoreland gravelly silt loam occurs mainly in scattered areas east of Allegheny River, and only a few small areas are west of the river. The larger bodies are in the vicinity of Girty, Long Run, Vandergrift, Kittanning, around Eddyville in the northeastern part, and in other places throughout the county. This soil occupies gentle slopes and the tops of ridges and knolls. Most of it is well drained, but it does not warm quite so early in the spring as Westmoreland shaly silt loam.

About 70 percent of Westmoreland gravelly silt loam is cleared, and the remainder is in brush and woodland. The forest growth consists of various oaks, wild cherry, hickory, maple, butternut, locust, and spruce, with an undergrowth of sassafras, dogwood, blackberries, and sweet myrrh; Kentucky bluegrass grows in the more open places. Of the cropland, corn occupies about 18 percent, wheat 14 percent, oats 20 percent, and hay and pasture the remainder. Acre yields of corn range from 20 to 50 bushels, wheat 20 to 30 bushels, oats 25 to 50 bushels, hay 1 to 1½ tons, and forage crops somewhat higher than hay. On account of the flaggy stones on the surface, which are particularly hard on tools and equipment, this soil is considered difficult to work. In a number of places many of the stones have been removed and built into fences. This soil is

considered excellent for grass and grain, and the pastures are very persistent.

Westmoreland gravelly silt loam, steep phase.—The steep phase of Westmoreland gravelly silt loam is similar to the typical soil, with the exception that it is generally more shallow and occupies steep slopes where it is exposed to serious wash and erosion. Erosion has been so excessive in places that the underlying rock is exposed.

Soil of this phase occurs in the southeastern, southern, west-central, and northern parts of the county. The larger areas are in the vicinities of Girty and Long Run, between Ford City and Apollo, west of Worthington, on both sides of Allegheny River north of Kittanning, and in the vicinities of Oakland and Putneyville.

About 40 percent of the land is cleared, and the rest supports a growth of trees and brush similar to that on the typical soil. Some of it is used for growing grain, but most of it is included in permanent pastures. Some difficulty is experienced in protecting this land from wash and erosion.

Westmoreland shaly silt loam.—The surface soil of Westmoreland shaly silt loam is similar in color to that of Westmoreland gravelly silt loam, but it is generally thinner and passes rather abruptly into brownish-yellow silty clay which, in a few places, extends below a depth of 20 inches. This material rests on shale intermixed with brown silt loam, beneath which is bedrock of shale or argillaceous shale, with, in places, seams of coal, fire clay, or limestone. Over the surface and throughout the surface soil is a conspicuous quantity of small thin angular chips of shale or argillaceous shale, but the subsoil is practically free of shale fragments. Included with this soil is a small area, near Hicksville on the Indiana County line, of Westmoreland shaly sandy loam which is too small to justify separate mapping.

Practically all of Westmoreland shaly silt loam occurs in small areas south of Cowanshannock Creek and east of Allegheny River in the southeastern and southern parts of the county. The larger areas are in the vicinities of Elderton and Long Run, and between Apollo and Ford City, and small bodies are in other places throughout the southern half of the county. This soil occupies the more gentle slopes and the tops of ridges and knolls. It is slightly more rolling than Westmoreland silt loam, but it is much more shallow and somewhat better drained.

About 75 percent of Westmoreland shaly silt loam is cleared, and the rest supports a cover of brush and forest. The tree growth consists of white, red, and black oaks; hickory; dogwood; cherry; locust; and spruce. The undergrowth is largely sassafras, dogwood shoots, blackberries, and sweet myrrh. This soil is used for the production of corn, oats, wheat, rye, buckwheat, vegetables, and fruit. Corn occupies about 18 percent, oats 15 percent, wheat 10 percent, rye 2 percent, and buckwheat 2 percent of the cultivated land. Acre yields of corn range from 25 to 50 bushels, oats 25 to 50 bushels, wheat 15 to 30 bushels, buckwheat 12 to 20 bushels, rye 18 to 35 bushels, and hay 1 to 1½ tons. Westmoreland shaly silt loam is the lightest textured Westmoreland soil in the county and is easily worked, as the shale chips are too small to interfere with cultiva-

tion. Crops get an earlier start in spring and mature earlier in fall than on Westmoreland silt loam, but the pastures are said to be less persistent. Potatoes and all kinds of garden vegetables do well, and the fruit produced is of excellent quality.

Westmoreland silt loam.—The surface soil and subsoil layers of Westmoreland silt loam are similar to the corresponding soil layers of Westmoreland gravelly silt loam, except that both the surface soil and the subsoil contain few fragments of sandstone and shale and that the soil material is somewhat variable in total thickness, ranging from about 24 inches to 70 inches. It is underlain by similar material as in the gravelly silt loam. Included with this soil, on account of their small extent, are a few small areas of Brooke clay loam. One of these is three-fourths mile southeast of Shady Plain, others are near the county line northeast of Olivet, and in other places within areas of Westmoreland soils.

Westmoreland silt loam is one of the less extensive soils of the county. Practically all of it is in the southern part east of Allegheny River. The larger bodies are in the vicinity of Olivet, in the section between Apollo and Allegheny River, and a few areas are mapped in the extreme northeastern part of the county.

Most of this soil has favorable relief and occupies the tops of ridges and the more gentle slopes. Most of it is cleared, and approximately 10 percent is in brush and trees. The forest growth consists of various oaks, poplar, chestnut, butternut, sassafras, spruce, and locust. Of the land devoted to field crops, corn occupies about 22 percent, wheat 14 percent, oats 18 percent, and the rest is used for forage, hay, or pasture. Rye, buckwheat, and barley are seldom grown. Acre yields of corn range from 35 to 50 bushels, oats 30 to 60 bushels, wheat 15 to 30 bushels, and hay 1 to 2 tons. In addition to the crops mentioned, some vegetables are grown in home gardens, and most farms have small orchards. Potatoes and garden vegetables are successfully and profitably grown, and apples, plums, and cherries do well, but peaches are said to be uncertain. Kentucky bluegrass is one of the common and conspicuous grasses on this soil, and it is used largely for pastures. Pastures are developed without difficulty and last for many seasons.

Upshur clay loam.—The 5- to 10-inch surface layer of Upshur clay loam consists of reddish-brown clay loam. It is underlain rather abruptly by dull-red or Indian-red clay which is somewhat variable in thickness but in most places extends to a depth of about 20 inches, where it rests on heavy sticky plastic dark-red clay splotched with gray, yellow, purple, and brown. This layer also is variable in thickness, in places contains nodules of lime or thin seams of limestone, and rests on bedrock of shale and sandstone at a depth ranging from 40 to 70 inches. Included with this soil, in the northern half of the county, are a few small areas which differ in some respects from the typical soil. One of the largest of these is south of Dayton, where the subsoil is deeper and shows a strongly acid reaction. In general, however, this soil ranges from slightly acid to alkaline; in most places it is more alkaline near the bottom of the soil mass, but in some places the upper part of the subsoil is alkaline.

Upshur clay loam is the least extensive soil in the county. It occurs principally in the southern part in numerous small areas

between Vandergrift and Ford City, and in places throughout the southern half. This soil occupies the tops of ridges, knobs, and saddles and the more gentle slopes. Its position in general is favorable for agriculture, but even in these situations it seems to be affected by sheet erosion unless carefully managed.

About 90 percent of this land is cleared, and the rest supports a mixed growth of various oaks, poplar, elm, hickory, maple, locust, and spruce. Corn, wheat, and oats occupy about 35 percent of the cropland, and the rest is in hay or forage and in pasture or is abandoned. Acre yields of corn range from 30 to 40 bushels, wheat 15 to 25 bushels, oats 20 to 40 bushels, and hay or forage 1 to 2 tons. Upshur clay loam is a very difficult soil to work, and this may account for the abandonment of a part of it, but when good tilth is obtained, it is said to be very productive. It requires less lime than the Rayne soils.

Belmont silt loam.—Belmont silt loam consists of a mixture of Upshur and Westmoreland soils so intimately associated that separations could not be made. In the northern part of the county the soil is distinctly acid. The larger areas are 2½ miles south of Dayton and 3 miles northeast of Kittanning, and many small areas are in the southern part on the uplands between Ford City and Vandergrift.

This soil in general occupies the tops of ridges, knolls, and saddles where the relief is favorable for agriculture. A large proportion of it in the southern part of the county is used for crops similar to those on Upshur clay loam, and the land has about the same agricultural value. In the northern part, a larger proportion is used for pasture, although in both sections more or less of the land has been abandoned because of the great difficulty in putting it into good physical condition.

IMPERFECTLY DRAINED SOILS

The imperfectly drained soils occur on the uplands, the stream terraces, and the bottom lands. Members of the Cavode and Ernest series are on the uplands and the Monongahela and Philo soils on stream terraces and first bottoms, respectively. The imperfect drainage may be due to either internal or external conditions, such as soil structure, nearly level relief, or position with respect to the underlying water table. The relief of the imperfectly drained soils of the uplands varies somewhat but, in general is favorable to the use of improved machinery and implements. The areas of Monongahela and Philo soils are generally level, but the meandering courses of the streams interfere somewhat with the use of machinery. The imperfectly drained soils lie at different elevations, ranging from the lowest bottoms to the highest uplands. These soils differ considerably in color, in kind and character of organic matter, and in degree of acidity.

Cavode silt loam.—The surface soil of Cavode silt loam is light grayish-yellow or grayish-brown silt loam to a depth ranging from 7 to 10 inches. This passes rather abruptly into pale-yellow light silty clay of uniform color. This layer, which extends to a depth ranging from 15 to 24 inches, is underlain by yellow silty clay mottled with gray. Below a depth ranging from 24 to 30 inches, the clay is heavier and more blocky. Gray is the dominant color along cleavage lines, but brown and yellow predominate within the blocks.

When dry, the material in this layer is very hard. Below this and resting on the bedrock, the material is darker and more brown but intricately mottled and, although lighter in texture, is generally indurated. In some places the indurated layer is lacking, and the blocky clay rests directly on shale and sandstone. Bedrock of shale is reached in most places at a depth ranging from 35 to 50 inches.

Included with this soil as mapped, are a few areas of a shallow phase, in which the soil differs essentially from the typical soil in that the subsoil is heavier in texture and is conspicuously mottled. The material in many places is very sticky and plastic when wet and very hard when dry. In places it is dull gray, splotched with yellow and brown; in other places it is lighter in texture and more yellow in color, splotched with brown; and in still other places it is red or reddish brown. Most of it is more shallow than the typical soil, and in few places does it extend to a depth of more than 30 inches. Soil of this phase occurs northeast of Greendale, south of Somerville, north of Nichola, south of Browns Crossroads, and at other places throughout the northeastern, northern, and western parts of the county. It is so impervious that water remains on the surface a long time after rains. It is a hard soil to work and difficult to put into good condition, and this may be the reason that so much of it is used for pasture or has been abandoned.

Also included with mapped areas of Cavode silt loam are some bodies of Cavode gravelly silt loam. This soil is similar to Cavode silt loam, with the exception that over the surface and throughout the soil mass is a conspicuous quantity of sandstone and, less commonly, shale fragments that range from 2 to 5 inches in diameter and are about 1 inch thick. A greater proportion of this soil is used for pasture or has been abandoned. The gravel fragments interfere somewhat with cultivation and are said to be wearing on farm tools. They have been removed in places and used for fences or thrown in rock heaps. Where cultivated, this soil is used for the same crops as is Cavode silt loam. It is well developed north, west, and northwest of Widnoon, southeast of Stone House, southeast of Putneyville, north of Goheenville, south of Snyderville, east of Nichola, and in other places throughout the northern and western parts of the county.

The larger areas of Cavode silt loam occur southeast of Apollo, north and northwest of Edmon, east of Oakland, north of Goheenville, in the vicinity of Browns Crossroads, and in the southern part of the county. This soil occupies nearly level or undulating country on the higher uplands, chiefly on ridge tops, saddles, or swales. The water table is rather close to the surface, and water remains on the surface in places for several days after heavy rains. Some effort has been made to improve the drainage by ditching and tiling.

About 80 percent of this soil is cleared. The remainder supports a mixed forest growth of black, red, and white oaks; poplar; hickory; chestnut; maple; and wild cherry; and an undergrowth of sassafras, young chestnut shoots, and some sumac, huckleberry, and wintergreen. Corn, oats, and hay are grown on about 60 percent of the cleared land, and the rest is used for pasture or has been abandoned.

Acre yields of corn range from 20 to 40 bushels, oats 15 to 35 bushels, and hay 1 to 2 tons. Crops do best in dry seasons. Wheat and rye are seldom sown, as they are said to winter-kill readily. Pastures on this soil, particularly on the better drained areas, are good.

Ernest silt loam.—The surface layer of Ernest silt loam consists of yellowish-brown silt loam from 5 to 12 inches thick. It passes rather abruptly into a subsurface layer of yellow light silty clay of uniform color. This layer, which ranges in thickness from 2 to 8 inches, rests on yellow silty clay with gray mottlings, that generally extends to a depth of about 24 inches, where it passes into heavy silty gray clay splotched with yellow and brown. This layer is variable in thickness and may extend to a depth ranging from 30 to 60 inches, where it is underlain by a hard comparatively impervious layer of more sandy or gritty dark-brown material intricately mottled with gray, brown, yellow, and black. The material in this layer is massive and lacks definite cleavage planes. This layer also is variable in thickness, ranging from 15 to 24 inches, and rests on gray silty clay splotched with yellow or brown; or on fragmentary rock of shale, sandstone, or mixed shale and sandstone and intermixed soil material of yellow or buff color mottled with gray or brown. Where seepage is common or where the soil has been subjected to wash or erosion, the uniform yellow layer is lacking and the mottled layer is exposed at the surface, or the surface soil rests directly on the mottled layer.

Included with Ernest silt loam in mapping are small areas of a soil which has the same general characteristics as Ernest silt loam, with the exception that the surface and subsurface layers are lighter in color and a little heavier in texture. The surface soil in cultivated fields is more definitely gray than yellow, and the subsoil is very pale yellow. This soil consists of outwash material from the Westmoreland soils. In this county the subsoil does not contain lime nodules or limestone, but the soil is less acid than Ernest silt loam and ranges from slightly acid to neutral in reaction. This included soil is not extensive and is restricted to the southern part of the county. It occurs along the headwaters of Elder Run, Rattling Run, Long Run, Flat Run, Craig Run, Big Run, and many other small streams. It has about the same agricultural value as Ernest silt loam, but as it does not require so much lime, some farmers consider it a better soil. Where well drained, legumes and leguminous forage are said to do better.

Ernest silt loam occupies areas in the uplands above the bottoms and terraces of the rivers and streams, and the surface slope of most of the land is toward the watercourses. The soil is widely distributed and occurs in all parts of the county, more particularly near the headwaters of streams. It is less well developed where the channels of the watercourses are more gorgelike. It is subject to more or less seepage, and in wet seasons in places small springs keep the surface soil wet and soggy.

About 60 percent of this land is cleared, and the rest supports a forest and brush cover. The principal trees are white, red, and black oaks, with some maple, hickory, wild cherry, elm, and poplar. Thorn apple and hazelnut are common in the undergrowth in places. In general, the relief of Ernest silt loam is favorable to the use of labor-saving machinery, and crops can be grown more economically

than on the steeper and rougher soils. Where this soil is well drained, it is considered a strong soil for grass and grain. The best yields are produced in dry years, as this is one of the deepest soils in the county and can withstand prolonged periods of drought. Of the land devoted to field crops, corn occupies about 25 percent and oats 15 percent, and the rest is in hay, forage, or pasture. Occasional crops of wheat and rye are grown, but these crops are said to winterkill readily. Nearly all farms on this soil have gardens and a few fruit trees. Where the soil is well drained, potatoes and all kinds of garden vegetables do well, and apples, plums, cherries, and cane fruits are said to be successfully grown, but peaches are uncertain, on account of late spring frosts. With the exception of the included areas noted, most of this soil is acid in reaction and commonly is limed.

Ernest gravelly silt loam.—Associated with Ernest silt loam are some areas of Ernest gravelly silt loam which is similar in most respects to Ernest silt loam but has a conspicuous quantity of gravel, ranging from 2 to 6 inches in diameter, scattered over the surface and throughout the soil mass. Ernest gravelly silt loam occurs on benches near Mahoning Creek, Cowanshannock Creek, Buffalo Creek, and many of their tributaries in the northern part of the county. This gravelly soil has about the same agricultural value as Ernest silt loam, but proportionately more of it is used for pasture or is abandoned.

Monongahela silt loam.—The surface soil of Monongahela silt loam is grayish-brown mellow silt loam from 10 to 14 inches thick. This is underlain by a layer of light silty clay of uniform yellow or brownish-yellow color, which ranges from 10 to 20 inches in thickness and in most places becomes heavier and more compact with depth. This material passes into yellow silty clay or fine sandy clay, mottled with gray and brown, which may extend to a depth of more than 3 feet and which rests on a heavier less pervious layer, generally massive and dark brown, mottled with gray and yellow. This layer contains more sand and grit than the layer above, but is cemented and hard in places.

Included with Monongahela silt loam are areas that occur on high terraces and have a greater extent than the typical soil. The soil on these high terraces is similar to the typical soil except that the color of the surface soil and subsoil is lighter and the mottled layer is thicker and more variable. The lower part of the mottled layer is heavier and more blocky in structure, and gray is the dominant color, particularly along the cleavage planes. In all places it is underlain by a bed of gravel that ranges from 2 to 6 feet in thickness. This soil occupies terraces that, in some places, are 300 feet above the watercourses. It is well developed along Allegheny River near Parker City, southwest of Foxburg, southeast of Redbank Furnace, at West Kittanning, near Ford City, south of Aladdin, and near Clinton; in spots along Pine, Cowanshannock, and Crooked Creeks; and in other places throughout the county. This high-terrace soil has flat to undulating relief and is considered excellent for general farm crops. Crops yield best in dry years, as drainage is not thoroughly established and on some of the flat areas water remains on the surface for many days after heavy rains. The close, impervious

character of the underlying clay and the compaction of the hardpan layer do not allow free movement of internal moisture. The soil has good water-holding capacity, however, and crops rarely suffer during protracted dry spells. Most of this soil is acid, and liming is necessary to insure the growth of clovers and legumes.

Drainage is not so well established on the typical soil, as the relief is more flat. Most of this soil lies from 4 to 6 feet above the first bottoms, or overflow land, although at long intervals and under unusual conditions the land has been more or less completely flooded. The heavy underlying clay and the hardpan do not allow ready absorption of rain water, which remains on the surface for many days after rains in places where surface drainage has not been established. As typically developed, Monongahela silt loam occurs from Greendale to Nu Mine along Cowanshannock Creek; at and northeast of Gastown and southeast of Elderton along Plum Creek; in the vicinities of Idaho, South Bend, Girty, and Tunnelville along Crooked Creek; and at other places throughout the county.

Probably 90 percent of this land is cleared, and the remainder is forested. It is used principally for the production of corn, oats, potatoes, hay or forage, and pasture. Rye and oats are not grown extensively, as they are said to winter-kill readily, particularly where the soil is not well drained. Acre yields of corn range from 25 to 40 bushels, oats 30 to 60 bushels, wheat 15 to 25 bushels, rye 12 to 30 bushels, potatoes 80 to 150 bushels, and hay or forage 1 to 2 tons. Monongahela silt loam is an easy soil to work, and crops can be economically grown, as all kinds of labor-saving machinery and implements can be used. Most of the soil is acid, and lime is commonly used.

Philo silt loam.—Philo silt loam has a grayish-brown or dark grayish-brown mellow silt loam surface soil which extends to a depth of 8 or 10 inches, where it passes into yellowish-brown heavy silt loam or light silty clay, and this, at a depth of about 24 inches, grades into yellowish-brown heavy silty or fine sandy clay conspicuously mottled with gray and rusty brown. This layer in few places exceeds a thickness of 30 inches and rests on sand, sandy loam, or gritty loam, with or without small rounded gravel. This lower material is nearly always saturated with water unless the season is very dry.

Included with mapped areas of this soil are some areas of Philo sandy loam, in which the surface material and subsurface material are more sandy. Such areas occur principally on the Allegheny River forelands and islands, particularly near Hillville, north of Parker City, and at Templeton; along Redbank Creek near Oak Ridge; on Glade Run; and along other streams. The soil in the included areas is said to be somewhat more dependable for crops, but the yields are not so heavy. It is used for the same crops as Philo silt loam, but some areas are not cultivated because of the danger of floods.

Philo silt loam occurs on the first, or overflow, bottoms of the rivers and streams, typically where the outwash material was not influenced by limestones but consisted largely of material from shales and sandstones. It occurs in spots along Redbank, Mahoning, Cowanshannock, Buffalo, and Crooked Creeks, and in places along

Allegheny and Kiskiminetas Rivers. It occupies flat or gently sloping areas along the watercourses and is subject to frequent overflow. Most of the land is cleared, as flat land is a desirable addition to the farms of this section. The forest growth comprises sycamore, wild cherry, walnut, various oaks, swamp maple, and elm. The principal crops grown on this soil are corn, oats, hay, and pasture grasses. Acre yields of corn range from 45 to 60 bushels, oats 20 to 50 bushels, and hay 1 to 2 tons. Crops are said to do best in dry years. Harvests are more or less uncertain because of danger from floods, and corn is sometimes harvested early and removed to higher lands to escape this hazard.

POORLY DRAINED SOILS

The group of poorly drained soils includes members of the Robertsville and Atkins series. It is the least important group, from the point of view of distribution, and has an aggregate area of only 13.6 square miles, or 2.1 percent of the area of the county. The members of this group are not restricted to any particular section, but are scattered in spots in all parts of the county. They are flat and range from imperfectly to poorly drained. About 10 percent of the land has been cleared of its merchantable timber, and the rest is covered with trees and brush. Where cleared, these soils have been utilized for pasture, and, during dry seasons, patches of corn and other crops are grown.

Robertsville silt loam.—The 6- to 12-inch surface soil of Robertsville silt loam consists of light grayish-brown silt loam with some faint mottlings of gray. This layer is rather abruptly underlain by bluish-gray silty clay, mottled with rust brown and yellow, which extends to a depth ranging from 20 to 24 inches and rests on heavy blocky gray clay splotched with yellow, rust brown, and some black, along the cleavage planes. This layer, in turn, is underlain by gray or bluish-white massive sandy clay splotched with yellow and rust brown, which extends to a depth ranging from 40 to 50 inches.

Robertsville silt loam occupies a very small total area. It occurs along Buffalo Creek near Craigsville, near the headwaters of Glade Run, and in a few spots along Cowanshannock and Crooked Creeks. It occupies second bottoms, or terraces, along some of the larger streams.

The relief is flat or sloping toward the watercourses. Where artificial drainage is established, this is considered a good soil for general farm crops. About 70 percent of the land is cleared, and the rest is in forest and brush. The tree growth consists of oak, maple, cherry, thorn apple, hickory, beech, elm, sycamore, and ash. Only the best drained patches are used for the production of corn, oats, and hay, and the rest of the land is used for pasture. Acre yields of corn range from 20 to 50 bushels, oats 20 to 40 bushels, and hay 1 to 2 tons. All kinds of labor-saving machinery and tools can be utilized, and, on the drained areas, crops can be produced economically.

Atkins silt loam.—The 4- to 10-inch surface layer of Atkins silt loam consists of grayish-brown or dark grayish-brown heavy silt loam, with gray or rust-brown mottlings. In most places, it is underlain by light grayish-yellow or yellow silty clay containing rust-

brown, black, and yellow mottlings. This layer, in turn, grades, at a depth ranging from 20 to 24 inches, into heavy silty gray clay mottled with yellow and rust brown. The material in this layer may extend below a depth of 3 feet, and it rests on bedrock, a bed of sand, or a bed of sand and gravel.

Atkins silt loam is developed chiefly about the headwaters of the larger streams and occurs in this situation on Glade Run, Patterson Creek, Buffalo Creek, and Cowanshannock Creek, and in isolated spots on South Fork Pine Creek. It occupies the first bottoms of streams that are subject to frequent inundation. More than 60 percent of the land is cleared, and the rest supports a mixed growth of oak, ash, maple, cherry, hickory, ironwood, and haw, with an undergrowth of alder, willow, swamp dogwood, thorn apple, ironweed, wild spirea, and joe-pye-weed. In dry years, some of the more favorably situated areas produce fair yields of corn, oats, and hay, and potatoes and root crops are occasionally produced, but generally the production of crops is uncertain, owing to the susceptibility of the land to overflow.

MISCELLANEOUS LAND TYPES

Alluvial soils, undifferentiated.—Alluvial soils, undifferentiated, consist of undifferentiated material that occurs along the smaller streams and of stream wash ranging from sand, sandy loam, and gritty loam, with or without gravel, to silt loam. This type of land may be shallow sandy loam or silt loam resting on a lighter colored, heavier layer which overlies the stream wash. It occurs in very narrow strips along streams in all parts of the county and occupies flat or inclined areas just above mean water level. The land is subject to frequent overflow. For this reason it is not a dependable soil for the production of crops, but it does afford some pasture for livestock.

Included with alluvial soils, undifferentiated, are a few small areas of Lickdale silt loam, the surface layer of which consists of grayish-brown heavy silt loam mottled with gray, yellow, or rust brown. This is underlain by grayish-yellow silty clay, mottled with yellow and brown, which extends to a depth of about 15 inches, where it passes into heavy silty clay mottled with gray and yellow. This material, in turn, extends to a depth of more than 36 inches and is nearly always saturated with water. Areas of this mixed soil are 2½ miles northeast of Oakland and one-fourth mile east of Browns Crossroads. Because of poor surface and subsurface drainage, the land has no agricultural value at present.

Rough stony land.—Rough stony land represents land too steep, stony, or broken for agricultural use. It consists of steep areas covered with all sizes of loose and outcropping rock. The fine soil material ranges from sandy or gritty loam to heavy silt loam. In some places, subsoils have developed. Underlying and surface rocks consist of sandstones, conglomerates, and shales, and in places local developments of limestones.

Rough stony land occurs intermittently on the slopes of Allegheny River, Redbank and Mahoning Creeks, Kiskiminetas River, and in places along tributary streams. Most of the land is covered with trees and brush, similar in most respects to those on contiguous

soils. Rough stony land has no value except for mineral and forest products. In some of the smoother sections it affords scanty pasture or protection for livestock.

LAND USES AND AGRICULTURAL METHODS [3]

Agriculture in Armstrong County consists of (1) general farming in conjunction with the raising and feeding of sheep and cattle, (2) general farming in conjunction with dairying, and (3) general farming without important livestock interests. The last is now the least important and holds over from the exhaustive hay and grain production common before the mines were electrified. Although the county now has no uniform agricultural system and is still undergoing a transition, it has made a more definite shift to dairy farming, and the crops produced are those that are more suitable to the dairy interests.

No definite crop rotation is universally practiced, although all those in use have much in common. Rotations cover periods ranging from 3 to 5 years. A favorite rotation is corn, oats or barley, and clover; another is wheat or rye following oats and serving as a nurse crop for timothy and clover, followed by hay for 1 or 2 years. When potatoes are grown, they are usually planted in place of corn in the rotation. Buckwheat is sometimes included in cropping systems and is followed by wheat or rye. Sometimes rye is substituted for wheat in the rotations.

Hay is still the most important crop of the county, and timothy the chief grass. The production of pure timothy hay has been greatly curtailed, and more clover and alfalfa are sown each year. Sweetclover is usually planted for soil improvement and is not often used for hay. Alfalfa is said to stand winters better when seeded with clovers. Where farmers are not growing enough alfalfa and clovers to meet their forage needs, they plant soybeans for feeding their horses, cattle, sheep, and poultry. Inoculation of seed is essential and generally practiced for alfalfa, sweetclover, vetch, and soybeans.

Next to hay, oats cover the largest total acreage. This crop is usually sown in April, and most farmers apply superphosphate on the ground used for corn the preceding year. Oats are generally seeded with a drill on a well-prepared firm seedbed, although an earlier practice was to broadcast the seed in the field and harrow it in. During the last few years barley has partly replaced oats, but this crop is still of minor importance. The newer smooth-awned varieties of barley, Velvet and Comfort, are generally sown. Most of the oats are consumed on the farm, as this crop is the basis for all livestock rations. The straw is used for bedding and is fed to some extent.

Corn is the most important cultivated crop and is grown on all arable soils. It is produced most commonly for grain, although much of it is utilized for silage. The prevailing variety of corn grown is a strain of Leaming which is acclimated to the general region. Lancaster Surecropper is more commonly grown for silage.

[3] The information contained in this section was furnished by S. A. Brame, county agricultural agent.

It is a desirable variety, as it ripens 3 out of 4 years, and the corn not needed for the silo can be husked and used for grain. Much corn is cut, shocked, and husked by hand, sometimes being hauled to the barns and husked inside. In some places, the tops are removed in the fields, and the corn is left standing until husking time, when it is husked and hauled out in wagons. This is said by some to be a quicker method of handling the grain. The silage corn is cut and removed entirely from the field.

Wheat is an important grain crop. It is no longer grown as a cash crop, but now is used largely as feed for poultry and livestock. It has an important place in the rotations and is used as a nurse crop for grass and clovers. It is harvested with a reaper and binder, shocked in the field, and ultimately threshed at the barn.

Buckwheat is an important cash crop and is used in rotation or as a catch crop on the light and less productive soils. Most of the buckwheat is sold, but a small proportion is used in cattle rations. It is usually seeded in early July and harvested in September. Most farmers apply about 125 pounds of 16- or 20-percent superphosphate at the time of seeding.

Rye is grown very generally. It is usually seeded later than wheat, and most of it is produced on the lighter textured soils. Some farmers think that rye withstands winter better than wheat and, therefore, grow it in place of wheat. Rye is an important part of the ration for hogs, and some farmers use a little rye in the ration for dairy cows. Rye straw makes excellent bedding. A crop of rye is occasionally turned under as a green manure for potatoes. It is grown also with hairy vetch and cut for hay.

The most important cash crop is potatoes. Although the acreage is not large, it is gradually being extended. Each year more farmers are using disease-free seed. The practices of plowing under legumes (heavily manured clover sod or sweetclover), making heavy applications of complete fertilizer, and using weeders, with less cultivation, and modern methods of power spraying are rapidly being adopted.

The development of dairying has made the farmers more concerned with their pastures, more especially those pastures that are considered permanent and not well adapted to the production of field crops. Such pastures occupy steep hilly land, shallow land, and stream bottoms or irregularly shaped fields. Many of these pastures are seeded to grass mixtures containing Kentucky bluegrass, timothy, redtop, sweetclover, and red, alsike, and white clovers. The grasses are seeded alone or with a nurse crop of oats or barley. The seeding is usually preceded by heavy applications of lime and superphosphate. Another plan is to top-dress old pastures with lime, superphosphate, and barnyard manure. Little highly concentrated complete fertilizer is used. When pastures are developed they are frequently divided and the cattle alternated from field to field.

Thrifty apple orchards grow in all parts of the county, some commercial orchards ranging in size from 10 to 15 acres, and nearly every farm has a few fruit trees. Most of the orchards are kept in sod and fertilized with manure and commercial mixtures, and in a few clean cultivation is practiced. Power sprayers are used to control disease and insects. Some apples are trucked out of the county,

but most of them are sold locally. They are usually kept in cellar storage, and the poorer grades are used for cider and vinegar.

Peach trees often fail to produce a crop because late frosts in spring kill the embryonic fruit. In a few places farmers have been successful with the production of peaches. Clean cultivation is better for peach orchards than sod, if soil erosion can be controlled. The most serious pest is the peach borer, which may be controlled by applying paradichlorobenzene around the base of the trunk.

Included within the county is a considerable acreage of marginal and submarginal agricultural land, including land too steep, shallow, stony, or poorly drained to be economically farmed. Most of it comprises cut-over woodland and is generally in brush, although in places the surface is clean and crops are occasionally produced. About 1,000 acres of such land have been planted to white pine for commercial purposes. A number of farmers are planting some seedlings of spruce and pine; but it is expected that ultimately a great proportion of these idle acres will be supporting evergreen forests, which will add greatly to the wealth of the county.

The change to more intensive farming, resulting from the gradual domination of the agriculture of this county by dairying, is doing much to increase crop yields. Practically all the roughage and nearly all of the grain produced are fed to livestock, and, in addition, farmers buy considerable amounts of prepared dairy feeds and such concentrates as gluten meal and cottonseed meal to balance the ration. Through the manure, the grains and concentrates add to soil fertility. Under this system the use of leguminous forage has, of necessity, been increasing and has resulted in the seeding of new and the improvement of old pastures. This practice has made the use of lime almost imperative, as most of the soils are more or less acid in reaction. Every year more and more farmers submit soil samples to the county agent for the determination of the lime requirement, so that they may apply enough lime to insure stands of clover, alfalfa, and other crops. The requirements range from 2,000 to 8,000 pounds of ground limestone an acre.

Limestone of variable quality occurs in all parts of the county and is very commonly used by the farmers. Much of the lime is burned in the field where used, but a few farmers get it already burned at the quarries. Ground limestone of good quality is prepared within the county and is in great demand. In addition, some hydrated lime and byproduct lime are shipped in.

Lime is usually applied in the rotation before seeding to a leguminous crop and is also used before seeding down permanent pastures. White and Holben [4] state:

> These studies indicate the economy in applying moderate amounts of lime at intervals of 3 to 5 years rather than using very heavy applications with the expectation of greatly lengthening the intervals. Lime is lost from the soil by leaching and by removal by crops. The legumes, such as clover and alfalfa, are not only less tolerant of soil acidity than the cereals, but they require more lime for healthy growth and remove more from the soil than do the cereals. It is therefore important to make the application of lime just preceding the seeding of the legumes. Where clover is seeded on winter wheat, a common

[4] WHITE, J. W., and HOLBEN, F. J. ECONOMIC VALUES OF DIFFERENT FORMS AND AMOUNTS OF AGRICULTURAL LIME. Pa. Agr. Expt. Sta. Bull. 211, 23 pp., illus. 1927. See p. 22.

practice in Pennsylvania, lime should be applied to the plowed ground a short time in advance of the seeding of the wheat. This brings it into action and promotes the catch and growth of clover.

The studies reported in this bulletin substantiate earlier studies on lime that have been in progress at the Experiment Station for 20 years and emphasize the importance of applying lime to the soil whenever it becomes a limiting factor in crop production. These tests all indicate that it makes little difference what form of lime is used as long as it is moderately well pulverized and evenly mixed with the surface soil. We advise using the form of lime that can be put on the land at the lowest cost per unit of active material, taking into account the convenience and economy of spreading as determined by the farm and the machinery available for distributing it.

Additional details of the studies on lime are given in the aforementioned bulletin.

The amount of manure used depends largely on the available supply and ranges from little or nothing to 10 or 12 tons an acre. Farmers are realizing more and more that a certain amount of mineral fertilizers, in addition to lime and manure, are needed. On most of the field crops, such as corn, wheat, oats, rye, and buckwheat, 16- to 20-percent superphosphate is generally used in amounts ranging from 100 to 300 pounds an acre, in addition to the manure. When only light applications of manure are available, 200 to 300 pounds of 2–12–4 [5] complete fertilizer is used. These methods are fairly in line with the State experiment station's suggestions for livestock farming.

The tendency at present is to use high-grade complete fertilizer on all crops, particularly on such special crops as potatoes and vegetables. For potatoes the growers use from 400 to 1,000 pounds of a 4–8–4 mixture, but some variations are used on the truck crops, and some farmers make their own mixtures. On sweet corn they use from 200 to 300 pounds of 3–10–6; on tomatoes, 300 to 500 pounds of 3–10–6; and on spinach, cabbage, lettuce, carrots, radishes, and onions, 200 to 500 pounds of 7–12–7.

The results of experiments on the Westmoreland soils, reported in another State bulletin,[6] have a direct bearing on soils which occur in Armstrong County and are of particular interest to the farmers in the southwestern part of the county.

Value of lime.—On field A, limestone used with superphosphate gave the following per cent increased yields over superphosphate alone: grain 28, hay 1, air dry matter (field weight of crop) 22. On field B, limestone with superphosphate gave a 92 per cent increased yield of Kentucky blue grass and caused a reduction in pasture weeds of 71 per cent. When used with manure, limestone gave the following percentages increase in excess of manure alone: grain 11, hay 38, air dry matter 26, Kentucky blue grass 38.

A table showing the results of fertilizer tests on Westmoreland soil brings out clearly the fact that phosphorus is of vital importance on this soil. Superphosphates used with lime have given the following percent increased yields over lime alone: Hay 61, corn 35, oats 100, wheat 83, and Kentucky bluegrass 63. When used to reinforce manure, superphosphates have given the following percent increased yields over manure alone: Hay 21, corn 18, oats 43, wheat 6, and Kentucky bluegrass 27.

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[5] Percentages, respectively, of nitrogen, phosphoric acid, and potash.

[6] WHITE, J. W., and GARDNER, F. D. SOIL FERTILITY EXPERIMENTS ON VOLUSIA AND WESTMORELAND SOILS. Pa. Agr. Expt. Sta. Bull. 229, 31 pp., illus. 1928.

Applications ranging from 300 to 900 pounds of superphosphate led to the conclusion that—

> The 600-pound application shows the greatest monetary returns nearly three times that of the smallest application, which was 300 pounds. [Superphosphate compared with rock phosphate.]
>
> Even though applied in amounts sufficient to furnish four times the phosphorus supplied in superphosphate, in only one instance did rock phosphate give yields in excess of superphosphate. As an average, the yields attributed to rock phosphate were 18 per cent below those secured with superphosphate.
>
> Applied nitrogen * * * has given an increase of 18 per cent in the production of grain on Westmoreland soil.

The information here quoted has a bearing on the heavy soils of the county which have been classed as Westmoreland, although it is recognized that some of them probably more nearly represent phases of these soils than typical representatives.

Armstrong County, by reason of its good roads, transportation facilities, and proximity to nearby cities and local markets, has many advantages in disposing of its products. Abundance of coal, limestone, natural gas, and water add greatly to the comfort, convenience, and value of the agriculture of this section. These advantages, in a measure, compensate for the unfavorable relief and for the difficulty in handling some of the soils.

The soils have been greatly depleted under former practices of hay and grain production, although great improvement has been effected since the initiation of dairy farming. Much unfavorably located land could be added to productive acres. Greater efforts should be made to protect the slopes more adequately from continuous wash and erosion, as, in places, the soil is removed almost as fast as it is formed. The steep slopes should be planted to evergreen seedlings and other forest trees.

It is difficult to predict just what the future agriculture of the county will be. It is undergoing a change now, and many persons are returning to the farms, although a few houses formerly abandoned are still unoccupied. The agriculture is intimately linked with the industrial activities and the prosperity of the coal and natural-gas fields. It seems reasonable, however, to anticipate that the agricultural development will involve more intensive farming, such as dairying, market gardening, poultry raising, and different phases of horticulture.

MORPHOLOGY AND GENESIS OF SOILS

Armstrong County lies within the region of Gray-Brown Podzolic soils, which extends from the Atlantic Ocean to the prairies of western Indiana, Illinois, Wisconsin, and Minnesota. In common with the soils of this region, the soils of the county have developed under forest cover, which has produced a surface covering of organic litter composed of leaves, bark, decayed wood, and other forest debris. Beneath this, in most places, is a more compact layer of leaves, twigs, and rotted wood, which is more nearly decomposed as the mineral soil is approached. In the soils developed from the more calcareous parent materials, the organic matter has become mixed with the upper layer of mineral soil, and the soil is dark brown to a depth of 2 or 3 inches. In the higher northeastern part of the county where these soils approach the weakly developed Podzols, the or-

ganic layer is more matlike and more sharply set off from the mineral soil below.

The rocks exposed are sedimentary rocks of Pennsylvanian and Mississippian age. The lowest (geologically oldest) formation is the Burgoon sandstone. Above this formation is the Pottsville, along Allegheny River above and below Bradys Bend; along Redbank, Mahoning, and Buffalo Creeks and their tributaries; and on the uplands in the vicinity of Craigsville. This formation consists of sandstone with interbedded shale, limestone, coal, and fire clay. It contributes little to soil formation, as most of it occurs on steep slopes.

The Allegheny formation lies above the Pottsville, and more of it comes to the surface; it is, therefore, of some importance as a source of soil materials. It occupies the higher slopes of the watercourses and is exposed along Allegheny River and Redbank, Mahoning, Pine, Cowanshannock, Crooked, and Buffalo Creeks. It occupies the surface north of Craigsville, in the vicinities of Worthington, Adams, and Lacys Store; between Mahoning and Redbank Creeks; in the vicinities of Kellersburg and Widnoon; and in other places throughout the county. It is made up of sandstone, limestone, and shale, with included veins of coal and fire clay. The Vanport, one of the most important beds of limestone in the county, occurs in this formation. Where exposed, this formation contributes to the soils of both major upland divisions.

Imposed upon the Allegheny is the Conemaugh formation. This is exposed on the surface of the uplands in nearly all sections of the county and has contributed more to soil formation than all the other formations combined. It is composed principally of sandstones and of sandy and argillaceous shales, with seams of coal, limestone, calcareous sandstone, clay, and fire clay. The Ames limestone is in about the middle of the formation. The sandstones range from gray to buff and reddish yellow, and the shales from gray to red. This formation contributes directly and indirectly to the soils of both major divisions.

Overlying the Conemaugh in the southeastern part of the county is a development of the Monongahela formation. It occurs east of Long Run and Olivet and includes the base of the Pittsburgh "Coal Measures", and the upper part of the formation includes the lower part of the Bentwood limestone. It is made up of sandstone with interbedded shale, limestone, and coal. This formation contributes directly to the reddish-brown soils.

All these formations dip toward the south and have been folded into anticlinal and synclinal folds. The folding of the strata explains in some measure the mixing of the soils in the various groups. It is recognized, however, that parent or geological material constitutes a soil only after it has been influenced by soil-forming processes and only attains regional development in undisturbed situations after a long time.

Gray-Brown Podzolic soils occur in all parts of the county and undoubtedly represent the normally developed regional profile, although, here and there, areas of weakly developed Podzol soil occur in the northeastern part near the Jefferson County line, east of McGregor, and northwestward toward McWilliams. Most of these spots

of Podzol soil are silt loam in texture. A few bodies of Podzol soil also occur on the slopes of Mahoning and Redbank Creeks, at the outlets of Pine and Cowanshannock Creeks, and in the lower gorge of Buffalo Creek. In all these sections the proportion of coarse-grained sandstone in the underlying rocks seems to be greater, and, where the surface has not been disturbed, the overlying humus is mat-like in character but is not so thick as that which generally occurs on the true Podzols. In these sections a growth of hemlock and white pine is dominant.

Not all of the soils have attained full regional development. Most of the upland soils are young, the external factors of soil formation have not been able to make the same impression, and parent material has contributed more to soil formation. In the southern part of the county where the soils are generally heavy and have been influenced more or less by calcareous material, regional development has been obstructed further. The soils of the terraces and first bottoms which border the streams occur in all parts of the county. The soils of the older, higher terraces have attained regional development, but the soils of the flood plains have not.

The more mature soils are restricted to the tops of the upland ridges and some of the higher and older terraces. Among the more mature or well-developed soils, those of the Rayne series are the only important soils of the uplands, and those of the Holston and Chenango series, of the terraces. The terrace soils have only a comparatively small total area, but they may be said to have attained regional development. They have the threefold arrangement that characterizes maturity of the normal soil, namely, a comparatively light-textured A horizon; a much heavier B horizon of uniform color, texture, and structure; and a C horizon which is generally lighter in texture. In all the normally developed soils, noticeable eluviation has taken place in the A horizon, and a part of the original fine material has been carried down into the B horizon or removed by lateral movement of water. This added material has made the B horizon heavier textured than the A horizon. The C horizon in the Rayne soils is lighter textured just below the B horizon but is more variable in thickness and color. The B horizon may rest directly on disintegrated shale and sandstone without a well-defined C horizon.

In addition to the soils that have normal profiles, young soils occur which are more closely related to the parent material. These soils are slightly developed on account of erosion which does not allow the accumulation of soil or the ultimate modification by soil processes. They may have a light-textured surface horizon which rests on consolidated or unconsolidated rock, or they may have a very thin B horizon. These soils are included in the Gilpin series. In addition to these, other soils have not developed normal profiles because the water table comes too close to the surface, as in some places in the Atkins and Robertsville soils. Another important group of soils that have not attained full normal development includes the Westmoreland and Upshur soils. The areas of these soils, like the Gilpin soils, have been much dissected, and, although the soil material is thicker than that of the Gilpin soils, normal development has been retarded, both by the relief and by the heavy texture of the material. Another important group of soils which have not attained

regional development is represented by the Ernest soils, in which the soil materials are colluvial and are characterized by the occurrence of a very compact claypan, or hardpan, below the B horizon. Another group of soils characterized by a very compact claypan, or hardpan, occurs in the upland flats. The compact horizon in these soils is related to the water table. In this group are included the Cavode and Monongahela soils.

The soils of the bottom lands along the rivers and streams comprise the more recent alluvium. These soils are too young to have developed profiles. In areas where the outwash material came from sandstone and shales, it was classed as Philo and Atkins soils.

The soils of the Rayne series are the most important in development and in distribution. Sandstones, sandy shales, and shales contribute to the parent materials. They are characterized by uniform color in the B horizon but may be more variable in color and texture in the C horizon, on account of the lenticular character or formation of the underlying rocks. These soils are generally strongly acid in reaction throughout and range in pH value from 4.9 to about 5.5. In the northeastern part of the county the surface soils are extremely acid. These soils, with the exception of Rayne shaly silt loam, have a fair depth but are not so deep as some of the soils of the terraces and the colluvial soils. A description of a profile of Rayne gravelly silt loam, observed 2½ miles north of Cowansville, is as follows:

A_0. A 1- or 2-inch layer of partly decomposed leaves and fibrous matter underlying a covering of loose leaves and forest debris.
A_1. 1 to 3 inches, dark grayish-brown mellow silt loam.
A_2. 3 to 8 inches, light grayish-brown silt loam.
B_1. 8 to 24 inches, yellowish-brown light silty clay loam of uniform color.
B_2. 24 to 48 inches, brownish-yellow light silty clay which is more compact and slightly heavier than the material in the layer above and is uniform in color.
C_1. 48 to 60 inches, a lenticular arrangement of sandy clay and silty clay layers with interbedded flaggy sandstone and shale. The material in this layer is generally lighter in texture than that in the layer above.
C_2. 60 inches+, bedrock of yellow sandstone.

The soil throughout contains shale and sandstone fragments.

The Chenango series is represented by only one member, Chenango silt loam. Although of little agricultural importance in the county, it represents a mature soil of the terraces. The underlying gravel bed is glacial outwash.

A description of a profile of Chenango silt loam, observed on an old fence line one-half mile south of the village of Garrett Run, is as follows:

A_0. Forest litter.
A_1. 1½ to 2 inches, grayish-brown light mellow silt loam containing some grass roots.
A_2. 2 to 6 inches, light yellowish-brown silt loam.
B_2. 6 to 30 inches, yellowish-brown friable silty clay of uniform color, which becomes heavier and more compact at the base of the layer and which breaks into small rounded aggregates.
C. 30 to 70 inches, a layer of yellowish-brown loose material consisting of sand, silt, and gravel. The gravel are small and consist largely of quartzite, quartz, sandstone, and shale.

The Westmoreland soils are extensive and are among those generally designated as heavy soils. These soils are not so acid as the

Rayne, Gilpin, Chenango, or Holston soils, and they range from acid to alkaline in reaction. The Upshur series is represented in this county only by the clay loam type. It differs from the Westmoreland soils in color. The surface soil is red or brownish red, and the immediate subsurface material is Indian red. Below this, the red is splotched with gray and yellow. In general, where the entire soil is shallow, it is more likely to be alkaline than where the soil material is deep. Some of the lower layers contain nodules of lime or thin layers of limestone.

Table 3 gives the pH determinations on several important soil profiles. These determinations were made in the laboratories of the Bureau of Chemistry and Soils by the hydrogen-electrode method.

TABLE 3.—*Results of pH determinations on three soil profiles from Armstrong County, Pa.*

Soil type and sample no.	Depth	pH	Soil type and sample no.	Depth	pH
Gilpin gravelly silt loam:	*Inches*		Rayne gravelly silt loam:	*Inches*	
183439	0 - 1	4.3	183461	0- 1	4.6
183440	1 - 2	4.3	183462	1- 3	4.7
183441	2 - 6	4.6	183463	3- 8	4.7
183442	6 -30	4.8	183464	8-24	4.7
183443	30+	5.3	183465	24-48	4.7
Cavode silt loam:			183466	48+	4.8
183450	0 - ½	3.6			
183451	½- 7	4.4			
183452	7 -18	4.4			
183453	18 -24	4.5			
183454	24 -37	4.5			
183455	37 -40	4.5			

Table 4 gives the results of mechanical analyses of samples of several soils.

TABLE 4.—*Mechanical analyses of four soils from Armstrong County, Pa.*

Soil type and sample no.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Upshur clay loam:	*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
183429	0 - ½	0.6	0.6	0.3	0.8	2.3	48.6	46.8
183430	½- 2	.2	.8	.6	1.1	1.6	48.2	47.4
183431	2 -20	.2	.7	.7	1.2	1.8	46.7	48.7
183432	20 -40	.0	.1	.1	.4	2.4	29.2	67.7
183433	40 -60	.0	.2	.2	.6	1.8	33.1	64.2
183434	60 -90	.3	.6	.4	.8	2.4	49.0	46.6
Gilpin gravelly silt loam:								
183440	0 - 2	4.2	3.5	1.4	2.5	8.5	48.3	31.6
183441	2 - 6	4.6	2.6	.8	1.4	9.7	52.6	28.3
183442	6 -30	5.4	6.5	2.1	2.9	16.1	38.2	28.8
183443	[1] 30+	------	------	------	------	------	------	------
Cavode silt loam:								
183451	0 - 7	1.0	1.2	1.4	9.2	12.8	51.4	22.9
183452	7 -18	.9	1.3	1.0	6.7	10.0	46.9	33.1
183453	18 -24	1.6	2.2	2.1	7.9	7.4	42.4	36.4
183454	24 -37	.0	.2	.3	3.6	9.7	46.9	39.2
183455	37 -40	.4	1.3	1.1	7.5	16.2	38.1	35.4
Rayne gravelly silt loam:								
183462	0 - 3	.5	2.3	3.1	5.9	6.4	52.5	29.3
183463	3 - 8	.9	2.1	3.0	5.9	5.8	52.2	30.0
183464	8 -24	.8	1.6	1.8	5.3	5.4	52.1	32.9
183465	24 -48	.2	.4	.5	3.9	8.7	57.1	29.2
183466	48+	2.4	5.1	4.0	15.6	14.5	38.0	20.3

[1] Sample consists of a few rocks, none of which is less than 2 millimeters in diameter.

SUMMARY

Armstrong County is in the west-central part of Pennsylvania, in the Allegheny Mountain (or Plateau) section of the Appalachian Mountain region. It lies southwest of the more mountainous areas and might be described as rolling to hilly country. It consists of a dissected plain, the smoothest parts of which are in the northern half and in the southwestern part and are for the most part restricted to the tops of the upland ridges. The rest of the land has been trenched deeply and is greatly cut and modified in the extension and ramifications of a well-developed drainage system. The rocks of the county are sandstone, sandy shales, and shales, with interbedded limestone, coal, and clay. In the northeastern, northwestern, and western parts of the county and including a southern extension toward Kiskiminetas River through the south-central part more sandstone comes to the surface; in the east-central part more shale; and in the west-central, southern, extreme northern, and southeastern parts the shales and sandstone are more intermixed and include some layers of limestone. The weathered products of these rocks constitute the parent materials of the soils of the uplands. The soils of the stream terraces and bottoms are derived from material washed from the uplands and deposited on the flood plains of the rivers and streams.

The soils of this county are included in the Gray-Brown Podzolic group. They represent the more youthful soils of the group, as erosion has not allowed soil processes to attain regional development in all parts of the county. The well-drained soils are divided into two major divisions, the grayish-brown and the brown soils. They occupy more than three-fourths of the total area, with the first group predominating. Two minor groups are the imperfectly drained and the poorly drained terrace soils, the members of which may contact with one or both of the major groups. All the soils have developed under a forest cover. Hardwood is the dominating growth, although a conspicuous number of conifers grow in different sections.

The grayish-brown soils include all the members of the Rayne, Gilpin, Chenango, and Holston series and, with the exception of the Gilpin, represent soils that have attained more or less definite maturity. They are easy soils to work, have a fair supply of plant nutrients, and respond to intelligent treatment. These soils have a wide range of usefulness and, where surface features are favorable, are the best lands for all-around farm purposes. They are, however, acid in reaction, and pastures are not so easily developed or maintained on them as on the brown soils.

The brown soils include all the members of the Westmoreland, Upshur, and Belmont series. These soils occupy a smaller total area than the soils of the grayish-brown group and have not attained regional development, as they have not been so thoroughly leached. The brown group includes the heavy soils of the county. The surface soils are generally more shallow and compact and have a tendency to run together. The subsoils are heavy, and consequently the members of the group are difficult to work and to put into good physical condition. This may be the reason so much of these soils is

abandoned. They have a more restricted use than the soils of the grayish-brown group but are generally considered good soils for the production of grass and grain. Pastures are more easily developed and maintained, and the soils are less acid in reaction than those of the grayish-brown group. With some exceptions, the relief of these soils is not so favorable for the economic production of crops as that of the grayish-brown soils, and erosion in places is very destructive.

The imperfectly drained soils include the members of the Cavode, Monongahela, Ernest, and Philo series. This group has a restricted use because surface and subsurface drainage are not thoroughly established. Most of the soils have a relief favorable to the economic production of crops, and, where drainage has been established, they comprise some of the most productive soils of the county.

The poorly drained soils form the least extensive group which includes members of the Robertsville and Atkins series. Alluvial soils, undifferentiated, which are classed among the miscellaneous land types, also are poorly drained. All of these, with the exception of the Robertsville soils, occupy first bottoms and are subject to frequent overflow or inundation.

About 25 percent of the total area of the county might be classed as marginal and submarginal agricultural land and includes much steep and rough stony land not suitable for the economic production of crops. In an effort to reforest some of the less rough and stony land, evergreen seedlings and other forest trees have been planted on a great many acres.

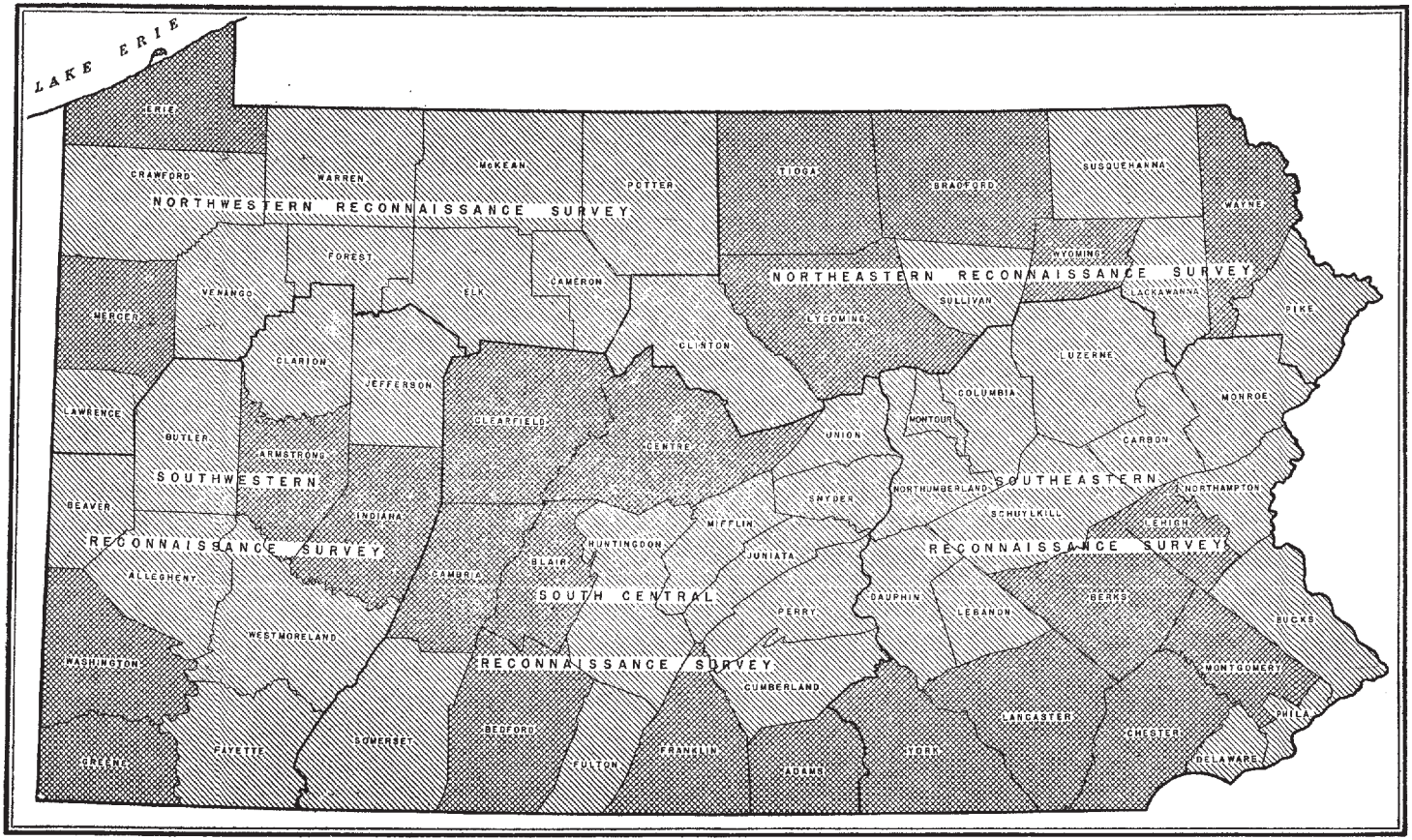
The county has a frost-free period of about 147 days, which allows the production of a wide range of crops. The principal crops produced are corn, oats, wheat, rye, potatoes, barley, buckwheat, hay, forage, pasture, vegetables, and fruit.

The agriculture might be described as general farming and dairy farming, but the dairy interests are gradually dominating the situation, and general farming is more a complement than a separate interest. It is difficult to predict just what the agriculture will be in the future. It is undergoing a change now, and many persons are returning to the farms. The agriculture is intimately linked with the activities and prosperity of the coal and natural-gas fields. It seems safe, however, to say that the agricultural development is toward more intensive dairy farming, market gardening, poultry raising, and different phases of horticulture.

U. S. GOVERNMENT PRINTING OFFICE: 1939

Authority for printing soil survey reports in this form is carried in the Appropriation Act for the Department of Agriculture for the fiscal year ending June 30, 1933 (47 U. S. Stat., p. 612), as follows:

There shall be printed, as soon as the manuscript can be prepared with the necessary maps and illustrations to accompany it, a report on each soil area surveyed by the Bureau of Chemistry and Soils, Department of Agriculture, in the form of advance sheets bound in paper covers, of which not more than two hundred and fifty copies shall be for the use of each Senator from the State and not more than one thousand copies for the use of each Representative for the congressional district or districts in which a survey is made, the actual number to be determined on inquiry by the Secretary of Agriculture made to the aforesaid Senators and Representatives, and as many copies for the use of the Department of Agriculture as in the judgment of the Secretary of Agriculture are deemed necessary.



Areas surveyed in Pennsylvania shown by shading. Reconnaissance surveys shown by northwest-southeast hatching; cross hatching indicates areas covered by both detailed and reconnaissance surveys.

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Office of the Assistant Secretary for Civil Rights
1400 Independence Avenue, SW
Washington, D.C. 20250-9410;

(2) fax: (202) 690-7442; or

(3) email: program.intake@usda.gov.

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