
Soil Survey

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Franklin County Pennsylvania

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In cooperation with the
Pennsylvania State College, School of Agriculture
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SOIL SURVEY OF FRANKLIN COUNTY, PENNSYLVANIA

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COUNTY SURVEYED

Franklin County is roughly triangular in shape and includes an area of 766 square miles, or 490,240 acres, in the central-southern part of Pennsylvania (fig. 1). Most of the county lies in that part of the State known as the Cumberland Valley which constitutes the northward continuation of the Shenandoah Valley of Virginia. The southern boundary is formed by the Pennsylvania-Maryland State line and extends for a distance of 34 miles.

Chambersburg, the county seat, is near the center of the county and is approximately 52 miles from Harrisburg, 140 miles from Philadelphia, 77 miles from Baltimore, and 92 miles from Washington, D. C. The nearness of Franklin County to these large cities provides markets for the agricultural products.

Franklin County occupies part of the eastern edge of the Appalachian Valley division, which is the central division of the Appalachian geographic province (9).² It comprises two important physiographic subdivisions—the Appalachian Valley Ridges and the Cumberland Valley. South Mountain, which is a part of the Blue Ridge Mountains, is considered with the Appalachian Valley Ridges.

The Cumberland Valley extends in a broad belt northward from Potomac River through Franklin County, curving gradually eastward to Susquehanna River. This valley includes a large proportion of the county extending from the foot of South Mountain on the east to the foot of the Appalachian Valley Ridges on the west and northwest. It ranges in width from 12 miles in the northern part

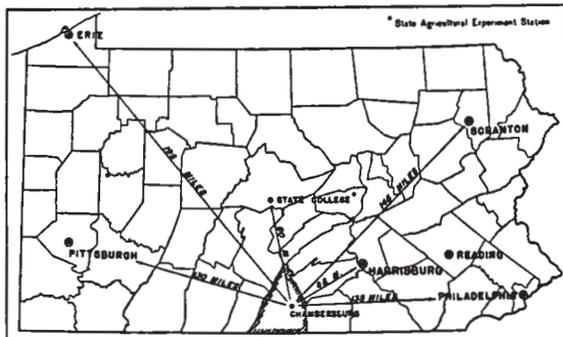


FIGURE 1.—Sketch map showing location of Franklin County, Pa.

¹ The Greater Pennsylvania Council cooperated during the early part of this survey.

² Italic numbers in parentheses refer to Literature Cited, p. 91.

of the county to 25 miles at its southern edge. Path Valley, in the northwestern part of the county, is similar to the Cumberland Valley in many respects, except that it is much narrower, being only from 1 to 5 miles wide. Little Horse, Burns, and Amberson Valleys connect with Path Valley from a northeast direction. Horse Valley and Little Cove Valley are the next largest valleys but are generally rather narrow, not more than $1\frac{1}{2}$ miles across at their widest parts.

The Cumberland Valley is a broad, gently rolling to smooth plain, with scattered rounded hills rising 100 or more feet above the valley level. It ranges in elevation from 550 to 900 feet above sea level. The higher elevations are on the rounded hills and knolls or on the plateau west of Chambersburg, which has a maximum width of about 6 miles. This plateau is less elevated along the northeastern and southern borders of the county but contains deeply incised, steep-sided streamways. A pronounced escarpment of about 150 feet marks its eastern border, and its western border merges into the main valley on the west with a gradual slope and no definite boundary. It includes some rather flat topped tablelands, with angular steep escarpments along drainage channels. It is almost entirely underlain by massive beds of mud shales. In general, that portion of the main valley underlain by limestone is lower than the shale areas.

The most pronounced hills are Timber Hill south of Shippensburg, Grindstone Hill, and other rather high hills between Chambersburg and Mont Alto. A range of rather high rolling hills, with elevations of 850 to 1,100 feet, are near and northward from Waynesboro, terminating west of Mont Alto.

The relief differs considerably in different parts of the valleys and is largely an expression of the different degrees of resistance of the underlying geological formations to weathering and erosion. In general, the smoothest relief is on the lower upland elevations which include those areas underlain by limestone. The valley slopes in most places are gradual and rounded, with no sharp escarpments. Different limestones have different degrees of hardness and weather down unevenly. This condition is reflected in the choppy or jagged relief of many of the limestone areas, where the hard limestones are exposed and form areas known locally as "limestone reefs."

Large areas of shales are exposed in the larger valleys. These shales are very resistant to solution or chemical weathering but are not resistant to physical weathering or erosion, and for this reason the streams which head in the shale sections are deeply entrenched in deep, narrow V-shaped valleys or canyons that have steep angular sides, which become well rounded at the higher elevations or near the top of the plateau. This condition gives the shale belts a rolling type of relief. Conococheague Creek is deeply entrenched and follows a meandering course that is largely within the shale belts.

The shale sections are thoroughly dissected by a dendritic drainage system, whereas the drainage pattern of the limestone sections is very irregular and follows no definite direction or pattern other than the natural courses of least resistance. Many of the drains in the limestone sections are discontinuous, in many places entering underground drainage systems. Many of these underground streams emerge, giving rise to large springs, several of which are south and east of Chambersburg and near Greencastle.

The Appalachian Valley Ridges are the most prominent physiographic features in the county. All these ridges rise to the same general height of about 2,000 feet above sea level. They occupy a belt, parallel with the western edge of the county, ranging in width from 2 to 8 miles, being widest at the northern end where five mountain ridges parallel one another, all crossing the county line in a northeast-southwest direction. The tops of the Appalachian Valley Ridges are all very sharp, rough, and rugged and extend for several miles almost in a straight line. The slopes of these ridges are steepest at the top and become less steep at the base, finally merging into the valleys. In general, the slopes of the Appalachian Valley Ridges are concave, and the valley floors are generally U-shaped. Tuscarora Mountain is the highest and longest of this group of ridges, extending almost the full length of the western boundary of the county with only two breaks where streams have cut channels through it. The highest elevation in the county is on Big Mountain, 2,450 feet, in the Tuscarora Mountain Range. Other outstanding mountains in this group are Jordans Knob, Parnell Knob, North Mountain, and Blue Mountain, all of which are some distance east of Tuscarora Mountain and face the Cumberland Valley.

Immediately east of Tuscarora Mountain in the northern section of this group of Appalachian Valley Ridges is Path Valley, which parallels Tuscarora Mountain for a distance of 23 miles. It is widest at the northern end where it joins Amberson, Burns, and Little Horse Valleys, which enter it from the northeast. This group of valleys is 1,000 feet below the mountaintops and 300 feet higher than the Cumberland Valley. Horse Valley is 13 miles long. Gunter Valley is a northeastward continuation of Horse Valley. Between Little Mountain and North Mountain is Bear Valley, which joins with Cumberland Valley northeast of Fort Loudon.

Several mountains extend into the southwestern corner of the county from Maryland, the principal one being Cove Mountain, a long and extremely sharp topped mountain that lies immediately east of Tuscarora Mountain and terminates at Cape Horn and Hogback Mountain. Little Cove Valley lies between Tuscarora and Cove Mountains and terminates in a point southwest of Cove Gap.

Only a small part of South Mountain is included in Franklin County along the eastern side. This mountain is made up of a series of irregular parallel ridges extending in a general northeast-southwest direction. Most of the streams are deeply entrenched and radiate outward from the main ridges. In contrast to the mountains in the western part, South Mountain has rounded ridge tops and well-rounded and convex slopes, with the steeper slopes nearer the base. The mountains in South Mountain range in elevation from 1,400 to 2,100 feet. Big Pine Flat, at the eastern edge of the county, is the highest; and Snowy Mountain, the next highest, is 2,085 feet above sea level (9).

The drainageways parallel the valleys for long distances and follow in general the geologic formations that have offered the least resistance to weathering and water erosion. The drainage of the main valley flows in two general directions, the dividing ridge being an approximately east-west line midway between Chambersburg and Shippensburg. South of this line the greater portion of Franklin

County drains into the Potomac River through Conococheague Creek, Licking Creek, Little Antietam Creek, and other smaller streams. The northern part drains to the Susquehanna River, mainly through Conodoguinet Creek.

Very few poorly drained areas or stagnant swamps occur. All the streams are swift-flowing and are actively grading and deepening their channels. The bottoms of all the streams are lined with large water-rounded gravel and cobbles. Nearer the mountains large rounded stones and even boulders line the stream channels. The average fall for West Branch Conococheague Creek is 16 feet a mile; for East Branch Conococheague Creek, 14 feet; for Little Antietam Creek, 20 feet; and for Conodoguinet Creek, 18 feet.

The native vegetation consists mainly of second-growth hardwood forests, oak being the dominant tree. Before settlement by white men the Cumberland Valley was not entirely covered by forests. The shale and some of the limestone belts were occupied by a mixture of wild grasses, sedges, briars, and a scattered tree growth. In addition to the wild grasses, laurel, plum, juniper, persimmon, hazel bush, wild currant, gooseberry, blackberry, raspberry, spice bush, sumac, strawberry, dewberry, and wintergreen occurred generally throughout the grasslands and more open wooded areas. The main tree growth along the streams was black walnut, oak, hickory, red maple, sugar maple, cherry, locust, ash, elm, linden, and beech.

The mountain areas were covered with heavy, dense forests consisting mainly of oaks and chestnut. Some scattered pines grew among the hardwoods and were most abundant on the mountaintops and on the talus deposits at the bases of the mountains. Some of these talus slopes that were occupied by the shortleaf pine still retain the name of "pineland." After settlement and the discovery of iron along the bases of the mountains about 1780, much of the virgin forest was cut and converted into charcoal which was used in the iron furnaces, and the larger timber was sawed into lumber and shipped to eastern markets. Today neither the iron nor lumber business is of any commercial importance. The mountain forests are practically all young trees consisting mainly of oaks, as the chestnut blight killed practically all chestnut trees in the county, and many of the dead trees still remain in the forests. Many wild flowers and shrubs, such as mountain-laurel, redbud, dogwood, rhododendron, trailing-arbutus, some species of wild orchids, huckleberry, sweetfern, wild-indigo, fly poison, teaberry, rattlesnake-plantain, pennyroyal, wintergreen, and cardinalflower, grow in the mountains and along the streams.

The entire county is, in general, well supplied with potable water, mainly from flowing streams, springs, and wells. The largest supply of economic importance comes from streams that rise in the mountains and flow across the valleys. All the larger towns depend on these mountain streams as a source of water supply. These streams also provide excellent water for livestock on many of the farms through which they flow. In places the water from the streams is diverted into millraces and used for power. The largest hydroelectric power plant, at Roxbury, utilizes water diverted from Conodoguinet Creek.

According to local historians, Cumberland Valley before settlement by white men was prized hunting ground of the Indians (2; 7, p. 140). Large game, especially deer and bears, were plentiful. Today bears are very scarce and are found only in the mountains in the western part of the county, but deer are still hunted in the mountains. A few foxes, wildcats, raccoons, squirrels, rabbits, skunks, opossums, beavers, minks, muskrats, weasels, and ground hogs are found in the county. The wild turkey and the ruffed grouse are found in the mountains; and pheasant and quail, in the valleys and lower mountains. Wild ducks and geese are rarely seen and then only during their migration seasons.

The Pennsylvania State Game Commission has established game preserves in the State forests for the purpose of propagating and preserving wild game, especially deer, pheasant, quail, rabbit, and squirrel. One preserve is in Horse Valley, and another is near Snowy Mountain in the South Mountain section.

The streams were originally well stocked with fish, trout being the principal game fish. These streams, although frequently restocked now contain very few sizable fish of any kind.

Franklin County, named in honor of Benjamin Franklin, was organized as a unit September 9, 1784, from the southwestern part of Cumberland County and extended to the present southern Pennsylvania State line. Only a few changes have occurred in the boundary line since that date.

The population, made up largely of descendants of Scotch, Irish, and German settlers, has increased gradually at the rate of about 300 a year since 1820. The rural population has gradually decreased at the rate of about 100 a year, but the urban or town population has increased at the rate of about 350 a year since 1880. The increase in urban population has been stimulated by the growth of manufacturing industries. The 1930 Federal census reports the population as 65,010, comprising 26,943 urban and 38,067 rural. Of the rural population, 17,990 are classed as rural farm and 20,077 as rural nonfarm. The population consists of 97.3 percent native white, 0.7 percent foreign-born white, and 2 percent Negro. Most of the Negroes live in the towns, and very few are employed on farms.

Chambersburg has a population of about 13,700; Waynesboro, in the southeastern corner, is the second largest town, with a population of 10,000. Greencastle, near the center of the southern edge; Mercersburg, in the southwestern part; and Shippensburg, near the center of the valley on the northeastern county line, the larger part of which is in Cumberland County, all have populations of more than 2,500.

The county is well served by two main railroad lines which parallel the valley. The Cumberland Valley Railroad, a part of the Pennsylvania Railroad system, extends across the county through Greencastle, Marion, Chambersburg, Scotland, and Shippensburg. The Western Maryland (Altenwald Cut-off) line serves Waynesboro, Chambersburg, and Shippensburg. At Marion the Southern Pennsylvania branches off to the west and serves Williamson, Lemasters, Mercersburg, Fort Loudon, and Richmond Furnace in the southern end of Path Valley. The Waynesboro Branch of the Cumberland Valley Railroad connects Waynesboro, Quincy, Mont Alto, and

Fayetteville with the main line of the Pennsylvania Railroad at Scotland.

The county has a well-developed network of hard-surfaced all-weather roads that serve practically every populated section. The Lincoln Highway, United States Highway No. 30, crosses the county in an east-west direction from Gettysburg through Caledonia, Fayetteville, Chambersburg, St. Thomas, Fort Loudon, and over Tuscarora Mountain. United States Highway No. 11 parallels the Cumberland Valley, extending from Hagerstown, Md., through Greencastle, Marion, Chambersburg, and Shippensburg to Harrisburg, Pa. Another important highway enters the county at Blue Ridge Summit and Monterey and extends westward across the valley through Waynesboro, Greencastle, Mercersburg, and over Tuscarora Mountain to McConnellsburg, Fulton County, where it connects with United States Highway No. 30. All the more important towns in and near Franklin County are connected by paved highways. Several years ago electric passenger railways connected Shippensburg, Chambersburg, Marion, Greencastle, and Waynesboro, but these lines have been abandoned as a result of competition by automobiles and bus lines that operate on the paved roads between the larger towns.

Practically all the farms have available service from electric-light and power-transmission lines. Telephones are widely used for communication by both farmers and city residents. In 1932,⁸ there were 3,550 farms in Franklin County, of which 1,760 had telephone service; 660, radios; 590, modern heating systems; 710, running-water systems; 360, bathrooms; and 1,120, electricity for light or power.

An excellent school system includes a number of consolidated rural schools to which transportation is furnished by motor busses. Several private schools and colleges are in the county. A State Teachers College at Shippensburg is a State-supported institution. The State Forestry Research Institute and State School of Forestry, where forestry students from Pennsylvania State College receive their preliminary forestry training, is at Mont Alto.

Nearly every community center has a large substantially built church, which is generally well kept and well attended.

The industries include the manufacture of power-transmission machinery, flour-mill machinery, hydraulic and steam machinery, threshing machines, tools, woolen textiles, hosiery, silk, paper, soap, and ice cream and other dairy products, as well as planing mills, foundries, milk plants, ice and cold-storage plants, canneries, and flour mills.

CLIMATE

The climate of Franklin County is typical of south-central Pennsylvania, being continental or inland, with prevailing winds from the west. The direction of the wind influences the humidity, as the west winds are drying and the east winds are moist and humid.

The valleys are somewhat protected from strong winds and storms by the mountain ranges. In general the strongest winds occur dur-

⁸ All 1932 data are from the Pennsylvania agricultural statistics.

ing fall and winter, the late spring and summer months being rather calm, with gentle breezes.

The summers are generally warm with bright sunshiny weather, and the winters rather cloudy and damp but not extremely cold. Data from the records of the Weather Bureau station at Chambersburg show the annual average summer temperature to be about 40° warmer than the winter temperature.

Chambersburg weather records show the average annual rainfall over a 14-year period ended 1935 to be 38.44 inches. This rainfall is rather evenly distributed throughout the year, although occasional periods of drought have occurred during the summer and fall months. During winter, snow sometimes covers the ground for months, and in other years the snowfall is very light. Winter seldom sets in with severity until the later part of December and commonly begins to moderate in late February. Occasional periods of mild weather occur in winter, during which time farmers may be able to plow. Near the end of February or early in March the snow generally disappears, but rather heavy snowfall has occurred as late as April 28. Late spring snows melt rapidly and cover the ground for only a few days. Vegetation advances rather slowly and unevenly in different years, and fruit blossoms are sometimes damaged by frosts during April and early May.

The average frost-free season is about 160 days, extending from May 5, the average date of the last killing frost, to October 12, the average date of the first. Frost has been recorded at Chambersburg as late as June 1 and as early as September 27. In general, the growing season is longest on the lower elevations and within the valleys. Slight variations in temperature and rainfall occur within the county. Fruit growers report that temperatures are slightly warmer during winter and spring months along the bases of North Mountain and Parnell Knob where the mountains protect the valley from the cold west winds. Reports also indicate that fruit along the bases of these mountains suffers slightly less from late spring frosts than elsewhere in the county. The intermountain valleys above Caledonia are the most outstanding late frost pockets. Farmers report that the higher elevations on the low hills west of South Mountain warm more slowly in spring, and crops are about a week later than in other parts of the main valley; but this section is reported to receive more rain in summer than the central or western parts of the main valley or Path Valley.

The warm summers, abundant sunshine, and general absence of dry, hot winds, are favorable to the production of high-quality fruits and vegetables. At night cool air drains down into the valleys from the mountains and aids in keeping the summer soil temperatures low and in conserving soil moisture. Occasionally, dry periods during late July, August, and early September reduce crop yields, especially corn, on the shallower soils of the valleys. The winter temperatures only occasionally go below zero, and for this reason peach buds generally go through the winters without appreciable damage. Wheat, rye, and Kentucky bluegrass remain green throughout the

winter. The soil is subject to alternate freezing and thawing all through the winter, and this condition during wet winters sometimes causes winter-killing of alfalfa and clover.

Table 1, compiled from the records of the United States Weather Bureau station at Chambersburg, gives data representative of the climatic conditions in Cumberland Valley.

TABLE 1.—Normal monthly, seasonal, and annual temperature and precipitation at Chambersburg, Franklin County, Pa.

[Elevation, 580 feet]

Month	Mean temperature	Precipitation			
		Mean	Total amount for the driest year (1930)	Total amount for the wettest year (1927)	Snow, average depth
	°F.	Inches	Inches	Inches	Inches
December.....	33 0	2.63	2 77	3 53	4.6
January.....	28.9	2.73	1 55	1 87	8.7
February.....	31 4	2 00	1.86	4 34	8 2
Winter.....	31 1	8 28	6 18	9 74	21.5
March.....	39 5	2 99	2 28	2 46	6 8
April.....	50 1	3 09	2 28	5 09	1.6
May.....	60.7	3.65	1.68	3 04	0
Spring.....	50.1	9.73	6 24	10.59	8 4
June.....	69.4	4 11	3 61	4 71	0
July.....	74 3	3 66	.60	5 58	0
August.....	71 8	3 96	.93	3 51	0
Summer.....	71 8	11 63	5.14	13 80	0
September.....	66 1	2.92	1 19	.76	0
October.....	52 9	3 20	.27	7 64	0
November.....	41.9	2.70	.58	4 62	1.0
Fall.....	53 6	8 82	2.04	13 02	1 0
Year.....	51 7	38 44	19 60	47 15	30.9

AGRICULTURAL HISTORY AND STATISTICS

Franklin County is among the older counties in the State of Pennsylvania. Its fertile soils attracted settlers as early as 1725. The Cumberland Valley was the first section developed agriculturally, followed by Path Valley and then by Little Cove Valley. Since its organization, the county has ranked as one of the best agricultural counties in the State. Its growth and development have been based mainly on general farming, with cereals and hay as the important crops, and on the feeding of livestock. In the early days, the farmers grew mainly those crops which were needed to supply food for the family or feed for livestock. As the county developed and roads were opened, wheat became an important export grain crop. Corn was grown in large quantities and fed to cattle and hogs, which were fattened and sold. A little later, a large number of small water-power mills were built, where the wheat was ground into

flour which was sold in eastern markets or exported, the bran and middlings being used locally as feed for livestock. Since 1910, livestock feeding has largely given way to dairying. The growing of fruit, especially apples and peaches, has become very important in the last 20 years. The important crops grown previous to 1880 were corn, wheat, oats, rye, hay, and buckwheat; and beef cattle, hogs, poultry, and some dairy products were produced.

The county has a land area of 490,240 acres, of which about 70 percent is in farms, the remainder being in forest or cut-over land. About 71 percent of the land included in farms is classed as improved. The early settlers recognized that great differences existed in the agricultural soils of the county. The Scotch and Irish settlers preferred the "shale lands" because they were less stony than the other lands. The "limestone lands" not only were more stony, but, before the introduction of clover, cultivated grasses, and improved crop rotation systems, were badly washed and disfigured by sheet and gully erosion.

Early historians (2; 7, p. 140) report that the county contained 180,000 acres of limestone land, 20,000 acres of pineland or a strip 2 miles wide along the foot of South Mountain, 160,000 acres of shale land covered with luxuriant prairie, and 120,000 acres of forest land.

The total number of farms in 1840 was 2,064.

Table 2 gives data on land and farm areas as reported by the Federal census for the census years 1880-1935, inclusive.

TABLE 2.—*Land and farm areas in the census years, 1880 to 1935, inclusive, in Franklin County, Pa.*

Year	Total farms	Area		Improved land	
		In farms	Per farm	In farms	Per farm
	<i>Number</i>	<i>Percent</i>	<i>Acres</i>	<i>Percent</i>	<i>Acres</i>
1880.....	3,602	79.2	106.0	73.6	77.8
1890.....	3,295	74.8	109.0	79.9	87.1
1900.....	3,785	82.2	104.2	74.7	77.8
1910.....	4,250	80.2	90.7	76.7	69.5
1920.....	3,884	84.2	104.1	71.3	74.3
1930.....	3,536	70.4	95.7	77.1	73.8
1935.....	3,861	71.3	88.7	72.5	64.3

The 1935 census reports the average size of farms as 88.7 acres, the average value of land and buildings per farm as \$4,372, and the average value per acre as \$49.29. These values are as low as or lower than those for many years. Land values have fluctuated considerably during the past 100 years but as a whole have moved gradually upward. Historical records indicate that the average value of cleared land in 1840 was about \$35 an acre and that of uncleared land about \$30 an acre, and the best farms sold for as much as \$100 an acre.

Table 3 gives the value of all property per farm and the acre value of land as reported by the Federal census for the years 1880 to 1930, inclusive.

TABLE 3.—Value of property per farm and acre value of land in the census years 1880 to 1930 in Franklin County, Pa.

Year	Per farm					Per acre
	All prop-erty	Land	Buildings	Imple-ments	Domestic animals	Land value
	Dollars	Percent	Percent	Percent	Percent	Dollars
1880.....	6,031	† 89.9	-----	3.4	6.6	-----
1890.....	5,913	† 88.1	-----	3.6	10.3	-----
1900.....	5,402	85.6	30.2	4.6	9.6	28.86
1910.....	6,698	81.4	31.1	5.0	12.5	37.92
1920.....	11,899	80.9	29.1	8.1	11.9	58.15
1930.....	8,942	81.1	44.3	10.2	14.4	70.47

† Land and buildings.

The present agriculture is built primarily around an excellent system of diversified farming, the production of livestock and livestock products, and fruit growing. The value of all agricultural products by classes is given at 10-year intervals from 1909 to 1929, in table 4.

TABLE 4.—Value of all agricultural products by classes as reported by the census for the years 1909, 1919, and 1929 in Franklin County, Pa.

Product	1909	1919	1929
Cereals.....	\$2,704,780	\$8,161,608	\$2,861,202
Other grains and seeds.....	17,817	154,714	15,957
Hay and forage.....	988,498	2,478,830	1,214,898
Vegetables.....	268,314	893,761	631,831
Fruits and nuts.....	359,246	1,392,452	1,060,371
All other crops.....	157,846	1,567	23
Livestock and products:			
Value of all domestic animals.....	1,407,088	5,104,651	4,183,461
Dairy products, excluding home use.....	555,199	1,510,639	2,484,126
Poultry and eggs.....	691,999	1,268,410	1,561,463
Wool and mohair.....	17,921	35,760	26,963
Total.....	7,168,706	20,992,292	14,040,295

The most important cereal crops now grown are corn, wheat, rye, oats, barley, and buckwheat. The important hay crops are clover and timothy mixed, alfalfa, and clover. Of the special crops, potatoes are the most important, but other special crops, such as tomatoes, peas, and beans, are grown for commercial canning. A wide variety of truck crops and vegetables is grown to supply, in part, fresh vegetables for local markets.

Corn, grown in the county as early as 1748, has been one of the most important grain crops in the agricultural development and has occupied about 20 percent of the cropland since 1900. The annual yields during this period range from 1½ to 2½ million bushels. Since 1880, wheat has occupied from 30 to 35 percent of the cultivated land with an average annual production of about 1¼ million bushels. Rye has increased in acreage more than 100 percent since 1900 and seems to have displaced wheat to some extent on the poorer soils. The acreage of oats has decreased to about 20 percent of the production previous to 1890. The increase in the acreage of winter bur-

ley has been large since 1910; from 1929 to 1934, the acreage increased from 553 acres to 8,273 acres.

Hay crops occupied about 60,000 acres, or about 25 percent of the cultivated land, from 1879 to 1934. Among these, clover and timothy mixed is the dominant crop and for more than 30 years has occupied about 90 percent of the total area devoted to hay crops. Alfalfa increased in acreage from 281 acres in 1909 to 7,237 acres in 1934. According to reports of the leading farmers and agricultural extension workers, the acreage of alfalfa will continue to increase because the quality and the yield of hay are better than those of clover and timothy, and alfalfa is a more valuable hay for feeding dairy cows.

The leading pasture grasses consist mainly of timothy and of clover and timothy mixed. On the better limestone soils, or Hagerstown soils, Kentucky bluegrass is the dominant pasture grass.

The growing of potatoes and other vegetables and truck crops is of considerable importance, and the canning and preservation of foods has developed into an important industry. Canning plants for tomatoes and tomato products are at Chambersburg, Greencastle, and Roxbury, and a canning plant for peas, sweet corn, and red beets is at Greencastle. Snap beans and red beets also are canned at Roxbury. Most of the tomatoes, beans, peas, beets, and corn are grown by the farmers under contract with the canning companies, and the farmers know in advance the price they will receive for their products. The principal varieties of tomatoes are the Greater Baltimore, Matchum, and Bonnie Best. The limestone soils are the best soils for the production of canning crops. Other fresh vegetables, such as celery, cabbage, spinach, cauliflower, beets, sweet corn, carrots, parsnips, and lettuce, are grown commercially on truck farms that supply in part the local market demands for fresh vegetables.

The commercial production of fruit, especially apples and peaches, ranks in importance next to dairying. In 1931 the production of apples was 1,050,870 bushels having a value of \$420,350, and the production of peaches was 250,940 bushels having a value of \$95,360. Cherries and pears are also of commercial importance. The main centers of fruit production are near the mountains in the vicinity of Scotland, Mont Alto, Quincy, St. Thomas, and Wayncastle. Practically all the fruit is packed either at the orchards or at the larger packing plants in the towns. From 25 to 40 percent of the crop is packed in barrels, and most of the remainder is packed in baskets, only a small proportion being marketed in bulk. Nearly all the fruit sold on the commercial markets is inspected by Federal or State fruit inspectors and is graded according to Federal grades, although some fruit growers use their own special grades. Most of the apples and peaches are marketed in the large eastern cities, such as Baltimore or Philadelphia, through commission men or commission firms. From 15 to 50 percent of the apple crop is exported yearly to foreign countries, and a small proportion of the peach crop is exported. Cold-storage plants for apples and peaches are located at Chambersburg, Greencastle, and Waynesboro.

Table 5 gives the acreage of the principal crops for the years 1879 to 1934, inclusive, as reported by the Federal census.

TABLE 5.—*Acreage of principal crops in Franklin County, Pa., in stated years*

Crop	1870	1889	1899	1909	1919	1929	1934
	<i>Acres</i>						
Corn.....	42,992	45,564	54,884	56,998	57,693	45,220	47,868
Oats.....	22,596	23,121	8,232	8,524	6,403	7,877	4,301
Wheat.....	71,205	68,848	85,453	77,610	89,781	71,315	63,153
Rye.....	5,402	5,212	3,455	9,187	13,296	10,664	11,664
Barley.....	64	17	109	13	492	553	8,273
Buckwheat.....	578	256	249	157	371	310	(¹)
Potatoes.....	2,423	2,573	2,516	3,211	2,556	3,289	2,687
Sweetpotatoes.....	126	49	262	41	208	43	47
All hay.....	58,350	65,990	67,926	64,762	59,824	59,027	59,932
Timothy.....				20,272	16,421		(¹)
Timothy and clover.....				41,144	40,092	53,643	51,844
Clover.....			8,536	2,898	1,854	1,774	(¹)
Alfalfa.....				281	1,020	3,593	7,273
Other tame grasses.....			55,790	167	437	307	603
Wild grasses.....			88	55	52	88	
Grains cut green.....			3,512	2	41	68	117
Legumes for hay.....					31	154	89
Silage crops.....					1,904		5,063
Coarse forage.....			1,749	219	36,637		(¹)
Strawberries.....			75	68	114	50	86
Raspberries.....			32	22	26	45	(¹)
Blackberries.....			25	8	10	7	(¹)
	<i>Trees</i>						
Apples.....		143,047	229,326	178,827	239,011	262,849	206,017
Peaches.....		48,134	339,689	87,433	134,375	163,325	190,313
Pears.....				11,601	16,601	4,028	4,594
Plums.....				9,400	7,566	2,108	745
Cherries.....				21,903	11,850		6,428
	<i>Vines</i>						
Grapes.....			27,668	15,041	15,928	32,516	15,753

¹ Not reported² Includes sorghums cut for silage, hay, or fodder.³ Includes wild grasses.

Dairying is by far the most important branch of livestock raising. With the development of scientific methods for the preservation and pasteurization of milk, the development of cold storage, the development of refrigeration in connection with transportation, and the increased demand for whole milk in the larger cities, dairying began to develop and is now highly specialized. It has displaced the feeding of beef cattle on farms to the extent of fully 90 percent, as the farmers find it more profitable to market their feed crops in the form of milk than in the form of beef.

State statistics for 1932 report 27,202 dairy cows, approximately 5 percent of which, or 1,289, were purebred animals. Most of the purebred dairy cows are Holstein-Friesian, and most of the grade dairy cows are of Holstein-Friesian breeding. Nearly all the dairy cows are raised within the county, although a few purebred Guernseys have been imported recently for use in the county calf clubs.

Practically all the milk sold is delivered as whole milk to milk plants located at various places over the county, from which it is shipped by motortruck and rail to retail markets in Philadelphia, New York, and Baltimore.

Bovine tuberculosis eradication, which is very important in connection with dairying, was started in 1925 and completed February 1, 1933. The county is now on the list of accredited counties, and less than 0.4 percent of the cattle of the county are reactors to tuberculin tests.

Several cow-testing associations have been organized. These associations keep accurate milk records of individual cows and, in general, promote greater milk production.

Beef-cattle raising and feeding has been on the decrease for a number of years, and at present only about 5 percent of the cattle are beef breeds. Aberdeen Angus is the only important beef breed, and this breed is owned largely by one breeder. Most of the beef cattle are bought as feeders on the Lancaster livestock market in the fall. They are brought into the county, fed for about 4 months, and then sold as fat cattle in the spring on the Lancaster or Baltimore livestock markets.

Sheep raising is primarily based on the production of wool and early spring lambs. The 1935 Federal census reports 9,980 sheep and lambs in the county on January 1. Most of the sheep are raised in Path Valley and other nearby mountain valleys in the Appalachian Valley Ridges. The lambing season generally occurs in February and March, and the spring lambs are fattened and sold during July and August. Most of the lambs are sold on the Baltimore and Lancaster livestock markets. The number of sheep on a farm ranges from 10 to 25. The Hampshire breed is the most popular, and recently the use of purebred rams has been increasing. In 1934 the wool production was 66,365 pounds. Most of this wool was marketed through a local pool.

The production of pork is of secondary importance, but nearly every farm has from 2 to 10 hogs. The 1935 Federal census reports 23,812 swine in the county on January 1. The principal breeds, in order of importance, are Poland China, Duroc-Jersey, Chester White, Spotted Poland China, and Hampshire. Most of the hogs are sold on the Lancaster or Baltimore markets when they reach a weight of 200 or 300 pounds.

Poultry raising is largely limited to farm flocks, although several commercial egg plants are located in the county. State statistics for 1932 indicate approximately 443,040 chickens in the county. The number of chickens raised was 635,606; chickens sold alive or dressed, 340,565; baby chicks bought, 343,682. The total number of eggs sold in 1930 was about 2,823,510 dozens. The 1935 Federal census reports 379,772 chickens on January 1, which produced 2,131,969 dozens of eggs in 1934. Recently the grading of eggs for market has been stimulated by the market demands. The important poultry breeds are White Leghorn, Barred Plymouth Rock, Rhode Island Red, and White Plymouth Rock. In addition to chickens, many ducks, geese, and turkeys are raised for market.

Franklin County has a large number of heavy draft horses, principally Percheron and Belgian breeds. It is well supplied with an adequate number of purebred stallions, and the registration of high-grade stallions probably equals or exceeds the number registered in any other county in Pennsylvania. Many of the draft horses are raised in the county, although some horses are imported from Virginia. State statistics for 1932 report 9,660 horses in the county with an average value of \$85 each. It is reported that the use of tractors on farms has decreased since 1928 and that no new tractors have been sold for general farm use since 1931, as heavy draft horses are replacing the tractors.

Table 6 gives the number of domestic animals in 1920, 1930, and 1935 as reported by the Federal census.

TABLE 6.—*Number of domestic animals in Franklin County, Pa., in stated years*

Kind of animal	1920	1930	1935	Kind of animal	1920	1930	1935
	<i>Number</i>	<i>Number</i>	<i>Number</i>		<i>Number</i>	<i>Number</i>	<i>Number</i>
Horses.....	15, 288	10, 375	9, 530	Sheep.....	10, 214	22, 131	9, 980
Mules.....	1, 314	1, 487	1, 346	Goats.....	103	76	-----
Asses and burros.....	3	12	-----	Swine.....	47, 252	25, 041	23, 812
Beef cattle.....	6, 399	-----	-----	Chickens.....	378, 600	359, 043	379, 772
Dairy cattle.....	24, 819	34, 822	34, 401	Other poultry.....	19, 157	-----	4, 719

¹ All cattle, mostly dairy cattle.

² Turkeys.

A large number of workers are employed, practically all of whom are native Americans. A small number work on farms in summer and in the factories or mills during the winter. When factories are not running full capacity, many factory workers find temporary employment on the farms in summer or in orchards during harvest seasons. The number of workers in factories and industry has constantly increased during the last 30 years. Many farm laborers are needed in the harvesting and packing of fruit, especially apples and peaches, and also during wheat harvest and corn harvest, but at other periods of the year the farmers and their families perform most of the farm work. According to the Federal census, 2,259 farmers reported the hire of labor in 1929 at a total cost of \$722,711, or an average of \$319.92 a farm reporting.

With the change from beef cattle to dairy cattle and dairying the cost of feeds bought on farms has increased, largely because of the increased use of mill feeds, particularly bran, middlings, and cracked grains, in the production of market milk. The dry year of 1930 reduced the yields of farm crops, and it was necessary for the farmers to use more commercial feeds in order to maintain milk production. The 1930 Federal census reports that 2,986 farms expended \$996,751 for feed in 1929, an average of \$333.81 a farm reporting such expenditure.

Farmers have used commercial fertilizers for more than 50 years, mostly on small-grain crops, such as wheat and oats, and in fruit orchards. Most of the fertilizers are purchased ready mixed, preference being given to 16- and 20-percent superphosphate, the 0-12-5⁴ phosphorus and potash fertilizer, and the complete 2-12-5 fertilizer mixture. These fertilizers are generally applied at the rate of 150 to 350 pounds an acre to small grains at the time of seeding. In fruit orchards the main fertilizers used are nitrogen fertilizers, both ammonium sulphate and nitrate of soda being used extensively. Occasionally phosphorus fertilizers are applied, according to the needs of the orchard cover crops, the individual orchard, or individual trees within an orchard. Fertilizer applications for mature peach trees range from 2 to 5 pounds of fertilizer a tree, and for mature apple trees from 5 to 10 pounds a tree.

As a part of the fertilizing practices, the soils have been limed for more than 50 years with burned limestone, raw ground limestone,

⁴ Percentages, respectively, of nitrogen, phosphoric acid, and potash.

or marl. The county is well supplied with natural deposits of limestone and marl, marl being least extensive and occurring as deposits along small drains or streams immediately below a number of springs that flow from the limestone areas. Most of these deposits are rather shallow, but a few are deep enough to be of commercial importance. The marl material contains from 50 to 90 percent of lime carbonate.

The Federal census reports the expenditure in 1929 of \$250,179 for fertilizer, including manure, lime, and marl, on 2,775 farms in the county, or an average of \$90.15 a farm reporting.

Farm tenure is practically the same today as it was 50 years ago. The 1935 Federal census reports that of the 3,861 farms in that year, 2,429 were operated by owners, 92 by part owners, 1,262 by tenants, and 78 by managers. About 98 percent of the rented farms are on the crop-share basis, the tenant furnishing the labor, work animals, and equipment, and one-half the fertilizer and receiving one-half the crop produced. A number of years ago the tenant was required to pay a portion of the taxes, such as school tax and road tax; but recently this requirement was virtually discontinued.

The farm buildings on most farms are large and substantial. The farmhouses, many of which are of brick, range from 5 to 10 rooms, with an average of 8 rooms. Many of these houses were built a number of years ago but are well preserved. The farm barns are large, most of them being bank barns with approaches and storage capacity for the year's crops. The basement is used as quarters for livestock. Practically all the small grain when dry enough is stored in the barn and later threshed and the straw stacked outside. Most farms are equipped with rather large and well-built poultry houses, many of which are equipped with electric lights that are used as an aid in forcing egg production during the winter months. Many of the other farm buildings also are lighted by electricity.

Modern farm machinery is used on most farms, but most of the corn is cut by hand. A few farms are equipped with power machinery, such as tractors and tractor-drawn machinery. Small tractors are used in cultivating the larger orchards. Practically every orchardist has one or more spraying machines and a set of tanks for mixing spraying materials, although some orchards are equipped with a central spraying system. Most of the fruit orchards, especially the larger orchards, have buildings that are equipped for the grading and packing of fruit.

The production of market milk has set up a new standard for equipment on modern dairy farms in order that the quality of the milk will meet the market demand, and the dairy barn must conform to sanitary requirements.

SOIL-SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field.

The soils are examined systematically in many locations. Test pits are dug, borings are made, and exposures, such as those in road or railroad cuts, are studied. Each excavation exposes a series of

distinct soil layers or horizons called, collectively, the soil profile. Each horizon of the soil, as well as the parent material beneath the soil, is studied in detail; and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The reaction of the soil⁵ and its content of lime and salts are determined by simple tests. The drainage, both internal and external, and other external features, such as the relief or lay of the land, are taken into consideration, and the interrelation of soils and vegetation is studied.

The soils are classified according to their characteristics, both internal and external, special emphasis being given to those features influencing the adaptation of the land for the growing of crop plants, grasses, and trees. Upon the basis of these characteristics soils are grouped into mapping units. The three principal units are: (1) Series, (2) type, and (3) phase. Areas of land, such as coastal beach or bare rocky mountain sides, that have no true soil are called (4) miscellaneous land types.

The most important of these groups is the series, which includes soils having the same genetic horizons, similar in their important characteristics and arrangement in the soil profile, and developed from a particular type of parent material. Thus the series includes soils having essentially the same color, structure, and other important internal characteristics and the same natural drainage conditions and range in relief. The texture of the upper part of the soil, including that commonly plowed, may vary within a series. The soil series are given names of places or geographic features near which they were first found. Thus Hagerstown, Dekalb, and Duffield are names of important soil series.

Within a soil series are one or more soil types, defined according to the texture of the upper portion of the 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, Hagerstown silt loam and Hagerstown silty clay loam are soil types within the Hagerstown series. Except for the texture of the surface soil, these soil types have approximately the same internal and external characteristics. The soil type is the principal unit of mapping and because of its specific character is usually the soil unit to which agronomic data are definitely related.

A phase of a soil type is a subgroup of soils within the type which differ from the type in some minor soil characteristic that may, nevertheless, have an important practical significance. Differences in relief, stoniness, and the degree of accelerated erosion are frequently shown as phases. Thus, for example, within the normal range of relief for a soil type, there may be portions which are adapted to the use of machinery and the growth of cultivated crops and other portions which are not. Even though there may be no important differences in the soil itself or in its capability for the growth of native vegetation throughout the range in relief, there may be important differences in respect to the growth of cultivated

⁵ The reaction of the soil is its degree of acidity or alkalinity expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality, higher values indicate alkalinity, and lower values indicate acidity.

crops. In such an instance the more sloping portions of the soil type may be segregated on the map as a sloping or hilly phase. Similarly, soils having differences in stoniness may be mapped as phases, even though these differences are not reflected in the character of the soil or in the growth of native plants.

The soil surveyor makes a map of the county or area, showing the location of each of the soil types, phases, and miscellaneous land types, in relation to roads, houses, streams, lakes, section and township lines, and other local cultural and natural features of the landscape.

SOILS AND CROPS

The soils of the county are predominately light-colored grayish-brown soils, but range from almost white sands through gray, yellow, and brown to reddish-brown silt loams and clays. All the mature soils are low in organic matter, as the larger part of the county was covered by forest until cleared for agricultural purposes, and conditions under forests are not favorable for the accumulation of organic matter in the soil. A layer of leaf litter, below which is a mat of raw humus, rarely exceeding 1 inch in thickness, lies on top of the mineral soil.

One of the common characteristics of the soils is the absence of free carbonates. In the formation of the soils the lime carbonates have been removed, even from those soils developed from limestone materials.

All the soils of the county respond readily to applications of commercial fertilizers and to the addition of large quantities of barnyard manure, which increases soil fertility and improves structure or tilth. Practically all the soils possess a fairly good structure which permits rapid absorption of water, and practically all are exceptionally well drained. In some soils the internal drainage is excessive, and most of the soils that occupy slopes or hillsides are subject to soil erosion unless well managed.

Franklin County includes a wide range of geologic materials which have developed into a great number of different kinds of soil. The geologic formations lie at steep angles and are exposed in narrow parallel belts that extend in a general northeast-southwest direction across the county; and, as the soils are closely related to the parent rocks, they also are developed in narrow belts coincident with the exposures of the geologic materials. Most of the upland soils are developed in place from the weathered products of the underlying rocks.

The soils may be broadly grouped as soils suitable for agriculture and soils suitable only for forest. The agricultural soils may in turn be considered as belonging to five subgroups on the basis of those soil characteristics due to differences in parent soil materials. These are: (1) Soils developed from limestone, commonly called "limestone soils"—rather deep fertile reddish-brown soils with silty clay subsoils; (2) soils developed from shale, called "shale soils"—comparatively shallow loamy soils; (3) soils developed from old colluvial or alluvial deposits of gravels, sands, and clays, called "gravelly soils"; (4) agricultural soils of the mountain lands; and (5) soils of the first bottoms and terraces, which consist of comparatively recent

alluvial deposits along the main streams. The soils adapted only to forest lie mostly in the mountains and are thin, stony, and of relatively low productivity.

Each of the five groups of agricultural soils has important agricultural differences which are directly related to the general features of the soils. The soils developed from limestone are naturally the most productive and, because of their depth, are especially well suited to the growing of corn. The soils developed from shale are rather shallow and droughty and for this reason are not so well suited to corn but produce about as good yields of small grain as the limestone soils. The soils developed from gravelly deposits are not so fertile, as a rule, as those from shale or limestone and are not so well adapted to general farm crops but are well adapted to orchards because they are exceptionally deep, are generally well drained, provide a great volume of soil in which the roots of fruit trees may spread, and store large quantities of water in their subsoils. The soils developed from gravelly deposits are very responsive to fertilizer treatments, and some areas of the better soils, when limed and fertilized, produce heavy yields of alfalfa. Soils of the first bottoms and terraces are not extensive and are lacking in uniformity. Much of their area is poorly drained and subject to overflow; in places they are gravelly and poor; in others they are highly productive. These five groups include all the valley soils that are devoted to agricultural purposes or to wood lots. In addition to these, some of the smoother mountain land is under cultivation or is devoted to other agricultural uses. All other land, which is nonarable, is classified and described as forest soils.

The acreage of land cultivated and devoted to farm crops differs considerably in the different groups of soils. Approximately 90 percent of all the soils developed from limestone is cultivated, but the rest is too stony or too badly eroded for economical cultivation, and these areas are devoted to pasture grasses or farm wood lots. In the sections where the soils developed from shale predominate the acreage of cultivated land ranges from 30 to 90 percent, or an average of about 75 percent—the rest being too badly eroded or too steep for cultivation. The main bodies of soils developed from gravelly deposits border the mountains, and naturally large areas of these soils are still under forest. Approximately 65 percent of the gravelly land is cultivated, and about 80 percent of all the fruit grown in the county is produced on these gravelly soils. Of the first-bottom and terrace soils, only about 50 percent is cultivated; many areas are too wet for cultivated crops and for this reason either remain forested or are devoted to various kinds of wild grasses. The agricultural land in the mountains consists mainly of scattered small areas that were at one time cleared and cultivated; at present, only about 40 percent is cultivated.

The soils and climatic conditions are naturally favorable to the production of corn, wheat, rye, barley, oats, clover, timothy, and alfalfa as general farm crops. Kentucky bluegrass is grown with success on the more nearly neutral soils developed from limestone. Most of these crops have been grown throughout the entire area of

agricultural land for more than 40 years, irrespective of the character of the soils, as they fit well into the general system of agriculture and crop rotation practiced. Commercial fruit growing, especially of apples and peaches, on the gravelly soils has been developed within the last 30 years; and more recently the growing of truck crops, such as canning peas, beans, and tomatoes, has become of considerable importance on the soils developed from limestone and shale. In general, the present system of diversified agriculture demands maximum production from the soil.

Four general types of agriculture are common—general farming and livestock production, diversified farming and dairying, orcharding and fruit production, and truck farming. General farming and livestock production is mainly in the intermountain valleys and in sections of marginal land bordering the forest land. The principal livestock are sheep, in connection with wool production, and a few beef cattle. Diversified farming and dairying occupies the main agricultural areas, especially the soils from limestone and shale. Orcharding and fruit production, and, to some extent, diversified farming and dairying, occupy the gravelly soil areas. Truck farming is not widely practiced and is confined mainly to first-bottom soils that are naturally very fertile and are well supplied with soil moisture.

The relief of the agricultural land is rather rolling to undulating. The most level areas are in the vicinities of Lemasters, Duffield, Greencastle, Chambersburg, and Green Village, all of which are in the limestone section. Fairly level to gently rolling areas of soils developed from shale are near Upper Strasburg and northeast of Roxbury. On the whole, the relief of the agricultural soils is not favorable to a continuous system of cultivation to intertilled crops because of the loss of soil by erosion, which occurs on many of the slopes and is a serious factor in clean-cultivated orchards and on cultivated land. At present the land is subject to a period of natural erosion and dissection which follows the geologic uplifting of the land surface. The deeper agricultural soils reached their greatest depths previous to this uplift, and now that these soils are brought under cultivation they are subject to accelerated erosion unless carefully managed. At present the deepest soils are on the more level areas on the ridge tops and near the bases of mountains where materials have accumulated from the higher mountain slopes. In general, the shallowest soils are on the steeper slopes or those nearest the larger drainage channels where run-off is most rapid. Tame grasses, especially timothy or timothy and clover, for most of the soils, or Kentucky bluegrass for the soils from limestone, may be used effectively and economically in preventing losses of soil by erosion on the more sloping lands and at the same time furnish hay or pasture.

In the following pages of this report the different soils are described, 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 7.

TABLE 7.—Acreage and proportionate extent of soils mapped in Franklin County, Pa.

Soil type	Acres	Per- cent	Soil type	Acres	Per- cent
Hagerstown silt loam.....	33,664	6.9	Lehew gravelly sandy loam.....	832	0.2
Hagerstown silt loam, shaly phase.....	576	.1	Lehew gravelly sandy loam, shaly phase.....	1,280	.2
Hagerstown silt loam, yellow phase.....	1,792	.4	Amberson shale loam.....	1,408	.3
Hagerstown silt loam, light-colored phase.....	1,344	.3	Ashe gravelly silt loam.....	3,648	.8
Hagerstown silt loam, colluvial phase.....	5,696	1.2	Ashe gravelly silt loam, heavy-subsoil phase.....	192	(¹)
Hagerstown silty clay loam.....	62,288	10.7	Montalto silt loam.....	448	.1
Hagerstown silty clay loam, shaly phase.....	9,024	1.8	Montalto stony loam.....	192	(¹)
Hagerstown silty clay loam, yellow phase.....	576	.1	Chandler gravelly loam.....	704	.2
Hagerstown clay loam.....	7,488	1.5	Leetonia gravelly loam.....	256	.1
Hagerstown stony silty clay loam.....	7,360	1.5	Holston silt loam.....	2,752	.6
Duffield silt loam.....	8,192	1.6	Holston silt loam, brown phase.....	192	(¹)
Duffield silt loam, colluvial phase.....	1,856	.4	Holston sandy loam.....	2,176	.5
Duffield silt loam, slope phase.....	7,680	1.6	Monongahela silt loam.....	2,496	.5
Duffield silt loam, eroded phase.....	1,920	.4	Robertsville gravelly silt loam.....	1,408	.3
Duffield very fine sandy loam.....	640	.1	Huntington silt loam.....	1,152	.2
Duffield very fine sandy loam, slope phase.....	896	.2	Chilo silty clay loam.....	448	.1
Frankstown cherty silt loam.....	1,664	.3	Warners silt loam.....	1,664	.3
Ryder silty clay loam.....	1,984	.4	Moshannon silt loam.....	2,112	.4
Murrill gravelly silt loam.....	5,056	1.0	Pope fine sandy loam.....	5,248	1.1
Murrill gravelly coarse sandy loam.....	6,016	1.2	Pope silt loam.....	2,112	.4
Berks silt loam.....	41,536	8.5	Philo silt loam.....	2,496	.5
Berks silt loam, colluvial phase.....	6,592	1.3	Philo silt loam, dark-colored phase.....	768	.2
Berks silt loam, rolling phase.....	58,960	11.9	Philo gravelly loam.....	2,304	.5
Berks silt loam, heavy-subsoil phase.....	1,344	.3	Atkins clay loam.....	192	(¹)
Berks shale loam.....	21,568	4.4	Algiers silt loam.....	2,432	.5
Berks shale.....	1,664	.3	Walkkill silty clay loam.....	128	(¹)
Gilpin shale loam.....	1,152	.2	Muck.....	64	(¹)
Gilpin shale loam, brown phase.....	704	.2	Leetonia stony loamy fine sand.....	2,496	.5
Lycoming gravelly fine sandy loam.....	11,620	2.4	Leetonia stony loamy sand.....	3,200	.7
Lycoming cobbly sandy loam.....	5,440	1.1	Leetonia stony coarse sandy loam.....	1,792	.4
Lycoming cobbly sandy loam, yellow-subsoil phase.....	1,920	.4	Dekalb stony fine sandy loam.....	14,848	3.0
Lycoming loamy sand.....	320	.1	Dekalb gravelly loam.....	15,936	3.3
Lycoming gravelly silt loam.....	576	.1	Dekalb stony coarse sandy loam.....	6,888	1.2
Lycoming gravelly silt loam, shaly phase.....	4,992	1.0	Dekalb stony fine sand, compact-subsoil phase.....	2,432	.5
Buchanan gravelly loam.....	6,720	1.4	Lehew stony loam.....	16,000	3.3
Amberson gravelly loam.....	4,992	1.0	Lycoming stony sandy loam.....	3,840	.8
Murrill gravelly coarse sandy loam, deep phase.....	6,336	1.3	Lickdale stony loam.....	4,160	.8
Holston cobbly sandy loam.....	2,880	.6	Ashe stony sandy loam.....	1,536	.3
			Rough stony land (Dekalb soil material).....	35,520	7.2
			Rough stony land (Lehew soil material).....	8,960	1.8
			Total.....	490,240	-----

¹ Less than 0.05 percent.

SOILS SUITABLE FOR AGRICULTURE

SOILS DEVELOPED FROM LIMESTONE

The soils developed from limestone, commonly called "limestone soils", which occupy approximately 32 percent of all the agricultural land in the county, occur in the valleys. These soils occupy generally smooth to rolling relief and are developed from residual silts and clays which are the accumulated products of weathered limestone. They also contain angular chert, siliceous fossils, and other inert materials from the parent limestones. These materials have accumulated to a depth ranging from a few inches to 15 feet, but generally to a depth of 3 to 7 feet. These soils originally had fine granular mellow silt loam surface soils that contained a considerable quantity of organic matter in the surface layer, which averaged about 3 inches in depth, and the subsoils are mostly granular silty clays or clays. They are well drained and well oxidized. In color they range from rich reddish brown to brownish yellow. They have been developed under a rather heavy rainfall, and for this reason

the lime carbonate has been leached from the soil material and the soils are acid down to within an inch of the parent limestone. Before these soils were cleared of their forests or put into cultivation, the lime material of the decaying organic matter kept the 1- to 3-inch surface layer neutral to slightly alkaline, but as soon as the soil was cultivated the annual deposit of forest litter ceased, decay continued to decrease the supply of soil organic matter, and the surface soils soon became acid.

These soils are considered the best farming soils in the county. They have a natural fertility level that is suitable to the growing of a large variety of crops but is especially well adapted to the production of corn, wheat, oats, rye, barley, clover, timothy, alfalfa, bluegrass, and fruits. In general, the crop adaptations of these soils are limited mostly by climatic conditions and the acidity of the soil. Crops that require neutral to alkaline soils, such as alfalfa, clover, and bluegrass, are benefited by applications of lime and phosphorus.

These soils are developed from limestones that are not exceptionally high in phosphorus, and in this respect they are naturally less fertile than soils of the inner bluegrass region of Kentucky and of parts of Tennessee developed from highly phosphatic limestones. For maximum yields of certain crops the addition of phosphate fertilizers to the soils developed from limestone is recommended. Even though these soils are somewhat deficient in lime and phosphorus they can be kept in a state of high productivity by proper soil management, as is demonstrated on many of the farms.

The soils developed from limestone have been classified in five soil series: The Hagerstown series, the most extensive and important, is characterized by reddish-brown silt loam surface soils and brownish-red granular silty clay subsoils; the Duffield series, which includes soils similar in most respects to those of the Hagerstown series except that the surface soils are more nearly brown and the subsoils are mellow porous yellowish-brown silty clay loam; the Frankstown series, which includes grayish-brown extremely cherty silt loam soils with yellow cherty silty clay subsoils; the Ryder series, which includes drab-colored heavy silty clay soils derived from calcareous shales interbedded with thin layers of limestone; and Murrill gravelly silt loam and Murrill gravelly coarse sandy loam which are developed from a comparatively thin layer of transported gravelly material over clays weathered from the underlying limestone bedrock.

The Hagerstown soils are the most productive upland soils in the county. They lie favorably for cultivation in most places, though some areas are broken by outcropping reefs of limestone. The original vegetation consisted mainly of hardwood forest, but now most of the land is cleared and cultivated. Under the forest were a covering of forest litter and a thin surface soil, dark brown or black, highly organic, neutral or slightly alkaline in reaction; but through cultivation the surface soil has been mixed with the acid light-colored materials below, and a part of this plowed surface soil has been removed by erosion, exposing the heavy reddish-brown or pale-red subsoil. These soils are well adapted to a number of crops, the most important being corn, wheat, oats, timothy and clover, alfalfa, and bluegrass. A number of large commercial apple orchards are on these soils.

The Duffield soils are similar to the Hagerstown soils but have yellower subsoils of softer, mellower structure. The surface is generally more rolling, rock outcrops are few, and most of the land is under cultivation. The productivity is about equal to that of the Hagerstown soils. Wheat, corn, and hay are the important crops. Others are rye, potatoes, apples, and peaches. These soils are subject, in places, to accelerated erosion if not protected by a cover of vegetation.

Hagerstown silt loam.—Hagerstown silt loam ranges in depth to bedrock from 2 to 12 feet. It occupies fairly level areas where very little soil is lost by erosion and very little limestone bedrock is exposed. This soil is developed not in broad extensive areas but as irregular small areas within areas of Hagerstown silty clay loam and Hagerstown clay loam. The rich-brown loose mellow and fluffy silt loam surface soil is rather deep, ranging from 6 to 18 inches. The material in this layer is generally medium acid, the pH value ranging from 5.5 to 6.0.^a The subsoil is normally a rich reddish-brown silty clay that is less acid than the surface soil, the pH value ranging from 6.0 to 6.5. Normally the soil is well drained either by surface drainage or by subsoil drainage through crevices in the limestone to underground drainage channels.

This soil, because of its smooth relief, great depth, ease of tillage, and large moisture-holding capacity, is exceptionally valuable for corn, the yields of which are estimated to range from 40 to 80 bushels an acre. If the soil is limed heavily, alfalfa will yield from 3 to 3½ tons an acre. Other crops, such as wheat and clover and timothy, also yield well.

The larger bodies of Hagerstown silt loam are near Lemasters, Greencastle, Marion, Chambersburg, and Green Village; and numerous small bodies occur throughout areas of other Hagerstown soils wherever the soil is deep, free from stone, fairly level, and not subject to much erosion. All the land is well drained and under cultivation.

Several variations of typical Hagerstown silt loam were mapped, mainly on the basis of minor differences of soil fertility, content of limestone impurities, soil color, and drainage.

A few areas of unusually rich reddish-brown silt loam soil are on elevated slopes or knolls where the drainage is excessive and the iron of the soil is highly oxidized. The soil in these areas is not quite so productive as the normal soil and is more acid, the pH value ranging from 4.5 to 5.5, and the content of organic matter is very low. Surface run-off is more rapid than on the normal soil and crops do not withstand drought quite so well as on the normal soil.

A number of areas included with Hagerstown silt loam are similar to the normal silt loam in all respects except that over the surface is deposited a thin layer of gravelly wash material, consisting largely of transported silt, sand, and gravel that had their origin in the mountain areas ages ago. This material ranges in depth from a thin film to about 6 or 8 inches and in most places is too shallow to affect the normal productivity of the soil to any great extent.

^a The pH values were determined colorimetrically by the use of the LaMotte Soil Teskit and Soiltex field testing equipment.

In a few scattered areas the soil contains various quantities of sharp angular cherty fragments which have accumulated along those areas where cherty limestones have been exposed and weathered to form soils. As a rule, the soil of these cherty areas also contains considerable quantities of coarse gritty impurities and imparts a sandy, gritty feel to the silt loam soil. The content of coarser impurities has decreased the productivity of the cherty areas as much as 10 percent below that of the normal soil.

Hagerstown silt loam, shaly phase.—Along the boundaries between the Hagerstown and the Duffield soils a few areas of the shaly phase of Hagerstown silt loam were mapped. The soil texture is practically a loam, and the main body of soil contains numerous particles of soft yellow platy shale fragments. In this respect the soil resembles the Duffield soil, but the subsoil is a reddish-brown silty clay, or in places a clay, and for this reason the soil was mapped as a Hagerstown soil.

Hagerstown silt loam, yellow phase.—Hagerstown silt loam, yellow phase, instead of having the normal reddish-brown or brown Hagerstown color has a brown or yellowish-brown surface soil, underlain by a heavy plastic brownish-yellow or yellow subsoil. It occupies rather flat areas, most of which are near the borders of the shale soil belts. The subsoil drainage is not so well developed as in the normal Hagerstown silt loam.

Hagerstown silt loam, light-colored phase.—Hagerstown silt loam, light-colored phase, for the most part is derived from an impure limestone containing large clusters of rosette and cauliflower chert (9). These materials, which in some areas constitute as much as 10 percent of the soil mass, are very destructive to the cutting edges of tillage implements. Farmers state that this soil is not so good as typical Hagerstown silt loam, as it is cold, clammy, and slow to warm in the spring, and that crop yields range from 5 to 15 percent below those on typical Hagerstown silt loam. Heavy liming and fertilizing are practiced on this soil. The largest areas are southeast of Lemasters. It normally occurs on the tops of low ridges. The surface soil is grayish-brown cherty silt loam, and the subsoil is yellowish-brown loose friable silty clay which in some places is rather compact.

Hagerstown silt loam, colluvial phase.—Many of the depressions or low places in the sections occupied by Hagerstown soils have been filled with recent deposits of soil eroded from the nearby sloping areas. This material, which in some places has accumulated to a depth of 3 or 4 feet, has been mapped as Hagerstown silt loam, colluvial phase. Most of this soil is only slightly acid and consists of rich-brown silt loam. In the process of erosion the first material deposited was the silt eroded from the uplands, but the more recent deposit in some places consists of silty clay because very little silt material remains to be washed off the adjacent upland areas. Several farmers report that this colluvial soil is becoming heavier in texture and more difficult to cultivate. The soil is very productive. Corn yields from 50 to 80 bushels an acre. Areas of this soil are frequently flooded by heavy rains, but the water drains off in a few hours leaving freshly deposited soil material. A few areas of this

colluvial soil are exceptionally dark in color, comparatively high in organic matter, and neutral to alkaline in reaction. Such areas are very valuable for the production of corn or pasture grasses, especially Kentucky bluegrass and clover.

Hagerstown silty clay loam.—Hagerstown silty clay loam is similar to Hagerstown silt loam in general soil characteristics but is not so deep as Hagerstown silt loam and has a decidedly choppy relief with numerous small knolls on which occur some exposures of limestone. The depth of the weathered material is variable, ranging from practically nothing to 5 feet. In general the surface soil is brown or reddish brown and is extremely variable in texture. On the steeper slopes and high places it is silty clay loam or silty clay, and on the lower slopes and more level ridge tops it is shallow silt loam, the change in texture occurring at too short intervals to be shown on the soil map. Cultivated fields of this soil are very spotted in color, the eroded areas being red or reddish brown and the lower or uneroded areas grayish brown or light brown. The subsoil is reddish-brown silty clay or clay.

Corn does not yield quite so well on Hagerstown silty clay loam as on Hagerstown silt loam, mainly because Hagerstown silty clay loam is shallower and less drought resistant; acre yields on the silty clay loam range from 25 to 50 bushels, depending on seasonal conditions and on soil depth. Like all Hagerstown soils, the silty clay loam is somewhat acid (pH 5.5 to 6.5). The surface soil is less acid than the surface soil of the silt loam and holds moisture a little better; therefore it is less difficult to obtain a good stand of grasses, clover, or alfalfa. Kentucky bluegrass grows well on this soil and is used mostly as a pasture crop. Clover and alfalfa yield about 1½ and 2½ tons an acre, respectively. Several very productive apple orchards, yields of which range from 150 to 400 bushels an acre, are located on this soil.

Extensive areas of Hagerstown silty clay loam lie in a broad belt that extends across the county east of Greencastle and Chambersburg and northwest of Shippensburg. Other areas are near Mercersburg and Williamson and in Path Valley.

A number of areas of unusually reddish brown to almost brick red silty clay loam occur on ridge tops and on slopes. The soil in these areas is exceptionally well drained, very granular, highly oxidized, and low in organic matter. In general, the surface silt loam layer has been subjected to sheet erosion, and the red silty clay loam subsoil is exposed. Crop yields on such areas are practically the same as on the normal silty clay loam even though the soil is slightly more acid in some places.

A number of areas of Hagerstown silty clay loam have shallow deposits of sand, silt, and water-worn gravel over the surface. Formerly these materials were deeper, but the finer materials have gradually washed away and left the gravel on the surface. Most of these gravelly areas are on the tops of low ridges that border extensive areas of gravelly soils. Crop yields are similar to those on the normal silty clay loam.

Hagerstown silty clay loam, shaly phase.—The shaly phase of Hagerstown silty clay loam is extensively developed along the boundaries of the Hagerstown and Duffield soils. The average texture of this soil is more loamy than that of typical Hagerstown silty

clay loam, but the relief is the same, being very choppy and undulating with frequent exposures of limestone. This soil, because of the steepness of many of the slopes, is subject to considerable erosion if not carefully managed, and many areas are badly eroded. The subsoil is friable loose brownish-yellow silty clay loam, in contrast to the normal reddish-brown clay or clay loam subsoil of the typical Hagerstown soils. This soil occupies a position midway between the Hagerstown and the Duffield soils but, because of its choppy and sloping relief with frequent rock exposures, was mapped as a phase of the Hagerstown soil.

A few areas of sandy clay loam were mapped with this phase. They occupy ridge tops in the vicinity of Grindstone Hill where narrow strips of calcareous fine-grained sandstone outcrop.

Hagerstown silty clay loam, yellow phase.—The yellow phase of Hagerstown silty clay loam might well be termed a heavy-subsoil phase. This soil consists of a brown silty clay loam surface soil underlain by a heavy tough brownish-yellow clay subsoil. Nearly all of it borders the shale soils. It is less fertile than normal Hagerstown silty clay loam, and crop yields average about 10 percent less. Farmers state that this soil is hard to cultivate. The subsoil drainage is not especially rapid, and during wet seasons the land dries slowly and tillage operations are retarded.

Hagerstown clay loam.—Hagerstown clay loam includes areas of rather shallow soil which is subject to rather severe erosion if not carefully handled. In general, the silt loam surface soil has been removed, and the heavy-textured subsoil is exposed, so that the surface soil is now reddish-brown or brownish-red clay loam, underlain by a yellowish-red or dull-red stiff but not especially plastic subsoil. This soil is not developed in extensive areas but occurs on slopes and tops of narrow low ridges in those sections where the surface is rather choppy or undulating. The soil is not confined to any one section of the soils developed from limestone but occurs wherever drainage is excessive and erosion has been active in removing the silt loam surface soil.

Hagerstown clay loam is difficult to cultivate because of its shallowness, the presence of large underlying limestone boulders that are exposed in many places, and its heavy claylike character. If plowed when wet it dries out hard, and if plowed when dry it breaks into large clods. The greater part of this soil is used for hay crops or pasture. In favorable seasons this soil will produce good crops of corn and wheat. Alfalfa grows well on it because it is generally not strongly acid and the roots soon penetrate the lower subsoil layer in which they obtain lime. Alfalfa produces from 1½ to 2 tons an acre. About one-half of this soil is devoted to grasses, either timothy or bluegrass, and is used as pasture.

The soil in some small areas of Hagerstown clay loam is unusually red, very granular, slightly more acid in soil reaction, lower in organic matter, and not quite so productive as typical Hagerstown clay loam.

Some areas are badly eroded and cut by gullies. These areas should be devoted to grass. A few areas have yellow plastic subsoils that contain small fragments of soft yellow shale. These areas are the least productive of the Hagerstown soils and are generally very acid in reaction.

Hagerstown stony silty clay loam.—Hagerstown stony silty clay loam consists of areas of very shallow soil which contains an abundance of limestone boulders and outcropping massive limestone bedrock. Many of the detached boulders weigh as much as 8 or 10 tons. Between them are very small areas of relatively deep soil (pl. 1). The soil ranges in texture from silt loam to clay but is so badly mixed that a separation based on texture is not practical.

This stony soil occupies the rougher sections underlain by limestone, most of which occur in a belt about 5 miles wide that extends across the county in a northeast-southwest direction east of Greencastle, Marion, Chambersburg, and Green Village, northward to and including Shippensburg.

Practically all of Hagerstown stony silty clay loam is devoted to bluegrass or other grasses, although a number of areas are occupied by a forest growth of oak, hickory, locust, cherry, and cedar. Many of these stony areas are used as sites for the farm buildings. All of this soil is too stony for either plowing or mowing.

Duffield silt loam.—Duffield silt loam, to a depth of 7 inches, consists of loose mellow to fluffy brown loam or silt loam. The dark color is mainly due to organic matter over the surfaces of the brown or light-brown mineral soil particles. The surface soil is medium acid, having a pH value of 6.0. Below a depth of 7 or 8 inches the subsurface soil is yellowish brown and is the most acid of any of the soil layers (pH 5.5). The surface and subsurface layers make up the leached portion of the soil. Between depths of 18 and 40 inches, the upper subsoil layer is brownish-yellow, yellow, or reddish-yellow silty clay loam that is faintly granular, very friable, and easily penetrated by plant roots and soil water. It has a pH value of 6.2. Below a depth of 40 inches the subsoil is generally a mixture of soil and thin platy layers of soft yellow shale (pl. 2, A) and is nearly neutral in reaction, having a pH value of 6.8.

Duffield silt loam occupies smooth fairly level areas (pl. 2, B). It erodes very little, and the soil material ranges from 4 to 12 feet in depth, averaging about 6 feet to bedrock. All the land is well drained.

Duffield silt loam, which is the best of the Duffield soils, comprises approximately 39 percent of all the Duffield soils in the county. Large areas are devoted to corn and wheat, for which the soil is very well adapted because of its depth and the ease with which it can be cultivated. All of it is under cultivation. Corn yields from 35 to 70 bushels an acre, and wheat 20 to 35 bushels. The loaminess of this soil makes it well suited to potatoes, some rather large fields of which are grown on it. Potato yields range from 100 to 150 bushels an acre, and other special crops, such as beans and tomatoes, produce good yields. Clover and timothy mixed and alfalfa yield from 2 to 3½ tons of hay an acre.

Duffield silt loam, colluvial phase.—Duffield silt loam, colluvial phase, consists mainly of deposits of silt loam soil material in depressions and along small drains that rise in areas of Duffield soils. Most of this material has been washed off the cultivated slopes adjacent to the streams or depressions. The depth of accumulated material ranges from 18 inches to 4 feet and overlies virgin Duffield silt loam. Soil of this phase consists of rich-brown silt loam down to

the layer of original soil, which is very dark brown silt loam about 8 inches thick. Below this layer the soil is more yellow, resembling typical Duffield subsoil. Generally the soil material of the colluvial phase is neutral or only slightly acid.

It is a very fertile soil but frequently is flooded and covered by a new deposit of soil material. After one heavy rain during September 1932, an average of one-fourth inch of soil sediment was deposited over many of the Duffield basin areas, and in a few places, following the same shower, some deposits were as much as 8 inches deep at the foot of very steep cultivated slopes. The flood water generally drains off in a few hours either by surface drains or down through the underlying limestone.

The same general farm crops are grown on this soil as on the typical silt loam. Hay is not widely grown on this soil because the land is subject to frequent flooding by muddy water which damages a hay crop. Corn is the main crop, followed by wheat, although wheat has a tendency to lodge when grown on this soil. Corn yields from 45 to 85 bushels an acre. A number of areas are devoted to pasture grasses, as the high fertility of the soil together with an abundance of moisture produces a very heavy growth. This soil is better supplied with organic matter than most soils, which makes it especially valuable for corn, which is probably the most profitable crop.

Duffield silt loam, slope phase.—Duffield silt loam, slope phase, occupies approximately 36 percent of the total area of the Duffield soils. It has the same general soil characteristics as the typical silt loam except that the soil material is not so deep, ranging from 2 to 6 feet in depth, and it occupies more rolling relief or slopes. The loose fluffy silt loam surface layer ranges from 4 to 8 inches in depth. This soil is subject to various degrees of soil erosion on the steeper slopes. The same crops are grown on the slope phase as on the more level typical soil, though the proportion of hay and grass crops is about 30 percent greater on the slope phase. Alfalfa, clover, and timothy are the important hay crops and yield from 1¾ to 2½ tons an acre. Corn yields from 20 to 40 bushels an acre, and wheat 12 to 25 bushels. Control of erosion should be included in the scheme of soil management; contour cultivation is recommended.

Duffield silt loam, eroded phase.—The eroded phase of Duffield silt loam occupies steep slopes where erosion has removed practically all the loose mellow surface silt loam leaving the silty clay loam subsoil exposed. The surface soil ranges in texture from silt loam to clay loam, depending on the amount of erosion. The yellowish-brown silt loam rarely exceeds 5 inches in depth. Cultivated areas of this soil appear spotted, the silt loam spots being brown and the silty clay spots reddish yellow. The subsoil is brownish-yellow, yellow, or reddish-yellow silty clay loam that contains from 10 to 15 percent of soft yellow shale fragments. The soil depth ranges from a few inches to 3 feet, averaging about 2 feet. This soil is subject to severe erosion and for this reason should not be frequently cultivated. Only about 20 percent is cultivated, and the rest is kept in grass, as it should be. A few small areas are forested.

Duffield very fine sandy loam.—A few small areas of Duffield very fine sandy loam are on the tops of high ridges that range from 950

to 1,000 feet in elevation, southwest of Duffield and at Mont Alto, where rather sandy limestones and narrow bands of calcareous sandstones have weathered into soil materials. The surface soil consists of brown very fine sandy loam to a depth of about 10 inches, below which is a brown, reddish-brown, or reddish-yellow silt loam or very fine sandy clay loam subsoil. Throughout the soil mass are a few small angular soft sandstone, white quartz, and soft yellow shale fragments. From these materials, when weathered, come the gritty materials that resemble sharp sand. The average depth of this soil is about 4 feet, although some areas are rather shallow.

About 65 percent of this soil is cultivated, and the rest is devoted to pasture and a few small forested areas. This soil, because of its sandy texture, is rather heavily leached and is not so fertile as Duffield silt loam. Cultivated areas erode rather badly unless carefully handled. Grain crops are not grown extensively on this soil; hay crops, especially clover and timothy or timothy alone, are grown more frequently. Several areas of this soil are set in peach orchards or apple orchards, which have proved rather profitable.

Duffield very fine sandy loam, slope phase.—Duffield very fine sandy loam, slope phase, is similar to typical Duffield very fine sandy loam under undisturbed conditions. The position of the areas on sloping land, has, however, made it more susceptible to erosion, and where the land has been cleared and cultivated, much of the surface soil has been lost by sheet wash. Such areas have been rendered relatively unproductive, and many of them are no longer cultivated. Yields are generally lower than on typical Duffield very fine sandy loam.

Frankstown cherty silt loam.—Frankstown cherty silt loam is developed from the weathered products of the Oriskany and Helderberg limestones and contains large quantities of sharp angular chert blocks. The surface soil consists of dark grayish-brown silt loam or loam to a depth of 2 inches, below which is a 7-inch subsurface layer of brownish-yellow silt loam or loam. In cultivated fields the 8-inch plow soil is dark gray to faintly yellowish gray. This surface soil is strongly leached and strongly acid, having a pH value of 4.5. Between depths of 9 and 15 inches the soil material is yellow silty clay loam, which from a depth of 15 inches to 20 inches is slightly granular. Below a depth of 20 inches to a depth of 40 inches the soil is bright-yellow to faintly pinkish yellow silty clay loam or clay loam that has little stickiness. Between depths of 40 and 50 inches the subsoil is gritty, cherty silty clay, which overlies a mass of hard flinty chert and the impure Helderberg limestone. This soil is very porous and open. It is highly leached to bedrock, and the acidity of the entire soil and subsoil ranges from a pH value of 4.5 to 5.0.

Both the surface soil and the subsoil contain large quantities of sharp angular chert blocks, hard sandstones, and some very light-weight gray sandstones and in many places consist of a mass of this cherty material with only a small proportion of finer soil materials. In cultivated fields the chert is present in such abundance that cultivation is difficult. The porous structure of both the surface soil and the subsoil gives thorough internal drainage which, together with the chert content, reduces erosion on the slopes. The soil is not so open and porous, however, that it does not retain large quantities

of soil moisture, which is valuable to plant growth during prolonged dry periods.

About 30 percent of this soil is cleared and cultivated, and the rest is cut-over land from which all sizable timber has been removed. The main tree growth consists of oak, hickory, ash, dogwood, some maple, pitch pine, and other similar growth. The undergrowth is mainly weeds, brambles, and huckleberries.

Corn, wheat, and timothy and clover are the main crops grown. Estimated corn yields range from 20 to 35 bushels an acre; wheat, 10 to 15 bushels; and hay, about 1 ton. This is not an especially good agricultural soil because it contains an exceptionally large amount of hard cherty material which in some places makes up fully 15 percent of the soil mass. The chert blocks average $1\frac{1}{2}$ inches in thickness, and many are 3 inches thick. Also it is a very acid and highly leached soil, which means that it is low in fertility. Because this soil does not possess sufficient fertility to promote good grass growth, very little of it is used for pasture. It might be adapted to fruit growing, as it has good subsoil drainage and fair air drainage.

This soil is very low in organic matter, which can be increased, however, by making heavy applications of lime in connection with the growing and plowing under of green-manure crops. Crops respond to applications of nitrogen and phosphorus fertilizers on this soil.

Much of this soil is subject to erosion, and contour farming, the running of crop rows on a level across the slope, is recommended.

Ryder silty clay loam.—The surface soil of Ryder silty clay loam consists of dark-drab to dull-brown coarse granular faintly acid silty clay to a depth of 4 inches. Below this to a depth of 14 inches the soil is brown or slightly reddish brown coarse-granular silty clay loam, ranging from neutral to alkaline. The granules when moist have slick shiny colloidal surfaces that are very sticky. Between depths of 14 and 32 inches the material is a dark-drab silty clay that is rather compact and is plastic when wet. At a depth of 26 inches the material contains numerous black and bluish-black parent shale fragments composed of an alkaline shale that contains considerable quantities of lime carbonate. The parent shales are largely black and bluish-black calcareous mud shales and thin shaly black limestones that are contact members between the Martinsburg shales and the Chambersburg limestones.

Areas of this soil occupy long narrow strips, between the Berks soils and the Hagerstown soils, rarely exceeding 200 yards in width and occurring wherever the calcareous shales are exposed to weathering. The largest areas are south of Fort Loudon and northwest of Greencastle.

The soil, because of its heavy clay loam texture, is more difficult to cultivate than most of the soils in the county. When dry it is rather cloddy or chunky.

One of the most important characteristics of this soil is that it is neutral or alkaline, and for this reason alfalfa grows well without liming, and clover is well adapted to it. Most grass crops grow exceptionally well on this soil. The most objectionable feature of the soil is its heavy texture, which makes cultivation difficult except at the optimum moisture content, and during dry periods it tends

to bake and crack, forming hard lumps. This soil is not agriculturally important, as its total area is not large.

Murrill gravelly silt loam.—Murrill gravelly silt loam is developed from two distinctly different classes of soil materials—the surface material being mainly silt, sand, and gravelly material that is alluvial or colluvial in origin and has been spread as a thin drift over the residual soil materials weathered from limestone. The upper materials originated in the mountains and were transported to their present positions by gravitational creep, snowslides, and surface flood water. The soil is generally well drained and well oxidized. It occupies gently rolling relief mainly on the crests of low ridges where erosion has been least active. Most of the gravel is water-rounded.

The surface soil, to a depth of 8 or 10 inches, consists of rich-brown gravelly silt loam to fine sandy loam which contains from 5 to 15 percent of water-worn gravel. Below this to a depth of about 20 inches the soil material is yellowish-brown heavy silt loam with from 2 to 5 percent of gravelly material scattered through it. Between depths of 20 and 40 inches the soil is generally reddish-yellow clay loam that resembles the Hagerstown subsoil but contains some gravel. Below a depth of 40 inches the soil is silty clay derived from residual materials weathered from limestones. The surface gravelly layer, as mapped in this county, ranges in depth from 6 inches to 4 feet, but is everywhere underlain by the reddish-yellow to reddish-brown clay material which overlies massive limestones. The rounded water-worn gravel of the surface soil ranges in diameter from one-half inch to 3 inches, and averages about 1 inch. Most of the colluvial material consists of weathered products of sandstones and shales. This soil is acid, ranging from a pH value of 5.5 in the surface soil to a pH value of 6.0 to 6.3 in the subsoil.

Murrill gravelly silt loam is most extensive north and west of Mercersburg, at the edge of the limestone soils southeast of Parnell Knob, and in Path Valley. The relief is gently rolling with occasional depressions or sinks where cavities in the limestones have developed. The internal drainage is very good, although this soil has an exceptionally good water-storage capacity and is very drought resistant. The open porous surface soil absorbs water rapidly, reducing surface run-off to a minimum, and the clay subsoil aids in retaining a large amount of soil water. This soil warms early in spring, and crops get an early start and mature early.

The gravel is not excessive, but it causes wear on tillage implements and is destructive to mowing-machine sickles. This is a factor to be considered in comparing this soil to the nongravelly Hagerstown and Duffield soils.

Murrill gravelly silt loam is devoted to the production of general farm crops, such as corn and small grains. Corn yields range from 30 to 60 bushels an acre, and wheat 12 to 25 bushels. Hay crops are not grown extensively, even though this soil produces good yields. Fruit growing, especially of peaches and apples, is important on this soil near Parnell Knob.

The same crop rotations are practiced on the Murrill and Hagerstown soils. The grass crops, such as clover and timothy, are generally pastured, and then the sod is plowed under for corn.

Murrill gravelly coarse sandy loam.—Murrill gravelly coarse sandy loam is similar to Murrill gravelly silt loam in that the

gravelly materials are underlain by reddish-brown residual clay materials derived from weathered limestones. The surface soil materials are largely transported materials that are derived from sandstone conglomerates, Cambrian quartzites, and aporphylites.

Murrill gravelly coarse sandy loam has a surface soil of brown gravelly sandy loam to a depth of 5 inches. Under virgin forest cover the surface soil is a dark-brown loose granular soil material containing water-rounded gravel. The entire surface soil contains coarse sharp sand which gives the soil a gritty feel. The content of gravel in the surface soil ranges from 3 to 15 percent. From a depth of 5 inches to a depth of 16 inches the material is brownish-yellow sandy loam. This is the highly leached layer which is strongly acid, with a pH value of 5.5. Between depths of 16 and 36 inches the soil grades into reddish-yellow sandy clay, and the influence of the residual clays from limestones begins to be noticeable. Below this layer to a depth of 50 inches is reddish-yellow silty clay loam which contains no gravel. The material in this layer has a pH value of 6.0.

The depth of the gravelly soil materials differs considerably, depending on the degree of slope and the amount of erosion that has occurred, ranging from a few inches to 5 feet. A few areas of Hagerstown silty clay loam too small to be shown were mapped with this soil.

The same general farm crops are grown on this soil as on the Hagerstown soils. The soil, being loose and sandy, warms early in the spring; this is favorable in getting such crops as potatoes and corn started early. The clay subsoil aids in storing large quantities of moisture, which is available to growing crops during dry periods. Corn is better adapted to this soil than any of the small-grain crops and yields from 35 to 60 bushels an acre. Wheat and oats, being shallow-rooted crops, do not yield so well on this soil as on the Hagerstown soils or on Murrill gravelly silt loam. Wheat yields from 10 to 20 bushels an acre and, when fertilized with phosphate, yields 12 to 25 bushels. Clover and alfalfa can be grown successfully on this soil if the acidity is corrected by liming. On some limed fields alfalfa yields from 2 to 3½ tons an acre, and clover 1½ to 2 tons. Several areas of this soil are devoted to orchards, as peaches and apples are naturally well adapted to it.

SOILS DEVELOPED FROM SHALE

The soils developed from shale, commonly called "shale soils", occupy approximately 27 percent of the agricultural land of the county. They range in depth from 8 to 30 inches and are mainly grayish-brown silt loams or shaly loams. They are characterized by loose friable surface soils and subsoils, the subsoils immediately overlying the parent shale beds.

These soils are not deep; therefore they are naturally less productive than the soils developed from limestone. The parent shales are low in lime; therefore the soils are likewise low in lime and are naturally acid in reaction. They have one advantage over the soils developed from limestone in that if the cultivated soils become shallower as a result of erosion, the raw shale materials which are turned up to the surface by the plow are soon weathered physically

into new soil material, whereas if a limestone is exposed on the surface it weathers more slowly than when covered because it is dissolved and leached by the chemical action of the acids contained in the soil water. The shallowness of the soils developed from shale is not so serious a factor in crop production, therefore, as some might think. If the rainfall throughout the growing season is normal, these soils produce reasonably good crop yields, which probably range from 10 to 25 percent below those on the soils developed from limestone.

Because of their shallowness, these soils do not hold sufficient soil water to supply the full moisture requirements of corn during droughty periods, but they are well adapted to growing small grains, hay, grass, and potatoes, as most of these crops mature early in the growing season and escape the effects of droughty periods in late summer. Like the soils from limestone, they are benefited by the addition of lime and phosphorus fertilizers.

The soils developed from shale have been classified as Berks and Gilpin soils. The largest areas of these soils are in a belt extending from the State line southwest of Greencastle northeastward across the county paralleling the Cumberland Valley and ranging in width from 4 to 9 miles. Other extensive areas of Berks soils are in Path Valley and south and east of Mercersburg.

The Berks soils occupy approximately one-half of the more important agricultural land in the county and about 99 percent of all agricultural soils developed from shale. They occupy the higher levels of the main valley floors, which range in elevation from 650 to 1,050 feet above sea level, averaging about 850 feet in the Cumberland Valley, and are about 100 feet higher than the average elevation of the Hagerstown soils. The surface is generally undulating to decidedly rolling and is well dissected by drainage channels (pl. 3, A). Much of the land is steeply sloping. The surface drainage is well developed and in many places is excessive. In places the weathered shale is exposed by erosion on the steeper areas adjacent to streams. These soils are developed from residual materials which have accumulated as a result of the physical weathering of the dark-drab Martinsburg shales.

The Berks soils were originally occupied by wild grasses and forests of oak, hickory, walnut, maple, and scrub pine. At present approximately 70 percent is cultivated, 20 percent being devoted to grass and 10 percent being occupied by hardwoods, mainly oaks, and by some scrub pine. Agriculturally they are important soils even though they are not so productive as the soils from limestone. They are loose and mellow, warm early in the spring, and are easily cultivated. The main crops grown are corn, wheat, rye, barley, clover and timothy, and some alfalfa. A few peach orchards are on the Berks soils, but as a rule these soils are not considered well adapted to orchards because they are too shallow. In general, the Berks soils are best adapted to small grains and grasses. Corn is widely grown, but the yields are frequently reduced by drought. Wheat and rye generally mature before the yields are reduced by the late summer dry periods. Farmers apply lime to the soil when they expect to grow clover. A few fields of alfalfa are grown and produce good yields on heavily limed soils. Crop yields differ considerably



Hagerstown stony silty clay loam furnishes excellent grazing because the soil between the rocks generally is rather deep



A, Duffield silt loam. Note the soft shaly limestone underlying the soil. *B*, Typical topography of Duffield silt loam. South Mountain in background. Photo taken northwest of Duffield looking east.

on the different Berks soils. Fertilizers, especially phosphorus, are widely used. With lime and commercial fertilizers the farmers also apply large quantities of barnyard manure.

Soil erosion is a serious problem on the Berks soils. They are not deep enough to be terraced, but contour cultivation and strip cropping are being recommended for the sloping areas. The steep areas should not be cultivated frequently but should be kept in grass or hay crops, as is being done on many farms.

The Gilpin soils, as correlated, are developed from the yellowish-brown to brownish-purple Waynesboro shales. Only a few areas were mapped, principally on high ridges near Waynesboro and northward toward Tomstown. Only one type and one phase were mapped. The Gilpin soils as mapped and correlated in Franklin County are not typical of the Gilpin soils as developed in central and west-central Pennsylvania. The more typical Gilpin soils are developed from fine-textured acid yellow shales.

Berks silt loam.—Berks silt loam, the deepest of the Berks soils, ranges from 12 to 30 inches in depth to the unweathered shale. The surface soil to a depth of 7 inches is light-brown or slightly grayish brown loose mellow silt loam. Below this to a depth of 12 inches the soil is brownish-drab or brownish-yellow silty clay loam. From a depth of 12 inches downward to the parent shale the soil color is a mixture of yellowish brown, yellow, and pinkish yellow which gives the lower subsoil layer a slightly mottled or spotted appearance. This color appearance is due to iron concretions rather than to imperfect drainage. The lower part of the soil contains numerous subangular fragments of weathered shale which gradually increase in size and quantity to a depth of 30 or 36 inches where the consolidated parent shale is reached (pl. 3, *B*).

This soil occupies the most level areas of the Berks soils and occurs mainly on ridge tops. Erosion is not excessive. Practically all the soil is cultivated. Corn and wheat are the principal crops. Corn yields range from 25 to 50 bushels during years of normal rainfall. Wheat yields range from 15 to 30 bushels an acre when fertilized with phosphate fertilizer. Alfalfa yields from 1 to 2 tons an acre on fields that have been heavily limed. Clover and timothy are the most popular hay crops and yield from 1 to 1½ tons an acre.

A number of small areas of Berks silt loam, which occur mainly on the tops of narrow ridges, are distinguished by an exceptionally well-drained and well-oxidized soil. The parent shale is coarser textured than the average Martinsburg shales. The soil developed from this shale approaches a loam or very fine sandy loam ranging from brown to reddish brown to a depth of 10 inches. Below this, to a depth of 30 inches, the soil is streaked with reddish-brown stains between which is the brown shale material. Because of its loose loamy texture, it is a little better soil for growing potatoes than typical Berks silt loam. Some areas of this soil variation are on the high ridge extending from Turkeyfoot north to Beautiful.

Berks silt loam, colluvial phase.—In many places where areas of the Hagerstown and Berks soils join, the Berks soils occupy the higher elevations and the Berks soil materials have been carried out over the Hagerstown soils by sheet erosion and gravitational soil creep. The soil of these areas, some of which are rather extensive,

has been classified as Berks silt loam, colluvial phase. The surface soil is like that of typical Berks silt loam, but the subsoil is similar to that of Hagerstown silt loam or Hagerstown clay loam. The depth of the Berks soil material ranges from a few inches to 2½ feet. Agriculturally, this soil is better than typical Berks silt loam. It is very well adapted for corn, which yields from 40 to 60 bushels an acre. Other crops, such as wheat, clover, and alfalfa, are also well adapted to this soil.

Other small areas included with Berks silt loam, colluvial phase, are mainly Berks silt loam soil material that has been recently deposited along very small streams or upland drains that rise in the Berks soil areas. The soil in these included areas differs from the Pope soils in that the soil material is all derived from Berks soils, whereas the Pope soils contain a mixture of sandstone and shale materials with the sandstone materials dominating the soil mass. The surface soil is generally brown silt loam to a depth of 12 or 14 inches. Below 14 inches the soil is brown, gray, and yellow mottled heavy silty clay loam. In places the subsoil is not well drained. Most of this land is devoted to mixed pasture grasses which produce high yields because of the good supply of soil moisture.

Berks silt loam, rolling phase.—Berks silt loam, rolling phase, occupies more rolling relief than typical Berks silt loam. Cultivated fields are subject to a little more erosion, and the silt loam surface soil is much shallower and contains numerous small weathered shale particles, ranging in thickness from one-eighth to one-fourth inch, which make up from 10 to 35 percent of the entire soil mass. The surface soil is brown, grayish-brown, or yellowish-brown silt loam to a depth of 7 inches, and below this depth the soil material is yellowish-brown or brownish-yellow silty clay loam, which rests on the parent shale beds at a depth ranging from 10 to 15 inches.

This soil is practically all cultivated, and the same crops are grown as on typical Berks silt loam. The corn acreage on this soil is about 30 percent less than on the typical soil, and the yields are from 15 to 30 percent lower because the soil is shallower and less fertile and has a lower moisture-holding capacity. The acreage of grasses and hay, especially timothy, is larger. The acreage and yields of small grains are about the same on this soil as on the typical soil; but the proportionate acreage of rye is larger because rye yields relatively better than most other crops on the less fertile soils, and that of wheat is smaller.

A number of areas of Berks silt loam, rolling phase, differ from most of the soil in having various quantities of gravel and sandy materials scattered over the surface. In general, such areas have a lower agricultural value than the more typical rolling phase because they occur at higher elevations and near the bases of mountains. Even though this soil is mapped as a silt loam the surface soil is rarely more than 12 inches deep, below which are the parent shales. Much of this land borders the mountain forested areas. About 40 percent of it is occupied by forests which grow along small mountain drains that flow across it. The main crops grown are corn, rye, and hay or grass. Timothy and clover are the main hay crops, and timothy is the most important grass crop. This soil is subject to considerable erosion and for this reason should not be cultivated frequently.

Berks silt loam, heavy-subsoil phase.—Berks silt loam, heavy-subsoil phase, is developed on rather flat areas and around drain heads where surface drainage is not well developed. The surface soil is grayish-brown silt loam to a depth of about 6 inches. Below this the soil material is heavy grayish-brown to bluish-gray and yellow mottled plastic silty clay that is not well drained. Most of these areas are small and occur on the plateau areas northeastward from St. Thomas to the county line. A large number of them are occupied by wild grasses that tolerate wet soils. About 60 percent of the land is cultivated.

Berks shale loam.—Berks shale loam is shallower than Berks silt loam. It occupies rather steep slopes and is subject to rather severe sheet erosion unless covered by vegetation. The depth of the soil ranges from 2 to 5 inches. The soil contains from 40 to 65 percent of weathered shale fragments not more than three-fourths of an inch thick. Only about 35 percent of this soil is cultivated, and the rest is devoted to pasture grasses or supports a growth of oaks and scrub pines. Timothy is the most important tame grass grown on this soil. Rye is the main small-grain crop and produces from 5 to 10 bushels an acre. Corn is grown in some places, but yields are very low, averaging not more than 20 bushels an acre during seasons of normal rainfall. This soil should be kept seeded to pasture grasses, because it erodes severely when cultivated.

Berks shale.—Berks shale is weathered raw shale bedrock covered by only a few inches of soil material. None of this land is cultivated, or ever should be, because it occurs only on very steep slopes and includes under-cut banks along streams. Most of the land is occupied by tree growth, which consists mainly of oaks, scrub pine, and some hickory.

Gilpin shale loam.—Gilpin shale loam is most extensively developed on the tops of high hills north and northeast of Waynesboro. It is developed from yellowish-brown Waynesboro shale.

The surface soil, to a depth of 10 inches, is brownish-yellow shaly loam. The weathered shale material comprises 10 to 25 percent of the soil mass. From a depth of 10 inches to a depth of 30 inches is a mixture of yellowish-brown soil material and weathered shale. The content of shale gradually increases with depth, and at a depth of 30 inches lie the bedded shales. This soil is acid in reaction, the pH value ranging from 5.5 to 6.0.

Gilpin shale loam is about as productive as Berks silt loam but has a better moisture-holding capacity, and for this reason is a better soil for peach orchards. About 85 percent of this soil is under cultivation, and several areas are devoted to orchards, including a few very productive peach orchards. Like all the other soils developed from shale, this soil is low in organic matter. Its productivity can be increased by liming, by applying nitrogen and phosphorus fertilizers, and by plowing under green-manure crops. Erosion, especially in clean-cultivated peach orchards, is a rather serious problem in orchard soil management.

A few areas included with this soil are very stony. They are on steep slopes and are occupied mostly by tree growth. Purple hard shales and stones occur on the surface and throughout the soil, making it unfit for cultivation.

Gilpin shale loam as mapped and correlated in Franklin County is not typical of the Gilpin soils as developed in central and west-central Pennsylvania. The more typical Gilpin soil of those sections is developed from fine-grained yellow shales.

Gilpin shale loam, brown phase.—Gilpin shale loam, brown phase, consists of brown or purplish-brown shaly loam to a depth of about 20 inches. Below this depth the materials are mainly mixed purple shales and soil materials to a depth of 30 inches, where solid shale beds are reached. The surface soil contains from 10 to 20 percent of purple shale fragments. This soil occupies the tops of high ridges or upper steep slopes of ridges. It is generally too shallow for corn but produces fair yields of small grains, such as wheat and rye. About 70 percent of this soil is cultivated, and the rest supports a cover of mixed pasture grasses or trees.

This soil, like the other Gilpin soils mapped in the county, is not typical of the Gilpin soils mapped elsewhere.

SOILS DEVELOPED FROM OLD GRAVELLY DEPOSITS

The group of soils developed from old gravelly deposits, commonly called "gravelly soils", comprises the Lycoming soils; Buchanan gravelly loam; Amberson gravelly loam; Murrill gravelly coarse sandy loam, deep phase; and Holston cobbly sandy loam.

The total area of these soils is approximately 12 percent of the agricultural land of the county. The largest areas are east of Scotland and along the base of South Mountain as far south as Quincy. Other important areas are along the foot of North Mountain, Parnell Knob, and from the vicinity of Fort Loudon southward toward Mercersburg. These soils are derived mainly from transported materials that had their origin in the mountain areas. They are generally rather gravelly, comparatively low in fertility, strongly acid and very low in lime, and have brown or grayish-brown surface soils and brownish-yellow or reddish-yellow gravelly sandy clay subsoils. About 20 percent of the gravelly soils are shallow and are underlain by silty clays that have been derived from materials weathered from the underlying limestones. Most of them range in depth from 3 to more than 30 feet.

These soils are naturally less productive than the soils developed from limestone and shale, but because of their depth and subsoil texture they have a high water-absorption and water-holding capacity and are much less subject to drought than are the soils from shale. Because the gravelly surface soils dry out quickly, grasses do not flourish, but deeper rooting crops grow well where the soil is sufficiently limed and fertilized. Many of the best commercial orchards are on these soils.

The Lycoming soils are the most acid, and the Holston and Amberson soils the least acid. The acidity ranges from pH 4.0 to pH 6.5, averaging about pH 5.5, which is greater than that ordinarily tolerated by clover, alfalfa, and bluegrass. The acidity of these soils can be overcome by heavy applications of lime.

All the gravelly soils are naturally low in organic matter. The addition of green-manure crops or of barnyard manure improves the physical condition of the soil and increases its water-holding capacity and fertility.

These soils are naturally low in nitrogen and phosphorus, which are essential plant-food elements, and they respond readily to commercial fertilizers containing these two elements. Fertilizer applications range from 150 to 300 pounds an acre of 16-percent superphosphate, most of which is applied to small-grain crops, especially wheat. Nitrate fertilizers are used in almost every orchard at rates ranging from 2 to 5 pounds a tree for peaches and from 5 to 10 pounds a tree for apples. The most popular complete fertilizers used are the 2-12-5 and 2-8-5 mixtures.

The Lycoming soils typically have brown surface soils, brownish-yellow subsurface soils, and subsoils ranging from reddish yellow to reddish brown. Both surface drainage and internal drainage are good, and the entire soil mass is well aerated and well oxidized.

Lycoming gravelly fine sandy loam.—The surface soil of typical Lycoming gravelly fine sandy loam consists of brown gravelly silt loam or fine sandy loam to a depth of 6 or 8 inches. The reaction is strongly acid. Between depths of 7 and 18 inches the soil is pale yellowish-brown fine sandy loam. This is the most completely leached layer and is generally more acid than the surface soil. From a depth of 18 inches to a depth of 36 inches the soil changes from yellowish-brown to decidedly reddish brown sandy clay loam which in places is nearly brick red. The clay content increases until the soil mass, even though sandy, is somewhat sticky when wet. Between depths of 36 and 72 inches the soil material consists of reddish-brown or brownish-red gravelly sandy material which is held together by fine silt and clay material. The entire soil mass contains considerable quantities of rounded and subangular sandstone gravel.

About three-fourths of Lycoming gravelly fine sandy loam lies over residual limestone materials which provide good subsoil drainage. These materials lie too deep to be of any value to general farm crops but may be reached by the roots of fruit trees. The most pronounced red subsoil color is generally on the steeper slopes or rounded ridges. Rounded and subangular red, yellow, and gray sandstone gravel, some of which are rather large, approaching the size of cobblestones, occur throughout the soil. In some fields these cobblestones are numerous and have been collected in piles from the fields. Near the mountains the content of coarse gravel and cobblestones increases. The crop adaptations of this soil are discussed under the heading Lycoming cobbly sandy loam, which follows.

Lycoming cobbly sandy loam.—Lycoming cobbly sandy loam is similar to Lycoming gravelly fine sandy loam except that instead of being gravelly the surface soil contains large amounts of well-rounded cobblestones. The content of cobblestones makes this soil more difficult to cultivate than the gravelly soil. Numerous piles of these cobblestones are along the edges of cultivated fields from which they have been collected.

Fully 85 percent of Lycoming gravelly fine sandy loam and about 70 percent of Lycoming cobbly sandy loam have been cleared and cultivated. The uncleared areas are occupied by farm wood lots and forest consisting mainly of oaks, wild cherry, hickory, maple, and other hardwoods. The cleared areas are devoted to general farm crops and fruit orchards. Corn is the most important grain crop, and acre yields range from 20 to 35 bushels. Peaches and apples

are the important fruit crops; some very productive orchards are located on these soils along the base of Parnell Knob. Apples yield from 75 to 150 bushels an acre depending on the seasonal conditions, the care of the orchard, and the age of the trees.

Included with Lycoming cobbly sandy loam are areas, at the base of South Mountain, in which the soil consists of gray or grayish-brown slightly acid gravelly fine sandy loam or sandy loam to a depth of 24 inches. Under forest cover, the 1-inch surface layer is dark-brown or nearly black organic matter or raw humus which lies like a mat over the mineral soil. Immediately under the raw humus is a thin leached layer of gray sandy material. When this soil is brought under cultivation the humus layer disappears. Between depths of 24 and 72 inches the soil gradually becomes pinkish yellow, then yellowish pink, and at a depth of 40 inches is decidedly yellowish red, considerably streaked with red iron stains. Between depths of 36 and 48 inches the fine silt and clay soil materials are slightly concentrated, but the greater portion of the soil material is gravel and sand, with the sand dominating. Below a depth of 30 inches the soil material is strongly acid, having a pH value of 5.0. Large gravel and a few rather large rounded cobblestones occur over the surface and throughout the entire soil mass, and in places beds of heavy white clay underlie this soil and retard subsoil drainage. Some of the better drained areas have a decidedly red subsoil. The soil in the exceptionally red areas is very acid. The more important areas of this included soil lie immediately above areas of Murrill gravelly coarse sandy loam, deep phase, and nearer the mountains.

Lycoming cobbly sandy loam, yellow-subsoil phase.—The surface soil of Lycoming cobbly sandy loam, yellow-subsoil phase, consists of brown or yellowish-brown cobbly or gravelly sandy loam to a depth of 6 or 8 inches. Below this the soil becomes brownish yellow, and between depths of 14 and 28 inches the material is yellow gravelly sandy clay loam. Below a depth of 28 inches to a depth of 40 inches it is generally mottled yellow, yellowish-brown, and blue-gray somewhat sticky sandy clay loam or clay.

This soil occupies rather smooth areas, but the surface drainage is sufficient to provide quick run-off for surplus water after rains. The sandy texture of the soil allows rapid absorption of rain water, and after prolonged heavy rains the soil becomes saturated with water, as the subsoil drainage is not well developed and the excess water does not drain out of this soil so rapidly as it does from typical Lycoming soils or Murrill soils. Fairly large areas of this soil are mapped east and northeast of Scotland, south of Mont Alto, and northeast of Roadside.

This soil is not so well adapted to orchards as the better drained soils. Corn, wheat, rye, clover, and, in some places, alfalfa are grown. Corn yields from 25 to 50 bushels an acre, clover and timothy 1 to 1½ tons of hay, and alfalfa on limed soils 2 to 3 tons.

Lycoming loamy sand.—Near Pond Bank is a rather smooth and level area of Lycoming soil that is nearly pure sand, containing only a small amount of gravel. This soil has been mapped as Lycoming loamy sand. The surface soil is yellowish-gray loamy sand to a depth of about 20 inches. Below this to a depth of 40 inches the sandy soil material contains sufficient clay to give it a sticky feel

when wet. The soil in this layer is considerably streaked or tinted with pinkish red, brownish gray, or yellowish gray. On well-drained knolls this soil layer is nearly solid brick red in color. Below a depth of 40 inches the soil is yellow or pinkish-yellow sand.

This soil is a marginal land type; it is highly leached and strongly acid; and a few areas are imperfectly drained. Most of it is on cut-over land on which the tree growth is mostly pin oak and short-leaf pine.

Lycoming gravelly silt loam.—Lycoming gravelly silt loam is similar to Murrill gravelly silt loam, except that the soil is underlain by the Waynesboro shales instead of limestone and the subsoil drainage is not so well developed. All of this soil is under cultivation. A few small areas are west of Mercersburg Junction, and others are in the southern part of Path Valley.

The surface soil, to a depth of 8 inches, is brown or yellowish-brown mellow gravelly silt loam. Between depths of 8 and 20 inches the soil is brownish yellow, and from a depth of 20 inches to 30 inches the color is reddish yellow to reddish brown and the texture changes to gravelly silty clay loam. Between depths of 30 and 50 inches the soil is reddish-yellow or reddish-brown gravelly silty clay. Below 50 inches the content of gravel decreases, and the content of silty clay increases. At a depth of 72 inches the soil material becomes more yellow or brown, depending on the color of the parent shales, which may be encountered at various depths below 4 feet, the depth being determined by the relief of the shale beds over which the gravelly soil materials have been deposited.

Agriculturally, Lycoming gravelly silt loam ranks with the Murrill soils. Corn yields from 40 to 70 bushels an acre. Apples yield from 100 to 175 bushels an acre, depending on the age of the trees and the seasonal conditions.

A few small areas of a colluvial phase of Lycoming silt loam were included with Lycoming gravelly silt loam in mapping. The surface soil consists of dark-brown silt loam to a depth of about 20 inches, and below this depth the subsoil consists of gravelly sandy loam soil materials characteristic of the Lycoming soils. The silt loam surface soil of these areas recently was washed into the low places from adjacent gravelly soil areas where erosion occurred. Although some of these areas are not especially well drained, most of them are devoted to general farm crops. Corn is the most important crop grown on this land and yields from 40 to 65 bushels an acre.

Lycoming gravelly silt loam, shallow phase.—Lycoming gravelly silt loam, shallow phase, is a shallow Lycoming soil that overlies shale materials. The surface soil is yellowish-brown gravelly silt loam to a depth of 8 inches. Below this to a depth of about 20 inches the soil material is reddish-yellow gravelly silt loam material in which the effect of the underlying shale begins to be noticeable. Below 20 inches the soil material is principally reddish-yellow silt loam which contains no gravel. The red color is an iron stain over the shale soil particles. At a depth ranging from 36 to 40 inches the underlying shales are encountered. The depth of the gravelly material differs considerably, ranging from 1 to 5 feet, but in most places is $1\frac{1}{2}$ or 2 feet. Soil of this phase generally has good surface drainage.

The agricultural value of Lycoming gravelly silt loam, shallow phase, is similar to that of the Berks soils, although crop yields on this soil average about 15 percent lower than those on Berks silt loam. The principal areas of this soil are on the flat tops of high ridges along Conococheague Creek and West Branch Conococheague Creek, along the lower mountain slopes southwest of Mercersburg, near Roxbury, and in Amberson Valley.

Most of this land is cleared and cultivated. Corn is the principal grain crop; and hay, especially mixed timothy and clover, is the second crop, and yields from three-fourths ton to 1 $\frac{1}{4}$ tons an acre.

Buchanan gravelly loam.—Buchanan gravelly loam is yellowish-brown or dark-brown gravelly silt loam or loam to a depth of 6 inches. Between depths of 6 and 24 inches, the material is yellow heavy gravelly silty clay loam, and between depths of 24 and 60 inches it is tough heavy gray and yellow mottled clay. The lower subsoil material is very plastic when wet and very hard and blocky when dry. The surface soil contains considerable quantities of rounded sandstone gravel and shale particles. On the higher areas of this soil, which are near the mountains, a considerable quantity of cobbly rock is scattered over the surface.

Buchanan gravelly loam is extensive in areas near Fort Loudon, along the east base of Parnell Knob, at Upper Strasburg, and along the east base of Cove Mountain southwest of Mercersburg.

Where this soil is mapped along the lower talus slopes of the mountains it represents in many places the upper limit of the better agricultural soils. It is generally a fairly good agricultural soil but is not well suited to orchards because the subsoil is too heavy and is not sufficiently well drained. Corn, wheat, and timothy and clover are the main crops grown on this soil.

Amberson gravelly loam.—Amberson gravelly loam is a brown soil developed from accumulations of transported materials that occur on valley slopes below the talus deposits of the mountains. The main body of this soil is developed from a mixture of soil materials similar to those of the Dekalb, Lehew, and Berks series; the Lehew material gives this soil its brown or reddish-brown color. Most of this soil is mapped in Horse Valley, but a few areas are in Little Cove Valley, where the Cayuga formation has been exposed and has weathered into soil material.

Amberson gravelly loam is rich reddish-brown silt loam or loam to a depth of 12 or 15 inches, although the material in a few areas approaches a sandy loam in texture. Below 15 inches the soil material is mixed brownish yellow and reddish yellow. The subsoil is open and friable. The entire soil mass contains numerous rounded gravel and shale fragments, the gravel being mainly fragments of Indian-red sandstone that is much heavier than the average sandstone. Locally these rocks are called "ironstone." On the higher slopes the gravel and ironstone become larger, and some areas of this soil range from cobbly to almost stony. Rounded yellow sandstone gravel and cobblestones and red shale fragments are also numerous in this soil.

This soil differs from the Lycoming soils in color, being dark reddish brown, whereas the Lycoming soils are yellowish red or reddish yellow. Much of the Lycoming soils overlies limestone and Berks shale, but the Amberson soils overlies the Cayuga formation

only, which consists of dark chocolate-colored or Indian-red interbedded shale and sandstone. The subsoil of the Lycoming soils contains considerable quantities of clay, whereas the texture of the subsoil of the Amberson soil is more nearly like that of its surface soil, averaging a silty clay loam.

From 25 to 40 percent of Amberson gravelly loam is under cultivation. Corn and wheat are the principal grain crops; and timothy and mixed clover and timothy, the main hay crops. This soil is rarely limed or fertilized even though it would respond to such treatment.

Murrill gravelly coarse sandy loam, deep phase.—Murrill gravelly coarse sandy loam, deep phase, is similar to Murrill gravelly coarse sandy loam but is deeper, ranging from 6 to 20 feet to the underlying limestone.

The surface soil, to a depth of 3 inches, is dark grayish-brown to light-brown gravelly coarse sandy loam, which is slightly acid. Between depths of 3 and 10 inches the soil material is brownish-yellow or yellowish-gray coarse sandy loam, also slightly acid. From a depth of 10 to 20 inches the color is yellowish brown, changing at a depth of 20 inches to reddish-brown spotted or streaky coarse sandy clay loam, which is distinctly acid. Below this, to a depth of 70 inches, the soil ranges from yellowish-brown to decidedly yellowish red coarse sandy clay having a high content of sand. The subsoil color varies according to the drainage. In the best drained areas, which are on the slopes and narrow ridge tops, the subsoil is decidedly red, but on the lower slopes or in depressions, which are not so well drained, the subsoil is brown or brownish yellow. The acidity gradually decreases with depth. This material extends downward to more than 20 feet in places but averages about 12 feet. The clay content generally decreases with depth until the clay that has weathered from limestone is encountered. The thickness of the limestone clay is not known but is estimated to be 2 or more feet. This overlies beds of massive limestone. Much very hard water-rounded gravel is on the surface and embedded in the soil. Many of the pieces of gravel are 2 or 3 inches in diameter and probably should be called cobblestones. Most of the gravel is yellow, gray, bluish-gray, or purplish-brown hard sandstone and quartzite. The gravel content of this soil ranges from 5 to 15 percent, the remainder of the material being hard gritty sand, silt, and clay. The content of gravelly material is not sufficiently high to prevent the cultivation of this soil.

The principal areas of this soil occupy rolling ridges southeast and northeast of Scotland, near Fayetteville, and southward to Quincy. An important area occurs southeast of Roadside.

Practically all of this soil is being cultivated. The more important farm crops consist of corn, wheat, clover and timothy, and alfalfa. Corn yields 35 to 65 bushels an acre when fertilized, and alfalfa on areas that are heavily limed produces from 2 to 3 tons an acre. This soil, because of its great depth and its well-drained sandy subsoil, is better adapted to orcharding than to general farming; it is the best soil in the county for growing orchard fruits, and many of the commercial apple orchards are located on it. Areas having red subsoils are much better adapted to orchards than are areas having yellow subsoils. Apple yields range from 125 to 250 bushels

an acre, depending on the age of the trees, the season, and the management of the orchard. This soil is not subject to much erosion, mainly because it is sandy and rain water penetrates it easily.

Holston cobbly sandy loam.—Holston cobbly sandy loam has been included in the group of soils developed from old gravelly deposits mainly because it has agricultural usefulness similar to that of the other gravelly soils and is developed from transported soil materials that had their origin in South Mountain. The surface soil, to a depth of 8 inches, is dark-brown cobbly sandy loam, in which the sandy material is decidedly gritty. Between depths of 8 and 24 inches the soil material is yellowish-brown or brownish-yellow gravelly loam or silt loam. Between depths of 24 and 48 inches is brownish-yellow to reddish-yellow gravelly coarse sandy material. Below 48 inches practically all the material is gravel and sand. Numerous yellow, brown, gray, and purplish-brown water-rounded hard sandstone and quartzite cobbles and gravel are on the surface and embedded in the soil. Many of the cobblestones range from 2 to 5 inches in diameter, and large piles of these stones are in fence corners where they have been collected from cultivated fields.

This soil occupies a terrace position along streams that rise in South Mountain. Practically all of it is cultivated or devoted to orcharding. It is a good farming soil. Corn and small grains are the main cultivated crops. Corn yields from 40 to 65 bushels an acre. Apples and peaches are the most important orchard fruits. They yield from 100 to 200 bushels an acre.

AGRICULTURAL SOILS OF THE MOUNTAIN LANDS

Approximately 9,000 acres of the more level mountain lands are considered agricultural land because they occupy comparatively smooth areas and may be devoted to growing farm crops. Most of the soils are gravelly, cherty, or stony and are weathered from a wide assortment of materials ranging from igneous metarhyolites and metabasalts to sandstones and shales. Most of these soils constitute marginal farm land that might better be devoted to forestry, but they have been cleared and are now used for the growing of either fruit trees or cultivated crops, such as corn and wheat, the yields of which usually are not very high. The soils of this group are naturally the lowest in fertility and the least valuable of all the agricultural soils in the county.

These soils have but few soil characteristics in common, except that all of them are acid and heavily leached and occur at relatively high elevations as compared to the other agricultural soils. They are classified in the Lehew, Amberson, Ashe, Montalto, Chandler, and Leetonia series.

The Lehew and Amberson soils are closely related soils and are most extensive in Horse Valley and Little Cove Valley. On all these soils the main type of agriculture consists of the growing of general farm crops and the raising of livestock, and a few farms are engaged in dairying. Fruit is not grown on these soils. They are seldom fertilized other than with barnyard manure. Liming of the soils in Horse Valley is not practiced, mainly because no limestone is available in the valley, but in a few places in Little

Cove Valley beds of limestone are exposed from which the farmers obtain lime for their soils.

The Ashe soils are developed on the intermountain uplands north and east of South Mountain, at elevations ranging from 1,400 to 1,700 feet. They are open and porous and absorb rather large quantities of water, and the high altitudes and cool nights favor soil-moisture conservation. The surface ranges from fairly smooth to rolling and undulating, and all areas of these soils are generally well drained. A few areas are subject to erosion, and gullies have been cut across cultivated fields in places. In general, the Ashe soils are better forest soils than agricultural soils; the agriculture is generally not especially flourishing, doubtless because of the comparatively low fertility of the soils, but corn yields are fairly high. Most of the farm fields are small, irregular, and generally surrounded by second-growth forest. A large proportion of the cultivated soil is devoted to hay and permanent pastures. A few apple orchards are growing on the Ashe soils, and the yields indicate that a time may come when the production of apples and peaches will be expanded on these soils.

The Montalto soils, as mapped in Franklin County, are not important agricultural soils, and practically all of the land devoted to agriculture is in grass or permanent pasture. These soils should respond to lime and fertilizers. Most of the area of the Montalto soils is occupied by summer cottage sites and golf courses.

Lehew gravelly sandy loam.—The surface soil of Lehew gravelly sandy loam consists of reddish chocolate-colored gravelly sandy loam to a depth of 6 inches. Between depths of 6 and 18 inches it is brown or faintly yellowish brown gravelly sandy loam. From a depth of 18 inches to a depth of 30 inches, it is a mixture of weathered sand, gravel, and Juniata shale material. The gravel is mostly angular hard shale and red, brown, or yellow sandstone, which are strewn over the surface and embedded within the soil.

This soil lies mainly at the bases of mountain slopes where small alluvial fans and slump materials have accumulated. About 50 percent of this land is cleared and is devoted to growing corn, wheat, rye, and hay. Corn yields from 15 to 30 bushels an acre. The uncleared land is in forest, consisting mainly of oaks.

Lehew gravelly sandy loam, shaly phase.—The shaly phase of Lehew gravelly sandy loam has been developed from material weathered from the Juniata formation, which consists of Indian-red shales. The weathered soil material retains the parent-shale color, and when mixed with organic matter becomes a reddish chocolate brown. This soil is shallow, ranging in depth from 4 inches to 2 feet, and consists mainly of loose mellow shaly loam. The soil material contains numerous rounded fragments of weathered shale.

The most extensive areas of this soil are in Horse Valley and Little Cove Valley, where it is closely associated with Lehew gravelly sandy loam. In many places it is also associated with and generally occurs at higher levels than the Amberson soils. The elevation ranges from 900 to 1,500 feet above sea level (9).

Only about 50 percent is cleared, and the remainder is in forest. This is not an especially valuable agricultural soil, but it is cultivated in a number of places. Corn, wheat, rye, barley, and timothy

and clover are the main crops grown; the small grains and hay are the most important.

Amberson shale loam.—Amberson shale loam is developed from soil materials that have been weathered from the Cayuga formation. The color of this soil ranges from grayish yellow to almost Indian red. The soil is a combination of Berks soils and Lehigh soils that are too thoroughly mixed to be separated on the map. In one place the surface soil may be yellowish brown, underlain by a reddish-brown subsoil; and 2 rods away the surface soil may be reddish brown, underlain by a yellow or yellowish-brown subsoil. About the only uniform characteristic of this soil is its texture. The surface soil is shaly silt loam to a depth of 10 inches, underlain by a heavier silty clay loam subsoil to a depth of about 30 inches, which in turn is underlain by the parent shales from which the soil materials have been weathered. These shales range in color from yellow to Indian red.

About 70 percent of Amberson shale loam is cleared and cultivated. The color of the cultivated fields is unusually spotted, ranging from grayish brown to brownish red. Agriculturally, Amberson shale loam may be compared with the Berks soils, as it supports the same general type of agriculture, which is built around the growing of small grains, hay, and some corn. Corn yields range from 20 to 35 bushels an acre, and other crops yield accordingly. The largest areas of Amberson shale loam are mapped in Little Cove Valley and in Horse Valley.

Ashe gravelly silt loam.—The surface soil of Ashe gravelly silt loam consists of dark grayish-brown or brownish-gray loose gravelly silt loam to a depth of 16 inches. Between depths of 16 and 28 inches, the soil material is light-brown or light grayish-brown slightly granular gravelly silt loam or silty clay loam. Below 28 inches and extending to a depth of 60 inches, the soil material is gray or purplish gray and contains fragments of soft and rotten aporhyolite rock. The underlying rocks are purple, blue, and brown aporhyolite or igneous volcanic rock materials. Scattered over the surface of the soil are numerous sharp angular fragments of hard aporhyolite.

Approximately 40 percent of Ashe gravelly silt loam is under cultivation, and the rest is devoted to forest, the tree growth consisting mainly of oaks and chestnut. This soil is generally low in organic matter, rather acid, and deficient in lime, and it responds to heavy liming or heavy fertilizer treatments consisting of either commercial fertilizers or barnyard manure.

The main crops grown on this soil are corn, wheat, rye, timothy hay, and vegetables. Corn yields range from 15 to 30 bushels an acre, and other crops yield accordingly.

A few areas of cobbly silt loam were included with Ashe gravelly silt loam in mapping. Many of the cobblestones in such areas range from 2 to 4 inches in diameter. As it occurs in the same fields with Ashe gravelly silt loam, most of this land is cultivated; but because of the larger stones, cultivation is not so easy as on the gravelly soil. Many fence corners contain piles of these aporhyolite cobblestones that have been collected from the cultivated fields. Crop yields on the cobbly areas are about the same as on the gravelly soil.

Ashe gravelly silt loam, heavy-subsoil phase.—Ashe gravelly silt loam, heavy - subsoil phase, has a surface soil of brownish - gray gravelly silt loam to a depth of 10 or 12 inches. Below 12 or 14 inches, the soil generally is yellow, gray, blue, and brown mottled gray silt clay loam or clay loam that becomes heavier and more plastic with depth. During wet seasons the subsoil drainage is not very good. The surface drainage can be improved by open ditches.

About 30 percent of this soil is cultivated, and the rest is forested, chiefly with oaks, chestnut, and some pine. Corn, wheat, rye, oats, and hay are the main crops. Corn yields are the same as on the typical soil.

Montalto silt loam.—The surface soil of Montalto silt loam consists of brown or reddish-brown loose, mellow, slightly granular, and slightly acid silt loam to an approximate depth of 12 inches. Between depths of 12 and 32 inches the soil is reddish-brown or brownish-red silty clay loam which is rather friable and granular, the granules being rounded instead of sharp-angular as in the Hagerstown soils. Small fragments of greenstone rock material occur in this soil layer. Between depths of 32 and 40 or more inches, the soil is brownish-red to yellowish-red silty clay material possessing no structure or soil granulation. The quantity of embedded greenstone rock material increases to a depth of 40 inches, below which most of the material is partly weathered greenstone.

This soil occupies smooth to gently rolling ridges. All of it can be easily cultivated and should produce good yields of corn or other cereals.

North of Blue Ridge Summit small areas included with this soil are more gravelly—containing 5 to 25 percent of gravel—and have a subsoil of mottled yellow, brown, and gray heavy silty clay. In these areas the lower subsoil is imperfectly drained. These areas occupy slopes from which erosion has removed the finer soil materials, allowing an accumulation of angular greenstone rock fragments. The content of rock fragments ranges from 3 to 10 percent of the soil mass. The soil is shallower than the more typical silt loam. The silt loam surface layer averages about 6 inches in depth. Between depths of 6 and 20 inches, the material is silty clay loam, and the mixture of silty clay and rocks generally occurs below a depth of 2 feet. About 30 percent of this land is cultivated, and the rest is kept in pasture grasses to prevent soil erosion.

Montalto stony loam.—Montalto stony loam lies on steep slopes, where erosion is active and the soil is shallow. Scattered over the surface and embedded in the soil mass are numerous large detached greenstone rocks and boulders, some of which weigh several tons. About half this land is occupied by forest trees, and the rest is cleared and used as permanent pasture.

Chandler gravelly loam.—Chandler gravelly loam is developed mostly from soil materials weathered from sandstone and schist materials. This soil lies on the low mountain slopes east of Penn Mar, northward over the low mountains near Rouzerville, and terminates on the western slopes of Green Ridge Mountains near the old Waynesboro Reservoir. The slope, depth, and gravel content of this soil differ considerably at different places.

The surface soil consists of dark-gray or brownish-gray gravelly fine sandy loam or loam to a depth of about 4 inches. Below this, the soil material is yellowish-gray sandy loam that gradually changes to yellowish brown at a depth of 24 inches. Between depths of 24 and 36 inches the subsoil is brown, reddish-brown, or reddish-yellow gravelly silty clay loam. Below a depth of 36 inches the soil material is decidedly reddish yellow.

This soil resembles Dekalb gravelly loam, except that the subsoil is decidedly reddish brown, whereas Dekalb gravelly loam has a rich-yellow subsoil. It is much more fertile than the Dekalb soils. Approximately 60 percent is under cultivation, and is mainly devoted to orchards consisting of apples and peaches, more peaches than apples being grown. Insofar as farm crops are concerned, Chandler gravelly loam is not very important, mainly because its natural fertility level is rather low. The soil is low in organic matter; it has a tendency to be slightly droughty during prolonged dry periods; and erosion becomes a problem where the soil is cultivated frequently, especially in peach orchards where cultivation is essential to the production of large fruit of good quality.

Leetonia gravelly loam.—Leetonia gravelly loam occupies the more gentle slopes along the bases of the mountains and is primarily developed from the weathered products of hard gray and greenish-gray quartzite conglomerates. The surface soil is gray or brownish-gray gravelly loam to a depth of about 25 inches. The gravel, mainly angular gray fragments of quartzite conglomerates, constitutes about 15 percent of the soil mass. Between depths of 20 and 36 inches the soil material is faintly yellowish gray gravelly sharp sandy loam, which is slightly sticky when wet. Below a depth of 36 inches, to a depth of 60 inches, the soil material is ash-gray sandy gritty material that contains some loamy soil material.

This soil is not important agriculturally, as it is strongly acid, heavily leached, and very low in organic matter. It is open and porous and absorbs large quantities of water which is beneficial to crops. The chief crops grown are miscellaneous garden truck crops and some corn, which receive very heavy applications of complete fertilizers.

A number of areas included with Leetonia gravelly loam differ from the typical soil in occupying steeper slopes, being more gravelly, and containing numerous large angular cobblestones and small stones which are mostly gray or greenish-gray quartzite conglomerates. Not more than 20 percent of this soil is cultivated, and the rest is in forest consisting mostly of oaks and a few pines, none of which is large enough to have much commercial value.

SOILS OF THE FIRST BOTTOMS AND TERRACES

The soils of the first bottoms and terraces are developed from stream-deposited materials consisting of sand, gravel, silt, and clay. They are variable in depth, gravel content, drainage, character of soil materials, and agricultural value. The present drainage conditions have an important influence on the agricultural value of these soils. Some of them are well drained and are very valuable farming soils, others are poorly drained and have little agricultural value,

and some remain wet and water-soaked throughout the year. A wide assortment of soil material has been deposited along the different streams, some of it coming from areas underlain by limestone and some from areas underlain by sandstones and shales; therefore the difference in soil fertility is great. The bottom-land soils derived from limestone materials are generally less acid and more productive than those derived from acid sandstone and shale soil materials.

Few extensive areas of stream-bottom soils exist in the county, mainly because the streams are not flowing on a base level but are actively deepening their channels and depositing but little sediment on flood plains. A large number of small areas of first-bottom and terrace soils occur as narrow strips along the larger streams. The largest of these bottom-land areas is along Conococheague Creek between Caledonia and Scotland, and other fairly extensive areas are along West Branch Conococheague Creek, Conodoguinet Creek, East Branch Little Antietam Creek, and Licking Creek.

In this group are included soils of the Holston, Monongahela, Robertsville, Huntington, Chilo, Warners, Moshannon, Pope, Philo, Atkins, Algiers, and Walkkill series, and muck.

The Holston soils are all good agricultural soils and are utilized for the production of general farm crops. Their depth and moisture-holding capacity make them very drought-resistant. They are, therefore, well adapted for corn. Wheat is not so well adapted to these soils, mainly because it lodges badly during seasons of heavy rainfall. Commercial fertilizers are frequently applied and give good increases in crop yields.

All the Philo soils are low first-bottom soils that occupy rather flat to level areas. In general, they would be benefited by open-ditch surface drainage. The soils are not strongly acid, ranging from pH 5.8 to 6.3. They are not so good agriculturally as the Pope soils because they are not so well drained and are not so loose and mellow. The surface soils do not dry readily after heavy rains because the heavy subsoils and rather high ground-water levels do not let the surface water settle rapidly. Good yields of corn are produced on the Philo soils where surface drainage is provided, and timothy is an important hay crop. Some wheat is grown, but in general the Philo soils are too wet for small grains, although fair yields of wheat are obtained in dry seasons. Bluegrass and timothy are grown for pasture on this soil.

Holston silt loam.—Holston silt loam consists of brown or light-brown mellow silt loam, ranging from 6 to 12 inches in thickness, below which is brownish-yellow or yellow silt loam that in places grades into silty clay loam at a depth of 24 inches. Below a depth of 36 inches the soil material in many places is rather gravelly. In places the yellow subsoil may be mottled with gray, brown, or even reddish brown, depending on the extent to which drainage is developed.

This soil is of small extent, and most of it is mapped along West Branch Conococheague Creek and its tributaries. Most of the areas are rather long and narrow or crescent shaped and occupy the flat or more level portions of low rounded slopes. This soil is well drained and is easily cultivated. It is medium acid, ranging in pH value from 6.0 to 6.5.

Holston silt loam, brown phase.—Holston silt loam, brown phase, differs from typical Holston silt loam in having been developed in part from limestone soil materials. It is well drained and has a mellow light-brown or yellowish-brown silt loam surface soil to a depth ranging from 6 to 15 inches, underlain by yellow or brownish-yellow compact but permeable silty clay loam or silty clay extending to a depth ranging from 3 to more than 7 feet. In places bordering the uplands the subsoil is slightly mottled with gray or reddish brown.

Only a few small areas are mapped, the largest of which are along East and West Branches Little Antietam Creek.

All of this soil is cultivated and is devoted to the production of general farm crops. Corn yields from 30 to 60 bushels an acre, wheat 15 to 25 bushels, and hay 1½ to 2 tons.

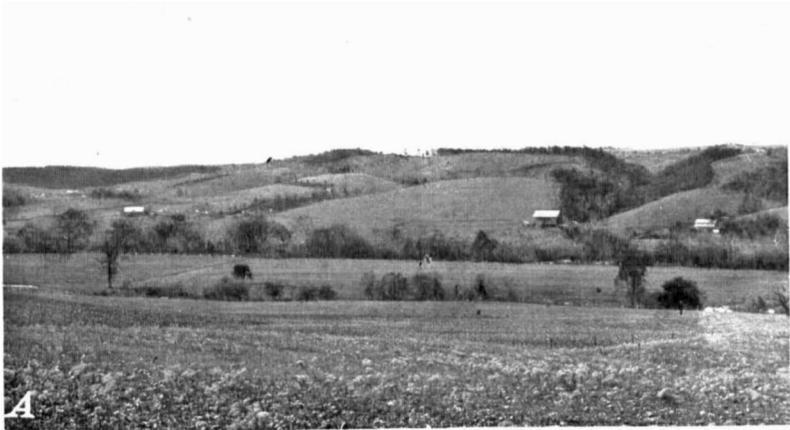
Holston sandy loam.—Holston sandy loam is practically the same soil as Holston silt loam except that it is more sandy and in many places contains fine gravelly material which makes it more porous. Because of its sandy texture it is slightly less productive than Holston silt loam.

A number of areas of Holston sandy loam, which are distinctly gravelly, occupy terrace positions that are generally higher and nearer the mountains than those of Holston silt loam and typical Holston sandy loam. The gravel consists chiefly of water-rounded gray, yellow, and brownish-red sandstone, ranging from one-fourth to 4 inches in diameter. It constitutes from 5 to 25 percent of the soil mass. About 80 percent of this soil is under cultivation, and the rest is forested.

Monongahela silt loam.—Monongahela silt loam is not so well drained as the Holston soils but has better drainage than the Robertsville soils. The surface soil, like that of the Holston soils, is brown or yellowish-brown silt loam to a depth of about 10 inches. This is underlain by a gray, yellow, and brown or rust-brown mottled silty clay subsoil which is not so well drained as the subsoil of the Holston soils.

Monongahela silt loam occupies comparatively level stream-terrace areas along West Branch Conococheague Creek and its tributaries, Back Creek, Conodoguinet Creek, and Cove Creek in Little Cove Valley. This soil has a tendency to be wet during wet seasons and is slow to warm in the spring. It is practically all under cultivation. Corn, wheat, and hay (clover and timothy) are the important crops grown. Corn yields range from 20 to 35 bushels an acre, and wheat from 12 to 20 bushels. Large areas of this soil are used for permanent pastures in addition to cultivated crops.

Robertsville gravelly silt loam.—Robertsville gravelly silt loam has a brownish-gray or gray gravelly silt loam surface soil, to a depth of about 12 inches, at which point the material changes abruptly to yellow, gray, and blue mottled very heavy and tight plastic clay that is poorly drained. The entire soil mass is acid. About 90 percent of this soil is cleared, and about half of the cleared areas are devoted to grass or hay. Some of the better drained areas are cultivated, and such crops as corn, wheat, and timothy hay are grown. Corn yields differ considerably, depending on seasonal conditions. Grain crops give fair yields during dry seasons but may be



A, Typical topography of Berks soils. Note steep wooded slopes along small streams. B, Profile of Berks silt loam.



A, Profile of Leetonia stony loamy fine sand in the Appalachian Valley Ridges. Photo taken on east summit of Broad Mountain on road west of Nancys Saddle **B**, Vegetation on burned over Leetonia soil, consisting principally of pitch pine, scrub oak, and mountain-laurel. Photo taken on road crossing Big Pine Flat.

almost complete failures during wet seasons. Timothy seems to do well, as it tolerates wet soils.

A few areas of this soil mapped southeast of Roxbury are somewhat better drained than the typical gravelly silt loam. The soil in these areas consists of a grayish-brown surface soil, to a depth of about 10 inches, and a subsoil of yellow and brown mottled gravelly sandy clay. Below a depth of 24 inches the soil material is gray and yellow mottled gravelly sandy clay. Strewn over the surface and embedded in the soil mass are numerous water-rounded cobbles consisting of dark-brown, yellow, and gray sandstones.

Huntington silt loam.—Huntington silt loam is rich dark-brown mellow silt loam to a depth of 8 or 10 inches, below which is yellowish-brown heavy silt loam or silty clay loam that gradually becomes lighter with depth. Below a depth of 36 inches the soil in places is slightly mottled with blue and rust-brown spots. Both the surface soil and the subsoil are neutral to alkaline in reaction.

Huntington silt loam occurs only along small streams in the limestone sections. The largest areas are mapped along Falling Spring Branch. This soil is frequently overflowed. It is very fertile and is well supplied with soil moisture. Most of it is devoted to permanent pasture consisting of clovers and bluegrass and other tame grasses. Corn and truck crops are grown on the cultivated areas. Corn yields range from 40 to 80 bushels an acre.

Chilo silty clay loam.—Chilo silty clay loam is developed from a mixture of transported materials, derived from sandstone, limestone, and shale areas, which are deposited on rather low terraces and first bottoms. The soil is subjected to subsoil seepage water that comes from higher limestone beds and contains lime carbonate materials which give the soil an alkaline reaction. The surface soil is nearly black heavy granular neutral silty clay to a depth of 10 inches. Between depths of 10 and 36 inches the soil material is rust-brown, yellow, and very dark gray splotched heavy clay that is alkaline in reaction. Scattered over the surface and embedded in the soil mass are hard yellow and brown cobblestones that range in diameter from 2 to 6 inches, but these are not numerous enough to interfere with tillage. The surface drainage is fair, but open ditches constructed to intercept the run-off water from higher slopes would be desirable. The subsoil drainage is not especially good.

The largest areas of this soil are mapped southeast and south of Fort Loudon. The heavy texture of the surface soil, which is sticky and somewhat plastic when wet, makes cultivation difficult. Most of this soil is devoted to permanent pasture, but small areas are cultivated. Corn is the important grain crop and yields from 20 to 35 bushels an acre. Hay yields from 1 to 1½ tons. Because of its heavy texture this soil is better adapted to pasture or hay than to cultivated crops.

Warners silt loam.—Typical Warners silt loam consists of a loose granular silt loam surface soil to a depth of about 12 inches. When wet it is black, but when dry it is dark gray. Below a depth of 12 inches, to an average depth of 35 inches, is a layer of very loose ash-gray material, which is largely lime carbonate, is strongly alkaline, and geologically may be called marl. When dry it is nearly white. Its thickness ranges from a few inches to as much as 10

feet. Below this is yellow or brownish-yellow slightly mottled silty clay which contains very little gray lime carbonate but which overlies massive limestones. The lime material is an accumulation or precipitation of lime carbonate from lime-charged ground water coming from limestone beds.

This soil occurs only along depressions or small drains immediately below springs in the limestone area. Most of it is mapped near Greencastle, Marion, and Chambersburg. A small area is mapped in the shale section northwest of Pinola, where spring water from limestone beds flows through the alluvium and has saturated it with lime materials, giving it an alkaline reaction.

Warners silt loam is generally cultivated, and corn and wheat are the main grain crops. Alfalfa is an important hay crop on this soil and yields from 1½ to 3 tons an acre.

Included with Warners silt loam are areas in which the soil is black granular silty clay to a depth of about 20 or 24 inches. Below this to a depth of 30 inches, it is a black or brownish-black organic muck and mineral soil mixture that when handled breaks into granules ranging from one-eighth to three-fourths of an inch in diameter. Below this is yellow, blue, and rust-brown very plastic clay. The entire surface soil and subsurface soil are alkaline and high in organic matter. Such areas occupy depressions in the limestone sections. The surface soil has fair drainage, but the subsoil is imperfectly drained, mainly because of a constant underflow of water from springs that rise from the limestones above areas of this soil. Only a few areas are mapped, the largest being at the southwestern edge of Guilford Springs. This soil is used primarily for the production of truck crops, consisting of lettuce, cabbage, celery, beets, spinach, cauliflower, and other market vegetables. The soil is naturally very productive, but commercial fertilizers, especially nitrogen, are used to forcé the growth of truck crops.

Moshannon silt loam.—Moshannon silt loam, to a depth of 12 inches, is rich-brown or reddish chocolate-brown loose silt loam underlain by a brown sandy loam subsoil to a depth of 36 or more inches, and this, in turn, is underlain by gravelly sandy material. In places the subsoil is grayish-brown and cherry-brown mottled material. The water table may be at any depth from 4 to 8 feet.

This soil is mapped along Conodoguinet Creek from the head of Horse Valley to the point where the creek leaves the county. From Roxbury downstream to the county line practically all the typical Moshannon silt loam is under cultivation.

Gravelly areas of Moshannon soil occur between the stream and areas of Moshannon silt loam. These gravelly areas are low and are frequently inundated by water. The surface soil, to a depth of 8 or 10 inches, is rich-brown gravelly fine sandy loam. Below this the soil is generally very gravelly. The water table lies at a depth ranging from 3 to 4 feet.

Somewhat sandier areas of Moshannon soil are mapped along Licking Creek. These areas have a reddish-brown very fine sandy loam surface soil to a depth of about 12 inches. Between depths of 12 and 24 inches the soil material is variable in texture, ranging from silt loam to fine sandy loam, and is a little lighter in color than the surface soil. Between depths of 24 and 60 or more inches, the

subsoil is light chocolate-brown material ranging in texture from loamy fine sand to sand. The entire soil mass is very mellow and friable. The depth of the soil material ranges from 5 to 10 or more feet. This soil occupies a high-bottom position and is seldom overflowed, but it is not above flood level.

Corn is the chief crop on Moshannon silt loam, and clover and timothy are grown in connection with wheat where crop rotations are practiced. Corn yields from 25 to 80 bushels an acre.

Pope fine sandy loam.—The surface soil of Pope fine sandy loam is brown or grayish-brown sandy loam to a depth of about 12 inches, below which is yellowish-brown or yellow silt loam to a depth of 36 or more inches. Both the surface soil and the subsoil contain gritty gravelly and sandy materials which nowhere are in sufficient quantity to interfere with cultivation. This soil is mapped along the smaller streams and is subject to overflow but has good surface drainage. About 60 percent of it is under cultivation to general farm crops, chiefly corn and hay, and the rest is occupied by brush and trees.

Pope silt loam.—The surface soil of Pope silt loam consists of brown or grayish-brown silt loam or heavy silt loam from 8 to 14 inches thick, and the subsoil is yellowish-brown heavy silt loam or silty clay loam. In places where the subsoil is not so well drained, the lower part of the subsoil, below a depth of 3 feet, is slightly mottled with gray, yellow, and rust brown.

Pope silt loam is derived largely from materials washed from Berks and Dekalb soils. The largest areas of this soil are mapped along West Branch Conococheague Creek and its tributaries, where the bottoms are wider and more level, and other areas are mapped along Conococheague Creek. The relief ranges from rather level to flat, but, as a whole, the soil has fair to good drainage. As a rule, Pope silt loam is mapped along larger streams than those along which Pope fine sandy loam lies. It spreads well out into the valley, whereas Pope fine sandy loam is nearer the mountains. Pope silt loam is generally a more productive soil than Pope fine sandy loam.

Practically all this soil is under cultivation. Small strips bordering streams generally support a tree growth consisting of maple, elm, willow, poplar, and other trees. General farm crops are grown. Corn yields range from 35 to 50 bushels, and hay, mostly timothy and some clover, yields from 1 to 1¾ tons an acre.

Philo silt loam.—Philo silt loam includes soil derived from materials washed from the Berks, Dekalb, and Lycoming soils. The surface soil, to a depth of about 8 inches, ranges from brown or grayish-brown to brownish-gray silt loam, below which is yellow, blue, and brown mottled silty clay loam extending to a depth of 3 or more feet. With increase in depth the soil is heavier and more compact or plastic. Most of this soil is mapped along streams that rise in the western part of the county. Some of it lies near the stream channels, and some lies a distance back from them where surface drainage is not well developed.

About half of the land is cleared and cultivated, and the rest supports a tree growth consisting of willow, ash, and oaks. The cultivated areas are devoted to grass, hay, or corn. Timothy is the most important hay crop.

Philo silt loam, dark-colored phase.—Philo silt loam, dark-colored phase, generally lies back from the main streams in low areas bordering the terraces or uplands. The surface drainage is rather poor during wet seasons, and the water table is generally within 4 feet of the surface. The dark color is due to accumulated organic matter in the surface soil. Only about 40 percent of this soil is cultivated, about 40 percent is in permanent pasture grass, and 20 percent supports a growth of willows, swamp alder, and scrubby pin oak.

Included with Philo silt loam, dark-colored phase, are areas of somewhat heavier soil in which the surface soil is very dark gray or nearly black slightly granular soil material to a depth of 6 inches. Below this to a depth of 20 inches the soil material is slightly lighter colored clay loam. Between depths of 20 and 40 inches the material is yellow, gray, blue, and rust-brown mottled clay loam, below which is heavy plastic clay. The entire soil is acid, ranging from pH 6.0 in the surface soil to 5.8 in the subsoil. Such soil occurs as a bottom-land soil along East Branch Little Antietam Creek. The transported soil material is derived from a mixture of materials washed from sandstone, quartzite, and schist materials, and some wash from limestone soils is included in a few areas. This soil is developed on flat areas which are not well drained. Most of it is cleared, but it is not extensively cultivated, about 60 percent being devoted to pasture grasses. Some corn and clover and timothy hay are grown on the better drained areas.

Philo gravelly loam.—Philo gravelly loam is derived primarily from materials washed from quartzite, schist, and aporhyolite and soil materials developed from them. The surface soil is brownish-gray loam or very fine sandy loam to a depth of 12 inches, where the soil changes abruptly to rust-brown, gray, and yellowish-gray mottled or splotted fine sandy clay loam. This soil occupies rather broad flat areas and is not very well drained. Corn, wheat, and pasture grasses are grown. Corn yields from 35 to 65 bushels an acre and wheat from 12 to 25 bushels. Timothy and clover are grown as hay crops, and bluegrass and timothy as pasture grasses.

The main areas of this soil are along Conococheague Creek southeast of Scotland, and smaller areas are south of Shippensburg and along East Branch Little Antietam Creek. This soil could be improved by the use of open-ditch surface drainage.

Philo gravelly loam is considered to be slightly better agriculturally than Philo silt loam because it has better surface drainage and warms a little earlier in the spring and therefore crops get started earlier.

Atkins clay loam.—Atkins clay loam represents the most poorly drained first-bottom land, the soil of which is derived from sandstone and shale soil materials. The 8-inch surface soil consists of dark-gray or brownish-gray mottled clay loam or silty clay loam. Below this is a heavy plastic blue, gray, yellow, and rust-brown clay subsoil which is very poorly drained. It is frequently overflowed by flood waters, and the water table is rarely more than 20 inches below the surface. This soil would be difficult to drain because of its low-lying position. It is strongly acid.

Most of Atkins clay loam occurs near the streams that rise in the western part of the county. Most of it supports a tree growth con-

sisting of pin oak and other trees that grow on wet soils. A few cleared areas support a growth of wild grasses.

Algiers silt loam.—Algiers silt loam is derived from materials washed from the soils developed from limestone and gravelly deposits and from the soils of the mountain areas, the older deposits coming from the adjoining Duffield soils and the soils developed from gravelly deposits. The surface soil, to a depth of about 6 inches, varies considerably in texture, ranging from silt loam to very fine sandy loam, but it is predominantly yellowish-brown silt loam that is neutral or alkaline in reaction, resembling the Huntington soils. Between depths of 6 and 24 inches the soil material is yellowish-brown, brown, and grayish-brown splotched or stippled silt loam. Below this, to a depth of 42 inches, is black or very dark gray silty clay. This material seems to represent the surface soil of the original bottom land that was developed before the land was put under cultivation. This layer is slightly acid. Between depths of 42 and 60 inches, the material is a mixture of gritty sandy clay and gravel, which with increase in depth becomes nearly all gravel. The color of this material is mottled gray, yellow, and brown. The reaction of the deeper material is slightly acid, gradually increasing in acidity with increased depth.

Most of the soil is developed along East Branch and West Branch Little Antietam Creek. The relief is rather level to almost flat. Surface drainage is good, but the water table frequently rises to within 3 feet of the surface during wet seasons. All of this soil is subject to frequent overflow, as it lies only about 5 or 6 feet above the normal stream level.

Practically all of this soil is cleared, and most of it is devoted to tame-grass pasture and to hay. The soil is very fertile and produces a heavy growth of bluegrass, which is a valuable pasture grass. Cultivation of this soil is restricted by the frequent overflow, but some areas that are cultivated produce corn yielding from 50 to 70 bushels an acre. This soil is more valuable for pasture, as the grass growth is heavy.

Wallkill silty clay loam.—The surface soil of Wallkill silty clay loam consists of very dark gray or nearly black highly granular silty clay loam or clay loam to a depth ranging from 6 to 10 inches. Below this is a layer of black muck material that contains possibly 40 percent of mineral soil material. The depth of this black muck layer ranges from a few inches to as much as 2 feet in some places. Below the muck layer is a layer of mineral soil consisting of brownish-gray sandy clay. Below a depth of 4 feet is a considerable quantity of fine gravelly material, and at a depth of about 6 feet the material is mostly a mixture of sand and gravel. Normally, the water table is 4 feet below the surface. The surface deposit that overlies the muck layer has been washed in from the nearby areas of Montalto and Leetonia soils. When this soil is well saturated with moisture, the soil mass quivers and shakes when walked over and a tractor or heavy truck probably would become mired if driven over it. The entire soil is strongly acid.

This soil is developed in a high mountain basin on South Mountain near Monterey. It was originally a swampy area which has been cleared and tile drained. The total area is only 128 acres. It is now

devoted to market vegetable crops. It is naturally strongly acid, and heavy liming (from 3 to 6 tons an acre) is recommended, in addition to nitrogen, phosphorus, and potassium fertilizers, for high production.

Muck.—A number of pockets of true muck soils, most of which are less than 200 feet across, too small to be mapped, occur in Bear Valley. The only area mapped is in the southern end of Horse Valley. The muck ranges in depth from 2 to 8 feet. The land has no agricultural value at present, but it may be a source of muck materials, if such materials are needed locally to supply greenhouses or for specialized floricultural purposes.

SOILS SUITABLE ONLY FOR FOREST

It is estimated that Franklin County contains approximately 108,000 acres of forest land, practically all of which occupies mountain areas and may be considered nonagricultural land. In addition, recent surveys (6) show that there are approximately 8,393 acres of idle cleared land, most of which is either cut-over mountain land or abandoned farms bordering forested areas. Thus a total of more than 116,000 acres of land should be classed as nonagricultural land or forest land.

The forest land is divided into two main sections—the forest land of South Mountain, and the forest land of the Appalachian Valley Ridges which includes all the mountains in the western part of the county. A large number of different geologic formations have been weathered into soil material from which the soils in the forested areas have developed. Among these are metabasalts, aporphylites, schists, quartzites, sandstones, conglomerates, shales, and limestones. All these different materials have been exposed to weathering and soil formation for long periods of time. The soils have developed under forest, and have been subject to acid podzolic leaching.⁷

The common or characteristic profile of these soils in the county is as follows:

(1) A thin layer of raw humus or very dark brown partly decomposed organic material lies over the mineral soil like a mat.

(2) Below the organic mat is the mineral soil which is subjected to the acid podzolic leaching. In most of the soils the surface soil has been leached until it has begun to turn gray, and in many places it consists of an ash-gray leached layer that ranges in thickness from one-eighth inch to 14 inches.

(3) Below the leached gray layer is a zone in which some of the organic acids and minerals seem to have been deposited, precipitated, or absorbed on the surface of the mineral soil materials. This zone ranges from one-eighth inch to 4 inches in thickness and from cinnamon brown to coffee brown in color.

(4) Below the coffee-brown zone is the little leached but partly weathered parent rock materials in which are most of the forest tree roots. No sharp line of demarcation separates the brown layer from the parent soil materials.

⁷ Podzolization is a process of solution and translocation wherein the alkali and alkaline earth elements are leached from the soil and the sesquioxides, colloidal clay, and organic matter may be translocated from the upper, or A, horizon, to the B horizon. The A horizon becomes highly siliceous, and the B horizon is enriched with sesquioxides and colloidal clay.

The general characteristics of the forest soils in this county are like those of most forest soils in the northeastern part of the United States, but there are many local variations, due to differences in parent soil materials, relief, and length of time these materials have been exposed to weathering and soil formation. Many of the rocks have different colors, different mineral constituents, and different degrees of resistance to weathering. Erosion has been continually wearing down the land surface and has naturally interfered with soil development; consequently the forest soils differ considerably in depth, color, texture, degree of leaching, and natural adaptability to different types of vegetation, but they all possess some of the characteristics of the generalized soil profile.

Several large areas of forest land have been burned over two or three times within the last 30 years. On these areas not only the forest trees and forest litter are burned but generally the organic layer of raw humus is also burned, leaving the surface of the mineral soil bare and scorched. The burned-over surface soil is subjected to severe leaching and erosion until new forest litter has accumulated, and the mineral or ash residues are readily flushed down into the subsoil by heavy rains. With the loss of the layer of raw humus and the fine soil materials from the surface soil, the soil becomes more droughty, and its fertility is reduced to a very low level. Where a new forest is growing up, a layer of raw humus accumulates rapidly, but it decomposes slowly, and podzolic leaching has rapidly developed a sterile highly acid gray leached soil layer. The estimated reduction of the growth of trees on burned-over land is from 40 to 60 percent.

The natural forest on South Mountain includes a thicker stand of pine than that on the Appalachian Valley Ridges in the western part of the county. The parent soil materials in the two mountain sections are different, but whether such differences will explain the difference in forest flora is problematic.

The virgin forest consisted primarily of hardwoods, mainly oak, hickory, and chestnut. (Most of the chestnut trees have recently been killed by the chestnut blight, or bark disease.) Among the hardwoods is a scattered stand of pine that ranges from 2 to 10 percent of the entire forest stand. Some of the mountain valleys support a growth of birch and hemlock. The undergrowth is principally huckleberry, low blueberries, and mountain-laurel.

Leetonia stony loamy fine sand.—Leetonia stony loamy fine sand is the oldest and most thoroughly leached of the forest soils in the mountain section. Typically this soil has over the surface a dark-brown or almost black humus layer ranging in thickness from a thin film to 2½ inches, over which is the undecomposed leaf litter. Below the raw humus layer is the leached layer of mineral soil, consisting of light-gray or nearly white loamy fine sand or very fine sandy loam that ranges in thickness from one-half inch to 14 inches and generally averages about 3 inches. The deeper leached layer occurs on the north or east slopes or on rather flat areas where the temperatures are low or where erosion has been less active in reducing the depth of the surface soil. During fall and winter months the prevailing westerly winds frequently become rather strong and blow the leaves off the western exposures of high mountains, reducing the

accumulation of organic matter and raw humus and subjecting the soil to wind drying. These conditions retard the speed of the podzolic leaching. Below the leached gray layer is the coffee-brown layer, or zone of accumulation or enrichment, in which organic materials or iron and aluminum colloidal materials have a tendency to accumulate on the surfaces of the soil particles. This layer is rather indefinite but ranges from 1 to 3 inches in thickness, below which is the partly weathered parent soil material consisting of a mixture of brownish-yellow or yellow silty sand and sandstone material. This material extends to a depth of about 36 inches, below which is the parent soil material, consisting of a bright-yellow mixture of various grades of sand and stones extending to a depth of 5 or 6 feet (pl. 4, *A*). The parent rocks are primarily the yellow or brownish-white Tuscarora sandstones. Scattered over the surface and through the soil mass are angular sandstones ranging from 2 to 14 inches in diameter.

Most of Leetonia stony loamy fine sand is mapped on Broad Mountain, North Mountain, and Rising Mountain. The dominant vegetation consists of scrub oak, mountain-laurel, and huckleberry (pl. 4, *B*). Other tree growth consists of rock oak, red oak, scarlet oak, white pine, pitch pine, table mountain pine, and sassafras. Some of the less abundant undergrowth consists of chicken grapevine, Virginia creeper, and black locust. The present forest growth is of very little commercial value.

Leetonia stony loamy sand.—Leetonia stony loamy sand, which occurs on South Mountain, has the same general characteristics as Leetonia stony loamy fine sand, but is developed over Cambrian quartzite conglomerates and Antietam sandstones. Areas of Leetonia stony loamy sand generally occur on the flat tops of mountains and are mapped on Sandy Ridge and on Big Pine Flat. The general elevation ranges from 1,800 to 2,100 feet.

The surface of this soil is covered by a very dark brown or black raw humus layer that ranges in thickness from one-half inch to 2½ inches, over which is the undecomposed forest litter consisting of leaves and broken twigs. Below the raw humus layer is the gray leached layer, which ranges in thickness from one-half inch to 10 inches and generally averages about 3 inches. The soil material of the gray layer to a depth of 4 or 6 inches consists of a grayish-white coarse sharp-angular sand derived from quartzite rock materials. Below the gray layer is a coffee-brown zone, ranging in thickness from one-half inch to 3 inches, in which organic acids, iron and aluminum sesquioxides, and colloidal clays have accumulated and been deposited on the outside surfaces of the grayish-yellow sand particles. This brown layer varies in concentration and does not extend parallel with the surface of the ground but varies in depth, and in places where drainage water follows the path of least resistance, it extends, in fingerlike projections, into the lower soil materials. Below the coffee-brown or chocolate-brown horizon is the weathered soil material in which colloidal material and other fine silt and clay particles have accumulated, forming a brown or grayish-brown gritty coarse sand and silty clay mixture which extends to a depth of about 24 inches. Below a depth of 24 inches is the parent soil material, consisting of gray or brownish-gray sharp coarse sand and angular quartzite rocks.

The forest vegetation on this soil consists mainly of scrub oak together with some scarlet oak, rock oak, red oak, pitch pine, and white pine and a heavy undergrowth of mountain-laurel and huckleberry.

This is the poorest soil on South Mountain, and probably 100 years would be required for the fastest growing tree to reach a diameter of 12 inches. This soil at present has little value as a forest soil and if cleared would be practically barren and desolate. If it is protected from forest fires for a half century or longer, however, it may be capable of supporting a stand of pitch pine, chestnut (rock) oak, or chestnut, and would retain water far better than it does at present.

Leetonia stony coarse sandy loam.—Leetonia stony coarse sandy loam is developed from a very hard greenish-gray quartzite conglomerate, which breaks through and not around the quartzite crystals. Freshly broken surfaces have glittering or sparkling clusters of rose-pink, pale-blue, and yellow crystals.

This soil has a shallow surface accumulation of raw humus ranging in the thickness from one-half to 2½ inches. Below the raw humus is the leached gray layer consisting of ash-gray sand which contains a small quantity of silty material and in few places exceeds 3 inches in thickness. A brown layer may or may not occur below the leached layer, but where present it ranges from a thin film to 1½ inches in thickness, averaging about three-fourths inch. The mineral is gray coarse sand, the particles of which are covered by a film of grayish-brown or brown material. Below the leached and brown layers are the parent soil materials consisting of gray or brownish-gray coarse gritty sharp sand and angular quartzite conglomerate stones. The soil contains considerable quantities of stone, most of which are only partly exposed.

Areas of Leetonia stony coarse sandy loam are mapped near Monterey and northward at elevations ranging from 1,500 to 1,800 feet. The tree growth is mainly rock oak, scrub oak, red oak, poplar, and pitch pine.

Dekalb stony fine sandy loam.—Dekalb stony fine sandy loam has only a very thin accumulation of organic material over the surface. The surface layer of mineral soil is only slightly leached and is only lightly sprinkled with gray sandy materials. The gray layer in few places exceeds one-eighth inch in thickness. The surface soil consists of grayish-brown or brownish-gray stony fine sandy loam to a depth of about 2 inches, below which the material is yellowish-brown sandy loam to a depth of about 12 inches. Immediately below this is the parent soil material, consisting of brownish-yellow or yellow sandy loam to a depth of 36 or more inches. Scattered over the surface and embedded in the soil mass are numerous brown and grayish-brown rock fragments, consisting mostly of Tuscarora and Juniata sandstone materials.

This soil occupies high mountain slopes, at elevations ranging from 1,400 to 2,200 feet, and is generally from 2 to 5 or more feet deep.

Most of this soil is good forest land and supports a good stand of growing timber. The dominant tree growth consists of rock oak and red oak with an undergrowth of mountain-laurel, huckleberry, and blueberry. Other trees growing on this land are chestnut, scarlet oak, birch, red maple, black oak, scrub oak, black gum, sassafras, and black locust.

Dekalb gravelly loam.—Dekalb gravelly loam is developed mostly from a mixture of sandstone and shaly materials. It occurs on the lower mountain slopes or midway up the mountain sides where the land is not exceptionally steep. The elevation of this soil ranges from 1,000 to 1,800 feet.

The surface soil is grayish-brown or yellowish-brown gravelly loose mellow loam to a depth of about 6 inches. Below this depth the soil material is brownish yellow and grades into bright-yellow material at a depth of 20 inches. Below a depth of 20 inches is the yellow gravelly and shaly parent soil material that continues downward to a depth ranging from 3 to 8 or more feet. The gravel consists principally of yellow, brown, and gray sandstones ranging in size from small gravel to fragments 8 inches in diameter; a few larger stones have rolled down on the gravelly soil from the higher mountain areas.

Dekalb gravelly loam is one of the better forest soils and comprises about half of the mountain forest land in the western part of the county. This soil occupies steep slopes, but it is open and porous and absorbs large quantities of rain water. In general, it contains considerable quantities of angular rock and shale materials. Hardwood forests in which white and red oaks are the most abundant trees are dominant on this soil. Rock oak is the dominant tree on the higher areas, and other trees are scarlet oak, chestnut, birch, maple, scrub oak, black gum, sassafras, black locust, and closely related species. The undergrowth is practically all mountain-laurel, huckleberry, and blueberry. Most of the forest trees are rather young, ranging in age from 15 to 35 years. Most of the forested areas have been cut over a number of times, and a few areas have been burned over by forest fires.

Included with this soil as mapped are a few areas of rather brown gravelly soil, the surface soil of which is brown material that has been influenced by Lehigh soil material that has slumped over the Dekalb soil. The largest area is mapped along the western slope of Timmons Mountain 5 miles north of Fort Loudon.

Also included with Dekalb gravelly loam are areas in which the soil has practically the same profile characteristics as the typical gravelly loam except that it contains only a small amount of gravelly material and is practically all derived from the yellow or drab-colored shales. The soil in such areas is not so deep and does not retain so much soil water as the typical gravelly loam, and for this reason it is not such a good forest soil as Dekalb stony fine sandy loam or typical Dekalb gravelly loam. These areas are along the lower mountain slopes at elevations ranging from 1,000 to 1,700 feet above sea level. The surface soil to a depth of about 6 inches is grayish-yellow or brownish-yellow shaly loam. Below this layer to a depth of 36 inches is the yellowish-gray shaly loam parent material, below which the material is practically all coarse angular yellowish-gray shale material. This land supports more scrub pine or pitch pine than any other area of soil in the Dekalb series, but the growth of hardwoods does not seem to be very vigorous. Oaks are the dominant trees.

Areas of gravelly silt loam on South Mountain developed mostly from a mixture of yellowish-brown or grayish-brown sandstone and

shaly schist materials are also included with Dekalb gravelly loam. No raw humus layer covers this land. The surface soil, to a depth of 4 inches, is brown or yellowish-brown gravelly silt loam showing only a faint gray color. Below a depth of 4 inches is brownish-yellow gravelly silt loam extending to a depth of approximately 20 inches, where the soil material is yellowish-brown or grayish-brown fine sandy to gritty silt loam. A few bodies have a decidedly brown subsoil. These gravelly silt loam areas are developed on rather smooth mountain land and are comparatively well adapted for forest. Their elevation ranges from 1,200 to 1,700 feet.

Dekalb stony coarse sandy loam.—Dekalb stony coarse sandy loam is developed mainly from a mixture of Antietam sandstone and quartzite rock materials. Only a thin layer of raw humus covers this soil, being practically absent over 50 percent of its area and in few places exceeding 1 inch in thickness. The podzolized layer is more pronounced, being from one-sixteenth to three-fourths of an inch thick, and it is brownish gray. The coffee-brown zone is lacking, and immediately below the gray surface layer is the grayish-brown or yellowish-brown coarse sandy loam to a depth of 14 inches, below which is the brownish- or yellowish-gray sharp gritty silty sand to a depth of 36 or more inches. This material when wet has a sticky feel, indicating that the sand grains are coated with fine clay and colloidal films. In place of a normal yellow Dekalb subsoil, this soil has a brownish- to yellowish-gray subsoil. Angular fragments of quartzite sandstone occur throughout the entire soil mass.

Dekalb stony coarse sandy loam occurs at an elevation ranging from 1,400 to 1,900 feet. Numerous areas are mapped in the intermountain section of South Mountain. The soil material is generally rather deep, and the land is well forested with a thick stand of thrifty young oaks, ranging in age from 20 to 40 years.

Included with Dekalb stony coarse sandy loam as mapped are small areas of soil along the lower eastern slope of Rocky Mountain and along the lower northern slope of Snowy Mountain, developed from materials weathered from rather soft purple arkose, composed largely of fragments of pre-Cambrian rhyolitic rocks and quartzites. The soil in such areas has a dark organic layer, ranging in thickness from a mere trace to as much as 1 inch, over the mineral soil. The grayish-brown leached layer is faintly developed but in few places exceeds one-half inch in thickness. The mineral soil, to a depth of 6 inches, is a grayish-brown coarse sandy material. Below a depth of 6 inches, to a depth of 30 inches, is a purplish-brown mixture of coarse sand and sticky clay in which the surfaces of the soil particles have developed a yellowish-brown color, below which the subsoil material gradually changes to a more purplish brown. The parent materials are purple to brown arkose. Scattered over the surface and embedded in the soil mass are large blocks of purple Antietam sandstone that have rolled from the higher mountain areas. This soil is generally well supplied with moisture but has good drainage. It lies at elevations of from 1,350 to 1,600 feet and occupies a benchlike position. The tree growth consists of red oak, white oak, black oak, tulip poplar, white pine, shortleaf pine, pitch pine, red maple, and black birch. The forest is generally thrifty, with trees ranging from 30 to 80 years old.

Dekalb stony fine sand, compact-subsoil phase.—Dekalb stony fine sand, compact-subsoil phase, is developed from a mixture of talus materials that have accumulated at the bases of mountains. Over the surface of the soil is a thin accumulation of raw humus ranging in depth from one-half to three-fourths inch. Under the raw humus is a thin leached layer ranging from one-eighth to one-half inch thick and consisting of dark drab-gray loamy fine sand. Between depths of 1 and 18 inches is dark-drab or drab loamy fine sand faintly splotched with yellow and bluish gray. Below a depth of 18 inches to a depth of 38 inches is compact heavy brownish-yellow and gray sandy clay streaked with rust brown. Below a depth of 38 inches the material is yellowish-gray heavy compact plastic sandy clay in which gray is the dominating color.

This soil occurs at an elevation ranging from 900 to 1,100 feet. It lies above the Lycoming soils and below the typical Dekalb soils of the mountains. The subsoil drainage differs considerably, some areas being well drained. During rainy seasons the water table is kept near the surface of the soil by the subsurface drainage from the higher mountain soils. Most of this soil is highly leached and too cobbly or stony to be of agricultural value, but it is good forest land on which tree growth is rapid. The forest growth consists of black oak and other oaks, shortleaf pine, white pine, pitch pine, mockernut (white) hickory (*Hicoria alba*), pignut hickory, tulip poplar, hemlock, beech, and yellow birch, and the undergrowth consists of mountain-laurel, huckleberry, and rhododendron.

Lehew stony loam.—The surface mineral soil of Lehew stony loam is covered with strongly acid raw humus material to a depth of 1½ or 2 inches, over which is the undecomposed forest litter consisting of leaves and dead twigs. Under the organic material is a very thin layer of sandy loam, ranging in thickness from one-eighth to three-fourths of an inch, in which the soil particles have gray surfaces and are reddish brown when crushed. Between depths of 3 and 12 inches is dull reddish-brown or purplish-brown sandy loam which is mixed with rounded Indian-red shale fragments. Below a depth of 12 inches are the parent soil materials consisting of a rich reddish-brown mixture of loam, shale, and sand to a depth of 5 or more feet. Below a depth of 2 feet the material is slightly pinkish brown in places and contains about 75 percent of gravel and shale at the lower depths. The soil is generally less leached and less acid than the Dekalb or Leetonia soils.

Lehew stony loam generally occupies higher mountain elevations. It is probably the best forest soil that occurs in the higher mountains of the western part of the county. The tree growth is of about the same type as that on the Dekalb soils, but the growth is more rapid. White and red oaks are the most valuable trees.

Included with Lehew stony loam are areas where the soil is essentially a combination of Lehew and Dekalb soils so thoroughly mixed that their separation on the map is impractical. These mixed soil materials are weathered from the Clinton and Cayuga formations from which the more typical Lehew soils are developed. Over the surface of these areas is a shallow layer of raw humus material ranging from one-eighth to three-fourths of an inch in thickness. The surface mineral soil consists of grayish-brown or yellowish-brown loose mellow loam to a depth of about 6 inches. Between

depths of 6 and 20 inches the soil ranges in color from brownish yellow to rich brown. Scattered over the surface of the soil and embedded in the soil mass are angular brownish-black hard sandstones that contain large quantities of iron. These stones are derived from the Clinton formation and are locally called "ironstones" because of their heavy weight. Soils developed from this formation where it is well oxidized are reddish brown. These included areas are closely associated with areas of Amberson gravelly loam. They occur on the high mountains above the Amberson soil, at elevations ranging from 1,300 to 1,800 feet, in Horse Valley and in Little Cove Valley. The soil of these areas is a good forest soil and supports a heavy growth of hardwoods, principally white oak and red oak, with generally 5 to 10 percent of pine. In a few places the pine constitutes probably 20 percent of the tree growth, all of which is rather young, ranging in age from 15 to 35 years.

Another variation of Lehew stony loam is developed primarily from the weathered Juniata formation which occurs in Bear Valley. This soil is mapped mostly across the bottom of Bear Valley and only a short distance up the mountain sides. Only a very small, if any, accumulation of raw humus is over the mineral soil, and the surface layer of mineral soil is only faintly grayish brown. The soil between depths of 1 and 24 inches is mellow granular reddish-brown silt loam that resembles the surface soil of the Hagerstown soils. Below a depth of 24 inches the soil is yellowish brown or brownish yellow. Embedded in the soil mass and scattered over the surface are large stones that range in diameter from 6 to more than 30 inches. The tulip tree, or yellow poplar, grows on this soil, and in the north end of Bear Valley some white walnut trees grow among the oaks, and in the south end of the valley both white and black walnuts grow. These three trees rarely, if ever, grow on the Dekalb soils of the higher mountains or on the more typical Lehew soils. Other tree growth in Bear Valley consists of black birch, hemlock, red maple, black gum, and several species of oaks.

Lycoming stony sandy loam.—The surface soil of Lycoming stony sandy loam is covered by a shallow layer of raw humus about one-half to 1 inch thick, below which is a very thin gray leached layer that averages about one-half inch in thickness. Below the leached layer to a depth of 12 inches is weathered yellow porous structureless stony loamy sand to sandy loam. Between depths of 12 and 30 inches the soil material is yellow to slightly reddish brown sandy clay loam which contains sufficient clay to cause the sand grains to stick together in clusters. Between depths of 30 and 70 inches the material is decidedly reddish brown heavy sandy clay, which contains black iron and manganese streaks. In places the lower soil material is more yellowish brown.

Some areas included with Lycoming stony sandy loam are cobbly rather than stony and are less steeply sloping than the stony areas. Most of the areas of this included soil overlie massive shale beds northeast of Fort Loudon on the high mountain slopes. Part of the land is cleared and planted to peach orchards, which so far have not proved to be of commercial importance. The subsoil drainage of this cobbly soil is rather poor because of a flow of seepage water over the underlying shale beds.

The forest growth on Lycoming stony loam includes red oak, white oak, red maple, sugar maple, black walnut, white walnut, cherry, black gum, hickory, spicewood, dogwood, redbud, Juneberry, persimmon, sassafras, tulip poplar, cucumbertree, black birch, white ash, and some other trees. The undergrowth consists of mountain-laurel, rhododendron along drains, brambles, huckleberry, and blueberry.

Lickdale stony loam.—Lickdale stony loam is mapped along the high mountain streams that flow out into the valleys. The soil is very cobbly or stony. The water table is generally within 4 feet of the surface, and the subsoil is poorly drained and is mottled with blue, yellow, and rust brown. The typical forest cover of this soil is ash, hemlock, yellow birch, tulip poplar, and similar types of tree growth. The undergrowth is mountain-laurel, rhododendron, and blueberry. Over the surface of the soil is a deep mat of moss, locally called "Jerusalem pine" because its characteristic growth resembles a miniature pine forest.

Ashe stony sandy loam.—Ashe stony sandy loam has been developed from material weathered from bluish-purple and copper-colored pre-Cambrian aporhyolite. It has been very resistant to podzolic leaching; the surface layer of mineral soil contains only a faint trace of gray, and no coffee-brown zone has developed. The weathered aporhyolite materials in the lower part of the subsoil are soft and rotten, but where exposed on the surface are very hard, brittle, and flinty. The surface soil is loose mellow dark grayish-brown cobbly or stony loam. Between depths of 4 and 24 inches the texture is silt loam or loam, and below a depth of 24 inches to a depth of 40 inches the subsoil is rich-brown or reddish-brown heavy silt loam or silty clay loam that contains some sharp gritty sandy material.

This soil is mapped on Snaggy Ridge, near the base of Snaggy Ridge, and south and west of South Mountain. It occupies a rather smooth bench position on the lower mountain plateau.

Rough stony land (Dekalb soil material).—Associated with Dekalb stony fine sandy loam are numerous areas of very steep, rough, and rugged mountain land that has been separated on the map as rough stony land (Dekalb soil material). Most of this land lies at high elevations ranging from 1,300 to 2,100 feet. It is very steep and is mainly a mass of sandstone boulders among which small amounts of Dekalb soil material have accumulated. This land supports only a thin stand of small trees, most of which are scrubby rock oaks and scarlet oaks with a few red and black oaks.

Rough stony land (Lehew soil material).—Rough stony land (Lehew soil material) consists of very steep and rugged mountain land, largely a mass of large stones and boulders, weathered from red sandstones, with small pockets of Lehew soil material in places between the rocks. Such land has little value, even for forest.

LAND USES AND AGRICULTURAL METHODS

Land uses and agricultural methods are more or less closely related to the natural soil groups of the county. Soils of the stony mountain lands have remained for the most part in forest, whereas those of the smoother valley lands have been cleared and cultivated;

soils developed from shale and limestone are used for general farming, and soils developed from old gravelly deposits are used largely for fruit growing. As detailed descriptions of the soils and their uses have been given in the preceding section on Soils and Crops, this section will be devoted largely to agricultural methods and soil management as related to the production of farm crops, fruits, and vegetables on the agricultural lands. The problems of grain and forage production and those of fruit production differ greatly and are therefore treated separately under the headings, General Farming Lands and Their Management and Fruit Lands and Their Management.

GENERAL FARMING LANDS AND THEIR MANAGEMENT

The agricultural history of the Cumberland Valley indicates that the production of farm crops and of livestock products has been influenced by the costs of production and by market facilities, or market demands, and that these factors have been important in the establishment of crop-production practices which were most profitable to the farmer. Changes in land use or crop production are made by the farmers in response to market outlets, but the nature of the soil and the soil-management problems largely determine the costs of production and the quality of product. As the country becomes older the cultivated soils become less productive and the cost of production continues to rise with the increased use of fertilizers, net profit per unit of product is lowered, and the tendency is to adopt a more profitable crop or cropping system. One of the major changes in production trends has been from the growing of crops used for the production of beef, pork, and mutton to the growing of crops which are needed for dairy cows and the production of commercial fluid milk. The production of special crops such as fruit and vegetables has been rapidly increasing in recent years.

A rather stable system of general crop production has been developed in the Cumberland Valley, and such crops as corn, wheat, rye, oats, barley, clover, timothy, alfalfa, and bluegrass have become the staple crops of the section. These crops have been grown in rather definite rotations that have been used in Franklin County for many years. Practically all of the soils have been subjected to a long period of leaching, which is characteristic of all humid forest regions where the rainfall is over 30 inches a year. Whenever the farmer grows crops on soils that are constantly being leached he is confronted with the problem of maintaining the productivity of his soil. It is essential, therefore, that he keep in mind the problems of maintaining soil productivity when he plans his systems of crop production or crop rotation.

One of the oldest and commonest crop rotations is the standard Pennsylvania 4-year corn—wheat—wheat—hay rotation. In this rotation system the corn is planted on sod land, which is land that was devoted to hay production the previous year. The sod land is plowed deeply in either the late fall or the early spring previous to the planting of the corn. The seedbed is prepared by the use of the spring-tooth or disk harrow, and the corn is generally surface planted with a checkrow planter. It is cultivated four or five times

during the growing season. The present trend is toward the use of six- and eight-shovel single-row cultivators for shallow cultivation, as deep cultivation of shallow soils destroys too many corn roots.

As soon as the corn is matured in September or early October, it is cut and shocked in the field. The land between the corn-shock rows is disked and plowed and is sown to wheat or winter barley during the last week of September or the first 2 weeks in October. Because of the presence of the hessian fly in the Cumberland Valley wheat seeding should be delayed until the fly-free seeding dates, which are generally after September 25 but which can be ascertained yearly from the county agricultural agent. In order that weeds and grass may be kept under control, the vacant strips, occupied by the shock rows during the fall and early winter, are generally sown to oats in early spring. Some farmers plant potatoes in the shock-row strips. After the wheat is harvested the stubble ground is plowed and prepared for the second crop of wheat.

When the second wheat crop is sown in the fall, timothy is sown on the surface of the soil with the wheat at the rate of 4 to 6 quarts of seed an acre. The timothy seeds germinate in early fall, and the young plants start growth with the wheat. Early in the following spring, red clover and alsike clover are sown broadcast over the wheat and timothy, at the rate of about 6 pounds of clover seed an acre. It is generally recognized that alsike clover is better adapted than red clover to the conditions that exist on the soils developed from shale, mainly because alsike clover tolerates wet winter soil conditions better and the losses due to winter-killing are less. Red clover is most popular on the better drained soils developed from limestone and gravelly deposits.

After the second crop of wheat is harvested, the timothy and the clover occupy the wheat stubble land and make considerable growth if there is sufficient soil moisture during the growing season. The clover-timothy stubble land is generally used for late summer and fall pasture. Weed growth is controlled by late summer or early fall mowing. The clover and the timothy are allowed to produce hay the following year. One crop of hay is cut, and then the land is used for pasture during the rest of the growing season. The sod land is generally given a liberal application of barnyard manure before it is plowed in the late fall or early spring for the corn crop which follows, thus completing the 4-year crop-rotation cycle.

Within the last 15 years a large increase in the number of dairy cows kept to supply the fluid-milk market created greater demand for forage crops that could be used in the dairy feeding rations, and the prevailing low market values for wheat discouraged its production as a cash crop. The combination of these two conditions created a demand for 3- and 6-year crop-rotation systems.

The dairymen's crop rotation, which is becoming increasingly popular, is a 3-year rotation consisting of corn, wheat, and clover and timothy hay. This results in a decrease in total wheat acreage and an increase in corn and clover-timothy hay acreages.

In the 3-year rotation, corn follows hay as in the 4-year rotation. The important change in the cropping system occurs when wheat follows corn. The wheat is sown in the corn stubble land in the fall as usual, but heavier applications of 16-percent superphosphate or

0-12-5 fertilizers are made at wheat-seeding time in order that there will be sufficient fertilizer in the soil for both the wheat and the following hay crop. The fertilizers are applied by the use of grain drill fertilizer attachments which place the fertilizers in the drill rows. Timothy is seeded on the surface with the wheat in the fall at the rate of 4 to 6 quarts an acre, then red clover or alsike clover is sown in early spring at the rate of about 6 or 8 pounds of seed an acre. After the wheat is cut the clover and the timothy occupy the land, and the following year one crop of hay is cut and the land is ready to be plowed for corn.

The acreage of winter barley has been increasing recently. The barley has been replacing oats and in some instances wheat, mainly because it yields more than oats, has a higher feeding value than oats or wheat for dairy cows, and is less susceptible than wheat to attacks of the hessian fly. Winter barley, when grown in the 3-year rotation, is planted at the rate of 2 bushels an acre on land from which the corn has been cut and taken off as a silage crop. The practice of sowing timothy and clover with the barley is the same as that with wheat in the 3-year rotation. Oats are sometimes included in the 3-year rotations, although they are generally used in a longer rotation as a nurse crop for alfalfa. Clover is sown the following spring.

The acreage of alfalfa has been increasing yearly since its introduction in 1900, and the trend is toward a continued increase because alfalfa is a valuable hay crop and is in strong demand as a feed in all livestock rations. Many of the soils have been leached until they are not naturally suited to the growing of alfalfa, but it has been demonstrated that alfalfa can be grown on most of the soils if certain soil amendments are made.

When alfalfa is included in the crop-production scheme, the farmer generally uses a 6-year rotation which provides for 1 year of corn, followed by 1 year of wheat, barley, or oats, in which is seeded the alfalfa, which occupies the land 4 years. The small-grain crop acts as a nurse crop, and, when the grain is cut, the alfalfa occupies the land. Winter barley has proved to be a valuable nurse crop for alfalfa. Relatively large quantities of calcium, phosphorus, and potassium are removed by each crop of alfalfa hay that is harvested. The production of large yields of hay necessitates the presence in the soil of large quantities of these elements.

If a farmer plans to grow alfalfa on a piece of land he should begin nearly 2 years in advance to prepare the soil for this crop. Barnyard manure and 1 to 4 tons of very finely ground limestone or its equivalent of burned lime, depending on lime-requirement tests, should be applied several months previous to the seeding of the alfalfa. If the lime and manure are spread on plowed land just before corn is planted, the clean cultivation of the corn will thoroughly mix and incorporate them with the soil and also destroy undesirable weeds or grasses. From 250 to 350 pounds of 16-percent superphosphate or a complete 2-12-4 fertilizer should be applied to the soil when the barley or wheat is sown in disked corn ground in the fall. Many of the soils do not contain sufficient numbers of alfalfa bacteria, therefore it is important that all alfalfa seed or the soil where the alfalfa is to be sown be inoculated with the right kind

of legume bacteria. Pure cultures of alfalfa bacteria may be obtained from Pennsylvania State College, the United States Department of Agriculture, or reliable commercial laboratories. The practice of inoculating the soil where the alfalfa is to be sown with soil taken from an old alfalfa field should be discouraged because there is great danger of spreading the alfalfa wilt disease or some other alfalfa disease on the new field. The alfalfa is sown in the barley or wheat early in the spring at the rate of about 15 pounds an acre. Some farmers make an additional surface application of 0-12-5 fertilizer or 16- or 20-percent superphosphate in the spring. It is important that the young alfalfa plants be started under as favorable soil conditions as possible because success or failure is largely determined during the plant's first growing season. It is also important that alfalfa be kept in a healthy, vigorous growing condition by maintaining the nutrition level of the soil; otherwise weak or stunted plants are subject to the attacks of insects or disease. The alfalfa-wilt disease is very destructive, and once a field is infected it should not be reseeded to alfalfa until after the land has been devoted for at least 2 years to cultivated crops.

Many farmers sow alfalfa with oats on corn stubble land in the spring. When this practice is followed, the fertilizer treatments should be about the same as those used when the alfalfa is sown in barley or wheat. Whenever alfalfa is sown on land that is steep or is subject to erosion, a good practice is to sow with the alfalfa 4 or 5 pounds of timothy and clover seed an acre. The timothy and clover provide for soil cover to retard erosion and for hay production on areas where the stand of alfalfa may be thin.

Practically all of the wheat grown is some variety of soft red winter wheat. Spring wheats have never yielded so well as winter wheats. Fulcaster is the most important variety, and Nittany (Pennsylvania 44) is the second. Nittany grows too rankly on the soils developed from limestone and is a more popular variety on the soils developed from shale and gravelly deposits, where it generally out-yields other wheat varieties. The beardless wheats, of which the important varieties are Leap Prolific and Forward, are easier to handle during harvest but yield less than the bearded varieties.

Corn has been one of the most important grain crops since early settlement, and indications are that the total acreage devoted to corn will continue to be large. The yellow varieties seem to be more popular than the white mainly because yellow corn matures earlier and is considered a better feeding corn because it contains a greater quantity of vitamins. The most important and best yielding yellow varieties are Lancaster Surecropper, Golden Queen, and Reid Yellow Dent. Lancaster Surecropper outyields all other varieties on the soils developed from shale. The yields of the three varieties are about the same on the soils developed from limestone. The important white varieties are Johnson County White and Boone County White. The total acreage of white corn is relatively small in comparison to that of yellow corn. Some farmers are growing the larger and later maturing corn varieties from the South mainly because these varieties yield a greater acre tonnage of silage.

The soils developed from shale and gravelly deposits in general are less productive than the soils developed from limestone. Rye

yields better than wheat on the less productive soils, therefore rye as a grain crop is grown almost entirely on the soils developed from shale and gravelly material. Rosen rye and what is locally known as common rye are the important varieties grown in the Cumberland Valley.

Rye, which is generally sown on disked cornland, is sown earlier than wheat—much of it is sown between the first and the middle of September. The seeding of timothy or clover in rye is not a common practice.

The growing of oats has been on the decline mainly because of relatively low yields of poor quality oats, which in some instances can be traced to the use of low quality or poor seed varieties. The best oat varieties for the Cumberland Valley at present are Patterson and Cornellian.

The best yielding varieties of winter barley are Tennessee Winter and Kentucky No. 1, both six-row barleys. Dummer Beardless, a winter six-row barley, is attracting attention because of its lack of beards and its good yielding qualities. Only a very small acreage of spring barley is grown. Wisconsin 38 and Comfort, both smooth-awn barleys, are the important varieties of spring barley. Most of the barley varieties grown in the Cumberland Valley are susceptible to the smut disease, and the seed should be treated for this disease before being planted.

Timothy, which does well under a wide range of soil conditions, is used in both hay seedings and pasture grass mixtures. Most of the timothy seed which is sown in the county is purchased from commercial seed dealers.

Clover, usually sown with timothy, has been occupying first place as a legume hay crop for many years. Red clover and alsike clover are the two most important varieties. Some Mammoth clover is grown on the shale soils in the county, but it has not been so popular as the red and alsike varieties. In selecting clover varieties, the farmer is advised to purchase good-quality seed that has been grown in the county. If local seed cannot be obtained, he should select some of the winter-hardy varieties native to the northeastern sections of the United States or from areas where the winters are as cold as or colder than those in Franklin County. Certified clover seed from Ohio and Michigan has proved satisfactory in the Cumberland Valley.

Sweetclover is taking its place among other legume crops as a soil builder, pasture crop, and cover crop. As a soil-improving crop it has no superior; it is hardy and produces a heavy vegetative growth during its second year. If plenty of lime is present in the soil, sweetclover will make good growth on very shallow soils. It is valuable in pasture-grass mixtures, and experiments show that it will produce at least as much pasture as other clovers or grasses when placed under the same soil and grazing conditions. Sweetclover seed, like alfalfa, should be inoculated with legume bacteria when sown on land on which alfalfa or sweetclover has not grown before.

There are two kinds of sweetclover—the white and the yellow. The white gives the greatest root and top growth. The yellow is frequently preferred for hay, because the stems are finer and give a better quality of hay.

Sweetclover is sometimes used in a rotation system where potatoes are grown. In this rotation it is sown in the spring in wheat or some other small-grain crop. The sweetclover grows the first year on grain stubble land; the second year it is allowed to grow to a height of 6 or 8 inches, then it is plowed under and potatoes are planted. It is sometimes used in orchards as part of a clover-grass cover crop. When so used it is kept clipped with a mower and is not allowed to grow to a height greater than 10 or 12 inches.

Some varieties of alfalfa are better adapted to the soil and climatic conditions of the Cumberland Valley than others. The farmers of Franklin County have been having the best success with the winter-hardy northwestern Common alfalfa seeds which come from Montana, Idaho, and the Dakotas, where winter conditions are more severe than those of the Cumberland Valley. The variegated alfalfas, which include the Grimm, Ontario, Hardigan, Baltic, and Cosack varieties, have also given satisfactory yields, but they are not so popular as the northwestern Common varieties. Some of the Kansas alfalfas have been grown with fair success on the better drained limestone soils where winter-killing due to wet soil conditions is reduced to a minimum.

Kentucky bluegrass does exceptionally well on all the soils developed from limestone. The soils developed from shale and gravelly deposits are not normally well suited for bluegrass, but if limed and fertilized they will produce very good bluegrass as long as there is sufficient moisture in the soil.

Wherever permanent pasture is established the pasture grass seeding usually is a mixture of red, alsike, and white clover, Kentucky bluegrass, Canada bluegrass, timothy, redbottom, and orchard grass. As the timothy and the red or alsike clover stand thins, the bluegrass and white clover fill in and produce a permanent pasture-grass sod.

The following pasture-grass seeding mixtures are commonly used: On the soils developed from limestone and alluvial soils—red clover 5 pounds, alsike clover 2 pounds, timothy 6 pounds, Kentucky bluegrass 8 pounds, white clover 1 pound, and redbottom 2 pounds an acre; and on the soils developed from shale and gravelly deposits and on the soils of the mountains—red clover 2 pounds, alsike clover 2 pounds, timothy 5 pounds, Kentucky bluegrass 5 pounds, Canada bluegrass 5 pounds, white clover 1 pound, orchard grass 2 pounds, and redbottom 2 pounds an acre.

Further details concerning pasture grasses and pasture management are given in publications of Pennsylvania State College (3, 4, 5) which report the results of experiments conducted for the purpose of obtaining information as to the establishment and maintenance of permanent pastures on the different kinds of soils in Pennsylvania.

Two of the important potato varieties are Irish Cobbler and Rural Russet. The Rural Russet seems to do better than the Irish Cobbler on the soils developed from shale. Two soils in this county are important for potato growing—Duffield silt loam and Berks silt loam. Duffield silt loam gives the better yields. The highest potato yield on record for the county, 568 bushels an acre, was made on Duffield silt loam. From 600 to 1,000 pounds an acre of high-grade commercial fertilizer is used on land on which potatoes are to be

grown. The fertilizer is placed in the rows with the potato seed when planted.

The important commercial canning crops which are grown consist of tomatoes, peas, beans, and sweet corn. The important varieties of tomatoes are Baltimore, Marigold, and Matchum. Alaska seems to be the most popular variety of canning pea. Country Gentleman and Shoepeg varieties of sweet corn are commercially important.

Nearly all the soils were occupied by dense forests for a long time before the white man cleared the land for cultivation. During this period the acids present in the forest litter were constantly being washed out by rain water. Once the acid was dissolved in water it moved down through the mineral soil. As it passed through the soil the more soluble compounds of basic elements, such as calcium, magnesium, potassium, and even some of the iron were dissolved and carried downward and out of the soil. All the soils thus have lost large quantities of the basic elements.

In order that the supply of available plant nutrients in the soils may be made sufficient for cereals and grasses, it is necessary that liberal applications of lime be made. In general the legume crops require more lime than such crops as wheat, corn, oats, barley, and rye. As some soils are more acid than others, the quantity of lime needed to correct or adjust the soil reaction varies with different soils. In general the soils developed from limestone require the least lime, and the mountain soils developed from sandstone require the most.

Table 8 gives the approximate quantities of lime that should be applied to soils of the important groups in order that maximum production of certain crops may be obtained.

TABLE 8.—Lime requirements for important crops when grown on the more important soils

[In tons per acre of finely ground limestone]

Crop	Soils developed from limestone ¹	Soils developed from shale ²	Soils developed from gravelly deposits ³	Soils of the mountains ⁴	Crop	Soils developed from limestone ¹	Soils developed from shale ²	Soils developed from gravelly deposits ³	Soils of the mountains ⁴
	Tons	Tons	Tons	Tons		Tons	Tons	Tons	Tons
Alfalfa.....	2-3	2-4	2-4	3-6	Bluegrass.....	0-3	2-3	2-3	3-6
Sweetclover.....					White clover.....				
Peas.....					Timothy.....				
Red clover.....					Redtop.....				
Alsike clover.....	1-2	2-3	2-3	2-4	Orchard grass.....	0	½-1	½-1	1-2
Mammoth clover.....									
Soybeans.....									
Cowpeas.....									
Corn.....	0-1	1-2	1-2	2-3					
Wheat.....									
Oats.....									
Rye.....									
Barley.....									

¹ Hagerstown, Duffield, Frankstown, and Murrill soils.

² Berks and Gilpin soils.

³ Murrill gravelly coarse sandy loam, deep phase, and Lycoming soils.

⁴ Dekalb soils.

NOTE.—The soils developed from shale and gravelly deposits show great response to lime even though the applications are only half the amounts shown in the table. Light applications have given generous returns on the money invested in limestone.

Lime is essential also to the preservation of organic matter, upon which the "life" or productivity of the soil largely depends. Organic matter aids greatly in increasing absorption and conservation of moisture and imparts to the soil a good physical structure which limits soil puddling and crusting. Most of the soils are naturally low in organic matter, and where cultivated for years without adequate return of this material removed in the form of crops, they soon become impoverished. Under cultivation the rate of decomposition or oxidation of organic matter is increased. Lime combines with the organic acids to form soil humus, which is resistant to the processes of soil leaching.

Preservation of the soil humus is important in conserving the nitrogen resources of the soil. The nitrogen present in soils comes from the following sources: (1) Small quantities brought down from the atmosphere by electrical storms and rainfall; (2) all organic material returned to the soil; (3) nitrogen fixed by free-living bacteria and other closely related soil organisms which use the organic matter of the soil as food energy and are capable of fixing nitrogen in the soil; and (4) that fixed by symbiotic or legume bacteria which form nodules on the roots of growing legume plants. If the nitrogen-fixing bacteria are to be most efficient it is important that the soil be kept well supplied with organic matter and with lime, in order that the soil reaction never becomes more than slightly acid, that is, below pH 6.6.

The nitrogen supplies of most of the soils are not sufficient for corn, wheat, barley, and nonleguminous crops, and provision for adding nitrogen to the soil should be an important part of any soil-improvement program. The humus and nitrogen supply of the soil can be maintained or increased by growing clover, alfalfa, or grasses in the crop rotation. Other measures for conserving organic matter and nitrogen are the return to the soil of all available crop residues, including all manure produced, and the restriction of cultivation to that which is absolutely necessary for the control of weeds and the production of cultivated crops. A system of farming, including livestock raising or dairying, combined with plenty of legumes in the crop rotation, provides the best and cheapest way of supplying nitrogen to the soil. Where intensive cropping systems are employed, the application of some form of nitrogen fertilizer will generally prove profitable.

All the upland soils are naturally low, not only in nitrogen, but in the other essential plant-nutrient elements, phosphorus and potassium. Phosphorus is generally the first element that limits crop production. In most of the soils the available supplies of phosphorus are so low that the amount required by any given crop should be supplied in applications of manure or commercial fertilizers. The total quantity of potassium in the mineral portion of the soil may be large, but the readily soluble or available supply is relatively low in most of the soils; therefore the application of potash in the form of either manure or fertilizer has proved profitable.

The most practical way to increase the phosphorus content of the soil is through the application of commercial phosphate fertilizers. Economic returns from the application of phosphate fertilizers to grain and legume crops have been greater than for any other commercial fertilizer element. Most farmers consider it essential that

phosphorus be applied to all small-grain and legume crops. Corn, when planted on sod land that has been manured heavily, does not respond so well to phosphate treatments as do the small grains which usually follow corn. Phosphorus is not easily leached from the soil, therefore heavy applications of phosphatic fertilizer are not considered wasteful, because that portion which is not used by the first crop will be held in reserve for the following crops. A part of it may be lost, however, by fixation in insoluble compounds. Each ton of manure applied will generally contain approximately 5 pounds of phosphoric acid.

The quantity of potassium, or potash, that should be applied as a fertilizer depends on the kind of soil, its general condition, and the quantity of manure that has been applied. Gray-colored soils are the most likely to be in need of potash fertilizers. The amount of readily available potash that a soil contains may be increased by growing and plowing under deep-rooted legume crops or other green-manure or grass crops, by applying liberal amounts of barnyard manure, and by using good tillage practices. The greater the amount of organic material, or manure, that is applied to the soil, the smaller will be the need of potash fertilizer. Most soils contain plenty of potash, but in the nonavailable form, and decomposing organic matter aids in making it available for plant use.

The general fertilizer practices which have proved to be successful and practical on the farms in Franklin County are summarized in table 9. These fertilizer practices have been developed for use in the crop rotations that are commonly used in the county. The manure produced in the dairy barns or livestock barns is spread usually either on hay or on wheat stubble ground which is to be plowed and planted to either wheat and grasses or to corn. In general, the soils developed from shale and gravelly deposits require more complete fertilizers than the soils developed from limestone.

TABLE 9.—Kinds and quantities of fertilizers used in the production of the more important cereal, forage, and truck crops on soils of the major groups in Franklin County, Pa.

Crop	Kind of fertilizer, and time and method of application	Quantities of fertilizer used per acre ¹ on—			
		Alluvial soils and soils developed from limestone		Soils of the mountains and soils developed from shale and from gravelly deposits	
		<i>Loads</i> ² 8-10	<i>Pounds</i> 200-250	<i>Loads</i> ² 10-12	<i>Pounds</i> 200-250
Alfalfa or sweetclover...	A. When seeded with nurse crop:				
	1. Manure, applied 3 to 10 months before seeding.				
	16-percent superphosphate, or 0-12-5, applied as top dressing with wheat or barley in fall before seeding alfalfa in spring.		200-250		200-250
	2. No manure				
	0-12-5, applied as above		150-200		150-300
	B. When not seeded with nurse crop:				
1. Manure, applied 3 to 10 months before seeding.	6-10			8-12	
16-percent superphosphate, applied on surface and harrowed in several weeks before seeding if possible.		200-250			200-250
2. No manure					
0-12-5, applied as above		150-250			150-300

TABLE 9.—Kinds and quantities of fertilizers used in the production of the more important cereal, forage, and truck crops on soils of the major groups in Franklin County, Pa.—Continued.

Crop	Kind of fertilizer, and time and method of application	Quantities of fertilizer used per acre ¹ on—			
		Alluvial soils and soils developed from limestone		Soils of the mountains and soils developed from gravelly deposits	
		Loads ²	Pounds	Loads ²	Pounds
Red clover, alsike clover, and timothy.	A. 16-percent superphosphate, applied with wheat (or barley) in the fall before clover is sown in wheat the following spring.	-----	250-300	-----	250-300
	B. 0-12-5, applied as above.	-----	150-250	-----	150-300
Corn	C. 2-12-4, when soil has not been receiving manure, applied as above.	-----	150-200	-----	150-250
	Manure, spread on sod land before ground is plowed, and 16-percent superphosphate, or 0-12-5 or 2-12-4, applied with corn planter in hills at corn-planting time.	8-14	-----	8-14	-----
Wheat, barley, and oats.	A. 16-percent superphosphate, or 0-12-5, when manure is used in rotation, applied with grain drill at seeding time.	-----	200-250	-----	200-250
	B. 0-12-5, when manure is used in rotation, applied with grain drill at seeding time.	-----	150-300	-----	150-300
	C. 2-12-5, when manure is not applied in rotation or for use on shale land, applied as above.	-----	150-250	-----	200-300
Rye	A. 16-percent superphosphate, when manure is used in rotation, applied with grain drill at seeding time.	-----	200-250	-----	200-250
	B. 2-12-4, when manure is not used in rotation, applied as above.	-----	150-200	-----	150-250
Potatoes	A. Manure, spread on sweetclover or red clover sod land before it is plowed.	10-15	-----	10-15	-----
	16-percent superphosphate, spread in the rows with the potato seed at planting time.	-----	600-800	-----	600-800
Canning crops (tomatoes, peas, beans, and sweet corn).	B. No manure. With or without clover plowed under.	-----	-----	-----	-----
	0-12-5 or 4-8-7, spread in rows with potato seed at planting time.	-----	600-1,000	-----	600-1,000
Pasture grasses (bluegrass, red clover, alsike clover, white clover, timothy, orchard grass, and red-top).	Manure, applied before plowing in early spring, and 2-12-4 or 4-8-7, spread on surface and mixed with soil by cultivation.	10-15	-----	10-15	-----
	A. Manure, ³ applied as top dressing in August or September before fall seeding, then once every 2 or 3 years, and 16-percent superphosphate, applied as above, or 20-percent superphosphate, applied as above.	8-10	-----	10-12	-----
	B. No manure	-----	400-500	-----	450-500
	0-12-5, applied as above.	-----	350-450	-----	350-450
		-----	400-500	-----	400-500

¹ The quantities of fertilizers applied to different soils do not differ greatly, but there is a marked difference in the net values returned per dollar invested in fertilizers for different soils.

² Loads refers to manure-spreader loads—50 to 75 bushels.

³ Manure is very valuable in establishing grasses on shallow or eroded soils which have a tendency to dry out rapidly.

FRUIT LANDS AND THEIR MANAGEMENT⁴

Commercial orchards were not planted on any considerable scale in Franklin County until the beginning of the present century. The heaviest planting of apples was between 1908 and 1921. The apple has always been the dominant fruit, with peach trees used chiefly as fillers in the apple orchards. There are a few plantings of sour

⁴ This section was furnished by R. D. Anthony and F. N. Fagan of the department of pomology, Pennsylvania State College.

cherries and a few small vineyards. The sweet cherry grows wild in fence corners and along the mountains.

At first it was expected that the fruit industry would be on a carlot shipping basis using rail transportation only, and large orchards of few varieties were the goal of the growers. The development of truck transportation and the heavy automobile traffic on the Lincoln Highway, which crosses the county from east to west, and on the Valley Pike, crossing from north to south, have created marketing conditions which have had a considerable effect on the size and location of the younger orchards and on the varieties grown.

In the older orchards York Imperial and Stayman Winesap are the chief apple varieties, and Rome Beauty, Jonathan, and Grimes Golden are also important. In the younger orchards Rome Beauty and Delicious rank high and are displacing Jonathan and Grimes Golden.

Most of the early orchards are planted on the gravelly foothills of the mountain ranges which form the east and west boundaries of the Cumberland Valley. These sites were selected to obtain good air drainage and also to use land not well suited to field crops. In such locations the Murrill and the Lycoming soils predominate. On these foothill benches and slopes, areas sufficiently level and not too stony for orchard use are scattered and of limited size.

A few of these early orchards were planted in the valley on soils developed from limestone on sites which were from 50 to 150 feet above the main valley floor. The excellent growth of these orchards, the lower production costs, and the large acreages available have led to a considerable use of the soils developed from limestone—both the Hagerstown and the Duffield soils—in the later plantings.

The Berks soils which form low ridges in the valley have not proved satisfactory for orchard sites in this county, although they have been used extensively for this purpose in the northern part of the Cumberland Valley.

A study of the apple industry of the Cumberland-Shenandoah area made some years ago (10) showed that frost and freezes were the chief causes of loss to the fruit growers of this general region although usually Franklin County did not suffer quite so heavy losses as did areas farther south. This danger was recognized from the beginning by many growers, and sites with good air drainage were selected, but in most of the larger orchards there are low spots where frost damage is serious. When dangerously low temperatures have been accompanied by high winds, orchards with an unprotected northwestern exposure have suffered more than those less exposed to the prevailing winter winds. Frequently cold air pours out of the mountain gaps into the lower valley. Orchards planted opposite these gaps have been seriously injured by frost, freezes, and hail.

In many counties in Pennsylvania the fruit industry has had a gradual development with the old home orchard as a nucleus, and the original farm owner has changed slowly from general farming to fruit growing as a special but not the only crop. In this county many of the larger fruit growers originally were business or professional men who purchased land solely for fruit growing and whose interest was chiefly in the apple. In such cases it was desirable to have an income from the land during the period when the apple

trees were too young to bear. For this purpose peaches were planted as fillers in most of the apple orchards.

This practice has had a considerable influence on the soil fertility problems of the county. It was the belief of many growers that peaches required cultivation late into the summer. With so many orchards on considerable slopes, this long cultivation not only greatly reduced the organic content of the soil but also caused serious erosion. Because of the continuing need for a cash income these peach interplants were left, in many orchards, until the apples were 12 to 15 years old. By that time the peach trees had crowded and checked the growth of the apples, and the cultivation had depleted the fertility of the soil. In all the early plantings these fillers have been out for several years. One of the most serious soil problems of the fruit grower has been to build up the fertility of these run-down orchard soils after the peaches were pulled out.

Fortunately both the practical experience of some of the growers and the research of the State agricultural experiment station proved the value of sods in building up depleted soils and also showed the necessary relation of fertilizer nitrogen to the sod orchard. Several of these experiments were carried on in the county (1, 8).

At present very few bearing apple orchards are under annual cultivation except in an occasional year when a heavy sod is being broken up. This change to fertilized sods which are occasionally harrowed or plowed has stopped erosion and has been restoring the organic matter of the soil to a more desirable level.

Many growers still feel that the peach needs summer cultivation, consequently soil erosion is still a serious problem in many of the younger apple orchards where peaches are growing as fillers and in those orchards planted solidly to peaches. There is a growing tendency, however, to advance the date of cover-crop seeding in peaches and to use such crops as sweetclover, vetch, and soybeans which soon form a soil-binding cover.

Changes in the use of fertilizers in the past 10 years were as great as in cultural practices. Young orchards under annual cultivation in soils of high initial fertility failed to show responses to fertilizers; consequently very little fertilizer was used in the earlier plantings. The growers realized, however, that the use of sod in the orchard would create a nitrogen shortage during the early growing season, and an application to the bearing tree of 5 pounds of nitrate of soda or the equivalent in some other commercial form became almost a standard practice.

With the increasing realization of the importance of organic matter in maintaining and building up the fertility of the soil and in checking erosion, more attention has been paid to obtaining a heavy cover over the entire orchard area. The nitrogen application which was made formerly to a ring under the branches now is usually spread over the entire tree-square area, and the amount has been increased to 8 or 10 pounds. Franklin County soils are so generally deficient in phosphorus that sods and cover crops make excellent responses to superphosphate. Many growers are making at least occasional application of this material either with the nitrogen in the early spring or at the time of seeding the cover crop or harrowing the sod. The need for potassium is less certain, but some

growers are using small amounts of potash when they think it will increase the growth of sod or cover crop. There seems to be little direct response by the tree to this use of superphosphate and potash; the value lies in the response of the soil cover.

Most of the foothill orchards are in acid soils. The general farmer of the Cumberland Valley has long known of the value of lime in increasing the stand and growth of legumes. One of the first steps in building up a depleted orchard soil is usually an application of ground limestone or some other source of calcium to encourage the growth of legume sods or legume covers.

CLASSIFICATION OF SOIL TYPES ACCORDING TO PRODUCTIVITY

Table 10 gives a rating of the soil types, phases, and miscellaneous land classes in Franklin County, according to productivity, for each of the important crops grown.

TABLE 10.—Classification of soil types, or map separations, in Franklin County, Pa., according to productivity

Soil type	Crop-productivity index † for—											Productivity grade according to—		Principal crops or type of farming	
	Corn (grain)	Wheat	Oats	Rye	Tame-grass hay ‡	Leguminous hay ‡	Alfalfa	Potatoes	Vegetables ‡	Vegetables ‡	Tree fruits ‡	Permanent pasture	Inherent productivity ‡		Current practices ‡
Hagerstown silt loam, colluvial phase.....	80(100)	70(100)	60(80)	70	80(100)	80(100)	55(90)	40(70)	-----	80	60(80)	100	3	1	General (corn, wheat, and hay).
Duffield silt loam, colluvial phase.....	80(100)	70(100)	60(80)	70	80(100)	80(100)	55(90)	40(70)	-----	80	60(80)	100	3	1	Do.
Huntington silt loam (protected from overflow)	100	60	60	60	100	100	80	60	-----	90	-----	100	2	2	Corn, hay, and pasture.
Huntington silt loam (unprotected from overflow).	90	40	40	40	90	50	45	50	-----	70	-----	100	4	4	Do.
Hagerstown silt loam.....	70(100)	70(100)	60(80)	70	80(100)	70(100)	45(90)	40(70)	-----	70	60(80)	90	3	1	General (corn, wheat and hay).
Duffield silt loam.....	70(100)	70(100)	60(80)	70	80(100)	70(100)	45(90)	50(80)	-----	70	60(80)	80	3	1	Do.
Hagerstown silt loam, shaly phase.....	60(100)	70(90)	60(80)	70	80(100)	70(100)	45(90)	50(80)	-----	60	60(80)	80	4	1	Do.
Hagerstown silt loam, yellow phase.....	60(100)	70(90)	60(80)	70	80(100)	70(100)	45(90)	40(70)	-----	60	60(80)	80	4	1	Do.
Ryder silty clay loam.....	50(80)	60(90)	60(80)	60	70(90)	80(90)	55	10	-----	40	50(70)	90	4	2	Do.
Holston silt loam, brown phase.....	60(100)	60(90)	60(80)	60	60(90)	60(90)	25(80)	50(80)	-----	70	50(70)	80	4	2	Do.
Hagerstown silty clay loam.....	50(90)	60(90)	50(70)	60	70(90)	70(90)	45(80)	40(60)	-----	60	50(80)	80	4	2	Do.
Hagerstown silty clay loam, shaly phase.....	50(90)	60(90)	50(70)	60	70(90)	70(90)	45(80)	40(60)	-----	50	50(80)	80	4	2	Do.
Hagerstown silt loam, light-colored phase.....	50(90)	60(90)	50(70)	60	70(90)	60(90)	45(80)	30(60)	-----	50	70	70	5	2	Do.
Holston silt loam.....	60(90)	60(80)	60(80)	60	60(70)	50(70)	10(70)	50(80)	-----	70	50(70)	60	5	3	Do.
Lycoming gravelly silt loam.....	60(90)	60(90)	50(70)	70	50(70)	40(70)	10(55)	50(80)	-----	70	50(80)	60	5	2	Fruit and general.
Berks silt loam, colluvial phase.....	50(90)	50(80)	50(70)	60	70(90)	50(70)	35(80)	50(70)	-----	60	50(70)	80	5	2	General.
Chilo silty clay loam (protected from overflow and drained).	90	60	60	60	90	80	45	-----	-----	80	-----	90	3	3	Corn, hay, and pasture.
Chilo silty clay loam (unprotected from overflow and undrained)	40	10	20	10	90	10	-----	-----	-----	30	-----	90	7	7	Do.
Moshannon silt loam (protected from overflow).	80	40	50	40	80	60	10	60	-----	80	-----	90	4	4	Do.
Moshannon silt loam (unprotected from overflow)	60	20	30	20	80	50	-----	-----	-----	60	-----	90	6	6	Do.
Pope silt loam (protected from overflow) ..	80	40	50	40	80	60	10	60	-----	80	-----	90	4	4	Do.
Pope silt loam (unprotected from overflow).	60	20	30	20	80	50	-----	-----	-----	60	-----	90	6	6	Do.
Murrill gravelly silt loam.....	60(90)	50(90)	50(70)	60	50(70)	50(70)	25(70)	50(80)	-----	70	60(100)	60	5	2	Fruit and general.
Warners silt loam (drained).....	70	50	50	50	80	80	70	-----	90(100)	70(90)	-----	90	4	4	Hay and pasture.
Warners silt loam (undrained).....	70	-----	-----	-----	70	-----	-----	-----	-----	-----	-----	80	6	6	Do.
Duffield very fine sandy loam.....	60(90)	50(70)	60(80)	60	50(70)	40(60)	25(70)	50(80)	-----	70	60(90)	50	5	3	General.

Pope fine sandy loam (protected from overflow).	80	40	80	40	70	60	10	70	-----	80	-----	80	5	5	Corn, hay, and pasture.
Pope fine sandy loam (unprotected from overflow).	60	20	30	20	70	50	-----	-----	-----	60	-----	80	6	6	Do.
Philo gravelly loam (protected from overflow and drained).	80	50	40	50	70	60	-----	70	-----	80	-----	70	4	4	Do.
Philo gravelly loam (unprotected from overflow and undrained).	60	20	30	20	70	30	-----	40	-----	60	-----	70	6	6	Do.
Duffield silt loam, slope phase	40(70)	50(80)	50(70)	50	70(90)	70(80)	35(70)	40(80)	-----	40	50(70)	70	5	3	General.
Berks silt loam	50(80)	60(90)	50(80)	60	50(70)	40(70)	(55)	50(80)	-----	60	40(60)	60	5	3	Do.
Holston sandy loam	60(80)	50(80)	50(80)	60	40(70)	40(60)	10(70)	50(80)	-----	70	50(70)	50	5	3	Do.
Hagerstown silty clay loam, yellow phase	40(70)	50(80)	50(70)	50	70(80)	60(80)	25(60)	30(40)	-----	40	40(60)	70	5	3	Do.
Lycoming cobbly sandy loam, yellow-subsoil phase.	50(90)	50(70)	50(70)	60	50(70)	50(70)	10(70)	50(80)	-----	60	30(50)	60	6	3	Fruit and general.
Algiers silt loam (drained)	90	60	50	60	100	90	70	50	-----	80	-----	100	3	3	Corn, hay, and pasture.
Algiers silt loam (undrained)	-----	-----	-----	-----	90	-----	-----	-----	-----	-----	-----	90	3	3	Hay and pasture.
Murrill gravelly coarse sandy loam	60(90)	40(80)	40(70)	50	40(60)	40(60)	10(80)	50(80)	-----	50	60(100)	50	6	3	Fruit and general.
Holston cobbly sandy loam	50(90)	50(70)	50(80)	60	40(70)	40(60)	10(70)	50(80)	-----	60	60(90)	40	6	3	General.
Philo silt loam, dark-colored phase (drained).	70	40	40	40	70	60	10	60	-----	80	-----	80	5	5	Corn, hay, and pasture.
Philo silt loam, dark-colored phase (undrained).	50	10	20	10	70	30	-----	30	-----	50	-----	80	7	7	Do.
Philo silt loam (drained)	70	40	40	40	70	60	10	60	-----	70	-----	80	5	5	Do.
Philo silt loam (undrained)	50	10	20	10	70	30	-----	30	-----	40	-----	80	7	7	Do.
Montalto silt loam	50	40	50	40	50(70)	40	25	50	-----	50	40	60	6	6	Pasture.
Monongahela silt loam	50(80)	50(70)	40(60)	50	50(70)	30(60)	-----	30	-----	60	-----	60	6	4	General.
Berks silt loam, rolling phase	40(60)	50(70)	50(70)	50	50(70)	40(60)	(45)	50(70)	-----	40	30(50)	60	6	4	Do.
Murrill gravelly coarse sandy loam, deep phase.	50(90)	30(60)	30(50)	40	40(60)	40(60)	(80)	50(80)	-----	60	60(100)	50	6	4	Fruit and general.
Amberson shale loam	40(70)	50	50	50	50	40	-----	50	-----	40	-----	50	6	6	General.
Frankstown cherty silt loam	40(60)	40(50)	30(50)	50	40(60)	40(60)	25(45)	50(80)	-----	50	-----	50	7	6	Do.
Duffield very fine sandy loam, slope phase.	30(50)	30(50)	40(60)	30	50(70)	50(60)	35(70)	40(60)	-----	30	40(60)	40	7	5	Pasture and general.
Hagerstown clay loam	30(40)	30(50)	30(50)	30	50(70)	50(70)	35(55)	50(70)	-----	40	-----	60	7	6	General.

¹ The productivity of each of the various soil types and for each specific crop is compared to a standard 100, which stands for the inherent productivity of the most productive soil in the United States for that crop. Figures not in parentheses indicate the inherent productivity of the soils for the specified crops, whereas figures in parentheses indicate the productivity under current practices, which include the use of soil amendments, such as lime and commercial fertilizers.

² In the case of items such as tame-grass hay, leguminous hay, vegetables, and tree fruits, each of which includes a group of associated crops, the rating indicates the productivity of the soil type for that member of the group best adapted to the soil in question. In Franklin County, timothy, red clover, and apples were used as criteria for tame-grass hay, leguminous hay, and tree fruits, respectively.

³ Vegetables doing best on organic soils; e. g., onions, celery, lettuce.

⁴ Vegetables not requiring highly organic soils.

⁵ The inherent productivity grade refers to the relative ability of the soil to produce without amendments. (Refer to text for further explanation.) When two inherent productivity ratings are given, the upper figure refers to the rating when the land is drained and/or protected from flood, and the lower figure refers to the rating when the land is undrained and/or not protected from flood.

⁶ This classification indicates the comparative general productivity of the various soils in the county, under the current farm practices (with amendments). It is determined in the same general way as the inherent-productivity grade.

NOTE.—Leaders, according to position, indicate either that the crop is not commonly grown because of poor adaptation, or that amendments are not commonly used.

TABLE 10.—Classification of soil types, or map separations, in Franklin County, Pa., according to productivity—Continued

Soil type	Crop-productivity index ¹ for—												Productivity grade according to—		Principal crops or type of farming
	Corn (grain)	Wheat	Oats	Rye	Tame-grass hay	Leguminous hay	Alfalfa	Pota-toes	Vegeta-bles	Vegeta-bles	Tree fruits	Perma-nent pas-ture	Inher-ent prod-uctivity	Cur-rent prac-tices	
Robertsville gravelly silt loam (drained).	40	40	40	40	60	-----	-----	-----	-----	40	-----	50	6	6	Corn, hay, and pas-ture.
Robertsville gravelly silt loam (un-drained).	20	10	-----	10	60	-----	-----	-----	-----	-----	-----	50	8	8	Do.
Lycoming gravelly fine sandy loam	40(60)	30(50)	30(50)	40	40(50)	20(40)	(45)	50(80)	-----	50	30(60)	40	7	5	Fruit and general.
Lycoming gravelly silt loam, shallow phase	30(50)	40(60)	40(60)	50	40(50)	10(40)	-----	50(80)	-----	40	-----	40	7	6	General.
Berks silt loam, heavy-subsoil phase	30(40)	30	40	30	50	10	-----	20	-----	30	-----	60	7	7	Do.
Ashe gravelly silt loam, heavy-subsoil phase.	30(50)	30(50)	30(60)	40	50(70)	20(40)	-----	20	-----	-----	-----	60	7	6	Do.
Ashe gravelly silt loam	30(50)	30(50)	30(60)	40	40(60)	30(50)	(45)	50(80)	-----	40	-----	50	7	6	Do.
Buchanan gravelly loam	30(50)	30(40)	30(50)	40	30(50)	20(40)	-----	20	-----	40	-----	40	8	6	Do.
Gilpin shale loam	20(40)	30(50)	30(60)	40	30(50)	20(40)	-----	50(80)	-----	30	40(70)	40	8	6	Fruit.
Gilpin shale loam, brown phase	20(40)	30(50)	30(60)	40	30(50)	20(40)	-----	50(80)	-----	30	40(60)	40	8	6	Fruit and grain.
Amberson gravelly loam	30(50)	30	30	40	30	20	-----	50(80)	-----	40	-----	40	8	7	General.
Duffield silt loam, eroded phase	20	20(30)	-----	20	50	40	25	30(50)	-----	-----	30	50	8	7	Pasture.
Walkkill silty clay loam (drained).	50	30	40	30	60	10	-----	20	30(40)	40(70)	-----	60	6	6	Vegetables.
Walkkill silty clay loam (undrained).	10	-----	-----	-----	40	-----	-----	-----	10	10	-----	50	9	9	Hay and pasture.
Chandler gravelly loam	20	20(40)	20(40)	30	30(40)	10(30)	-----	40(70)	-----	30	30(80)	40	8	6	Fruit.
Lycoming cobbly sandy loam	30(60)	20(40)	20(40)	30	20(30)	20(30)	-----	50(80)	-----	30	40(60)	40	8	5	Fruit and general.
Berks shale loam	10(30)	20(40)	20(40)	20(50)	30(40)	20(40)	-----	40(70)	-----	20	-----	40	9	7	General.
Leetonia gravelly loam	20(40)	-----	20(40)	30	30(40)	20(40)	-----	50(80)	10(20)	20	-----	40	9	8	Pasture and general.
Lehew gravelly sandy loam	20(40)	10(20)	10(30)	20(40)	-----	10(20)	(20)	-----	-----	30	20(40)	10	9	8	General.
Atkins clay loam (unprotected from over-flow and undrained).	-----	-----	-----	-----	40	-----	-----	-----	-----	-----	-----	50	9	9	Pasture.
Lehew gravelly sandy loam, shaly phase	10(30)	10(20)	10(30)	20(40)	10(20)	(20)	-----	-----	-----	20	20(40)	10	9	8	General.
Hagerstown stony silty clay loam	-----	-----	-----	-----	20	20	-----	-----	-----	30	-----	50	10	10	Pasture and hay.
Montalto stony loam	-----	-----	-----	-----	20	10	-----	-----	-----	-----	-----	40	10	10	Forest and pasture.
Lycoming loamy sand	10(30)	-----	-----	30(50)	-----	-----	-----	20(40)	-----	30	-----	10	10	9	Forest.
Dekalb gravelly loam	-----	-----	-----	10	10	10	-----	-----	-----	-----	20	10	10	10	Do.
Dekalb stony fine sandy loam	-----	-----	-----	-----	10	-----	-----	-----	-----	-----	10	10	10	10	Do.
Muck	-----	-----	-----	-----	10	-----	-----	-----	-----	-----	-----	10	10	10	Do.
Lycoming stony sandy loam	-----	-----	-----	-----	-----	-----	-----	-----	-----	30	-----	10	10	10	Do.
Lehew stony loam	-----	-----	-----	-----	10	-----	-----	-----	-----	-----	-----	10	10	10	Do.
Ashe stony sandy loam	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	20	10	10	Do.

Dekalb stony fine sand, compact-subsoil phase.											10	10	10	Do.
Dekalb stony coarse sandy loam											10	10	10	Do.
Berks shale											10	10	10	Do.
Leetonia stony loamy fine sand											10	10	10	Do.
Lickdale stony loam														Do.
Leetonia stony coarse sandy loam												10	10	Do.
Rough stony land (Lehew soil material)												10	10	Do.
Rough stony land (Dekalb soil material)												10	10	Do.
Leetonia stony loamy sand												10	10	Do.

The rating compares the productivity of each of the soil types (or map separations) in the county for a given crop, to a standard, 100. This standard represents the inherent productivity of the most productive soil type (or types) of significant acreage in the United States for the specified crop. These standards of reference are obtained from the more widely known crop regions. A soil estimated to be about half as productive for the specified crop as the type with the standard index receives an index of 50. In a few instances unusually productive soils of limited acreage will have an index above 100 for a specified crop.

The inherent-productivity indexes are based on the ability of the land to produce under a system of management capable of maintaining the inherent level of productivity without the use of soil amendments. The inherent level of productivity is conceived to be the level at or near that existing when the virgin condition became adjusted to tillage practices. Under current farming practices in this county, amendments, such as lime, phosphate, and complete commercial fertilizers are commonly used. Manure produced on the land is not considered an amendment. Because the inherent-productivity rating does not express the responsiveness of soils to fertilizers, and in many instances, as in Franklin County, does not represent production as obtained by current practices, a second index is used in parentheses to show the productivity of the soil with the use of amendments. The same standard of reference is used as for the inherent crop productivity index.

The factors influencing the productivity of land are mainly those of climate, soil, and relief, or lay of the land. All are concerned in the determination of the productivity ratings, and low ratings for a particular crop may as likely be due to an unfavorable climate or unsuitable lay of the land as to lack of fertility of the soil. As long-time crop yields furnish the best available summation of the factors contributing to soil productivity, they have been made the basis, insofar as such information is available, for the determination of the indexes.

For soils with poor natural drainage, two series of indexes are given, one applying to those with no artificial drainage, the other to those to which the most favorable artificial drainage has been applied. In many instances some artificial drainage, but not the most favorable, has been applied to poorly drained lands; consequently their inherent productivity under the best drainage is not realized.

For bottom land subject to periodic overflow, two sets of indexes are given, one applying to the land when it receives the best protection from overflow, the other to the land with no protection.

The cost or difficulty of providing drainage or protection from overflow plays no part in the productivity rating of such lands. Two kinds of soils having the same productivity when drained are rated the same, although adequate artificial drainage may cost 10 times as much on one as on the other. In certain instances, however, a lack of information may preclude the giving of any rating other than that for the natural condition.

In addition to productivity indexes for each important crop, each soil type, phase, or map separation is assigned two general

productivity ratings or grades of agricultural quality. These ratings are based on the ability of the soils to produce the crops of the general agricultural region in which they occur. The rating in the column Inherent productivity is obtained from a weighted average of the inherent-productivity indexes (the numbers not in parentheses) for the specified crops, and the rating in the column Current practices is obtained from a weighted average of the crop indexes in parentheses. These averages have been obtained by weighting each crop-productivity index according to the approximate percentage of the cropland occupied by the specified crop in the general agricultural region. Allowances have been made for variations in acreage trends in the county and, to some extent, for differences in crop acre values. The making of a general rating involves many considerations, and certain arbitrary assumptions have been made to obtain a reasonable result. If the weighted average for the crop-productivity indexes falls between 90 and 100, the soil type is assigned a productivity grade of 1; if the weighted average falls between 80 and 90, a grade of 2 is given, etc. In the case of those soils on which amendments are not used under practices of current management, the crop-productivity index for inherent productivity is the same as that for current practices.

Although a soil may be inherently the most productive in a county or region, it does not necessarily receive a rating of 1. For example, Huntington silt loam in Franklin County, when protected from overflow, is the inherently most productive soil. The limitations of this type for winter wheat and the importance of winter wheat in this county prevent Huntington silt loam from rating 1 in general productivity. This does not mean that this soil is not to be valued highly or that it does not take an important place in the successful operation of the farm unit of which it forms a part.

The soil types are listed in the order of their general inherent productivity. Although they could have been placed according to their productivity under Current practices, the inherent-productivity grade is an attempt to evaluate a characteristic of soils that remains stable, in contrast to the fluctuating production under changed conditions of management. Thus the soil types falling in the same grade are listed in the order of the weighted average of their inherent crop-productivity indexes. It is to be noted that although the classification into grades is an attempt to group the soils, a soil type, the weighted average of which places it in the lower part of a group, may be more closely akin in productivity to the soil first listed in the following group than it is to the foremost members of its own group.

Productivity tables do not present the relative roles which soil types, because of their extent and the pattern of their distribution, play in the agriculture of a county. For example, Hagerstown silt loam, Hagerstown silty clay loam, Duffield silt loam, and Berks silt loam may be said to be the most important soils of the county because they are not only productive soils but are so extensive that they dominate the agriculture.

It must be stated clearly that this classification is not to be interpreted directly into specific land values. Table 10 is not based on enough of the factors which influence land use to warrant such an interpretation. The intention is to confine attention to the essentially

permanent factors of inherent productivity and to the responsiveness of soils to fertilization and management, little consideration being given to the economic factors involved. In some instances the information on which the ratings are based is not so complete as is desired; further study may suggest changes.

The following tabulation gives the more important crops of the county and the acre yields that have been set up as standards of 100 for each crop. These yields represent long-time production averages of the inherently most productive soils of significant acreage in the United States for products of satisfactory quality and are obtained without the use of soil amendments other than those produced directly or indirectly by the soil.

	<i>Bushels</i>
Corn (grain)-----	50
Wheat-----	25
Oats-----	50
Rye-----	25
Potatoes-----	200
Apples-----	200
	<i>Tons</i>
Timothy hay-----	2
Red clover-----	2
Alfalfa-----	4
	<i>Cow-acre-days per year¹</i>
Pasture-----	100

¹ "Cow-acre-days" is a term used to express the carrying capacity of pasture land. It is the numerical equivalent of the number of animal units supported by 1 acre during a given number of days.

MORPHOLOGY AND GENESIS OF SOILS

Marbut¹⁰ has set down the following criteria as necessary for the identification of soils: (1) Number of horizons in the soil profile; (2) color of the material of the different horizons; (3) texture of the material of the different horizons; (4) structure of the material of the different horizons; (5) relative arrangement of horizons; (6) chemical composition of the material of each horizon; (7) thickness of horizons; (8) thickness of the true soil; (9) the character of the soil material; and (10) the geologic origin of the soil material. He has pointed out that the soil profiles of that part of the United States east of the Mississippi River may be classified in five or six broad groups. The true Podzol and the Gray-Brown Podzolic soils occur in the northern humid part of the United States, including the region of which Franklin County forms a part.

The true Podzol soil profile consists of:

- A. Forest debris or raw humus. As a rule it rests directly on the soil with a very thin layer (A₁) or no layer at all of decomposed organic matter on the bottom.
- A₂. Light-gray ashlike horizon ranging in thickness from a film in very heavy soils to several inches in sand soils. This podzolized horizon may have a maximum thickness of 14 inches.
- B. Chocolate-brown, coffee-brown, or rust-brown horizon—the orterde or ortstein horizon. In some places the material may be indurated and may have a maximum thickness of 12 inches.
- C. Partly weathered parent soil material.
- D. The unweathered geologic materials.

¹⁰ MARBUT, C. F. SOIL CLASSIFICATION. Amer. Soil Survey Assoc. Bull. 3: 24-32, illus. 1922. [Mimeographed]

The generalized Gray-Brown Podzolic soil profile may be described as follows:

- A. Forest debris, but very little raw humus. The organic matter is decomposed and incorporated with the surface layer of mineral soil.
- A. A dark-gray horizon comparatively rich in humus.
- A. Grayish-brown leached horizon but not a gray layer—the horizon of eluviation.
- B. Grayish-brown, brown, or yellowish-brown horizon of accumulation—the horizon of illuviation.
- C. The weathered parent material.
- D. Unweathered geologic materials.

The true Podzol and Gray-Brown Podzolic profiles practically represent the general profile characteristics of the well-drained well-developed soils of Franklin County. Minor differences, such as color and number of soil horizons, occur, primarily because of the differences in character of the geologic materials and not of the differences in climate or vegetation.

The climate is humid temperate with warm summers and cold winters and with spring and fall seasons that are comparatively cool. The annual rainfall is approximately 38 inches.

The original vegetation consisted principally of an oak and chestnut forest with probably about 15 percent of pine. Exceptions to this occurred in the valleys where the limestone and shale sections were occupied by an oak, hickory, beech, walnut, and elm forest, although not all of the shale and limestone areas were forested, as some open areas between the valleys supported a cover of wild grasses and shrubs.

Differences in the characteristics of the soils are better understood when the geology of the region is considered. Many kinds of rocks, chiefly of sedimentary origin, including representatives of the Cambrian, Ordovician, Silurian, and Devonian systems are exposed. In South Mountain, in the eastern part of the county, volcanic rocks form the base on which the oldest sediments were laid down. The youngest sedimentary rocks are in Horse and Little Cove Valleys and are represented by Chemung shales, Oriskany and Helderberg limestones, and Cayuga and Clinton shales. The Chemung shales are the youngest of the group (7).

The igneous rocks of the eastern edge of the county are mainly metabasalt and aporhyolites. Areas of the metabasalt, consisting mainly of greenstone, are in the high mountain valleys near Monterey and Blue Ridge Summit and eastward. Another small area is in a high mountain valley southwest of South Mountain (7 p. 140). Additional areas of volcanic rocks or aporhyolites are around South Mountain, eastward and northward along Rocky Mountain Creek to Caledonia, thence eastward. These aporhyolites are chiefly bluish gray and purplish red with light-colored specks or spots. They are very hard and flinty and are glasslike on the fracture planes. Throughout South Mountain extensive areas of quartzite occur, with occasional small bands of schists outcropping along the western slopes of the mountains, especially east and north of Waynesboro. The low mountains and foothills of South Mountain that border the valley are chiefly hard and soft Antietam sandstones. (9). A few of these sandstones are easily crushed between the fingers and when dug out with a pick pulverize into a coarse sharp sand.

The sedimentary formations of Cumberland and Path Valleys are mainly shales and hard massive limestones, all of which occur as narrow bands. They are exposed at steep angles and, in many places, are nearly perpendicular to the present land surface. This condition provides a wide range of geologic materials from which the soils have been developed.

The geologic materials which make up the Appalachian Valley Ridges in this county consist mainly of a variety of red, white, gray, and yellow hard sandstones on the mountaintops and of softer red and yellow sandstones and shales along the mountain sides. Some of these shales approach the hardness of the soft sandstones, but others are very soft.

The county also contains alluvial deposits along the present stream bottoms and terraces; Tertiary (9) mountain wash, terraces, and talus deposits along the mountain fronts; and alluvial fans at the mouths of mountain gulches.

Rather rich accumulations of iron ore occur in small scattered areas at the bases of the mountains in different places in the county. This iron probably has been leached by podzolic acid leaching of the mountain-rock materials, carried to the bases of the mountains by subsurface seepage water, and precipitated at the contact with the lime hydroxides from limestones, a natural reduction of the iron below the upper level of the water table that existed before the late uplift and dissection of the Cumberland Valley. Most of this iron is in the Tertiary deposits of limestone fissures. It is largely hematite iron, known as pipe iron when in columnar structure. Some of this material is reported to have smelted as high as 50 percent of iron (9). Some of the mountain sandstones and shales are heavily impregnated with iron ore, some of which possesses the properties of limonite crystals. In Horse Valley some of these sandstones are called ironstones mainly because of their heavy weight.

The present relief of the county ranges from smooth or rolling in the valleys to very steep, rough, and rugged on the sharp-topped mountain ridges. The present land surface is a product of millions of years of land erosion. The hard sandstones and quartzites that were the most resistant to weathering and erosion still remain at high levels and form the high mountain sections. The softer shales and limestones weathered and eroded easily; consequently they were rapidly reduced to temporary base level where further erosion ceased, and the broad flat-surfaced valleys were developed. More recently the land surface has been elevated, and a new land erosion cycle is now operating vigorously throughout the Harrisburg peneplain (9) which was formerly the old base-level valley floor. At present the great valleys are well dissected by numerous drainage channels. The elevations of the valleys range from 650 to 1,000 feet with most of the streams flowing from 50 to 150 feet below the valley land surface. The mountains rise from 600 to 1,800 feet above the levels of the valley and range from 1,200 to 2,450 feet in elevation above sea level (9).

The true Podzol soils are confined to the higher, more level areas, of the mountains. They include all soils that have three or more distinct soil horizons consisting of (1) an acid raw humus, A₀ horizon; (2) an acid leached gray layer, or A₂ horizon; (3) a coffee-

brown layer, or B horizon, immediately under the gray layer; and (4) the weathered parent soil materials, or C horizon; under which are the geologic materials, or D horizon.

Included in this group are the Leetonia soils, which occur only under forest conditions on the higher mountaintops or slopes where the temperature is a little cooler than in the main valleys. The Leetonia soils of the Appalachian Valley Ridges are developed from sandstone materials, and those on South Mountain, from Cambrian quartzites and quartzite conglomerates. The profiles of the different types of these soils show only minor differences. The layer of raw humus is of about the same thickness on the different soil types; the leached gray layer and the coffee-brown horizon are deepest where the soil is developed from the sandstones of the Appalachian Valley Ridges and shallowest on South Mountain where the soil is developed from quartzite conglomerates. The color of the C horizon of the Podzol soils ranges from pale yellow and yellow on the Appalachian Valley Ridges to brownish gray and gray on South Mountain. The textures of the parent materials are much coarser where the soils are developed from quartzite conglomerates and quartzites.

Following is a profile description of Leetonia stony loamy fine sand as observed $2\frac{3}{4}$ miles north of Edenville, along the mountain road past Nancys Saddle to the east slope near the summit of North Mountain. The forest cover consists of oak and other hardwoods, with an undergrowth of mountain-laurel and huckleberry.

1. (A^o) 0 to $2\frac{1}{2}$ inches, forest litter under which is a 2-inch layer of dark-brown raw humus. It is nongranular, highly acid, and matted.
2. (A₁) $2\frac{1}{2}$ to 9 inches, the bleicherde, or the light-gray or almost white layer of loose highly leached fine sand that is strongly acid. The soil material has a single-grain structure. Very few plant roots are in this horizon.
3. (B) 9 to 11 inches, the coffee-brown layer, or orterde, containing organic complexes of iron and aluminum sesquioxides and colloidal clay, absorbed or precipitated on the surfaces of the soil particles which mainly consist of coarse sand grains. The material is slightly coherent when wet and gradually fades unevenly into horizon C.
4. (C₁) 11 to 36 inches, the upper weathered parent soil materials consisting of yellow silty sand that is slightly adhesive because of the presence of colloidal-clay films on the surfaces of the soil particles.
5. (C₂) 36 to 50 inches, very loose parent soil material, mostly bright-yellow fine sand, silt, and stone. The material is not gray as in the Leetonia soil of South Mountain.
6. (D) Geological material consisting of Tuscarora sandstone. The entire solum contains loose angular stone.

Following is the description of a profile of Leetonia stony loamy sand as observed $4\frac{1}{2}$ miles east of Scotland, along Still House Hollow Road at a point one-fourth mile south of Still House Hollow on the north slope of South Mountain. The vegetation on this area consists of oak, chestnut, and 20 percent of pine forest with an undergrowth of mountain-laurel and huckleberry.

- A^o. 0 to 2 inches, forest litter under which is a layer of dark-brown raw humus that changes to black at a depth of 2 inches. It is somewhat tough in texture and is highly acid. The raw humus is ramified by plant roots.
- A₁. 2 to 8 inches, the bleicherde, or the light-gray sharp-angular coarse quartz sand. The material in this horizon is strongly leached and highly acid.

- B. 8 to 9 inches, the orterde, or the brown or grayish-brown zone of accumulated organic complexes of iron and aluminum sesquioxides and colloidal clays which coat the surfaces of the sand grains. This zone is very irregular. Fingerlike projections of this brown zone extend down into the parent material as much as 14 inches below the normal depth of the B horizon.
- Ba. 9 to 24 inches, grayish-brown gritty, angular, sharp coarse sand and silty clay material. The material in this layer is not yellow as in the corresponding layer of this soil on North Mountain.
- C. 24 to 48 inches, gray or brownish-gray sharp coarse sand containing a few grayish-yellow stains. The entire solum contains angular quartzite stones.
- D. The geological materials consisting of Montalto quartzite (9).

On areas that have been burnt over by forest fires the organic raw humus has been consumed, and the minerals that were liberated have been leached down through the gray horizon into the B and C horizons. The A horizon of these areas is now a bed of gray and white highly acid sand over which is a small amount of forest litter that has accumulated from the scrub-oak brush growth. This litter does not seem to form raw humus.

The same type of podzolic soil development has been going on in all of the mountain soils of the county, but the parent soil materials have in part been more resistant to podzolic leaching, and insufficient time has elapsed to develop typical Podzol profiles even though many of these soils are covered by a raw humus layer. Water erosion and wind erosion have also been active in the removal of surface soil materials on the steeper mountain slopes, and these forces have retarded podzolic leaching, especially on the higher areas that are exposed to the stronger western winds. Soils of such areas have three more or less distinctive layers consisting of (1) the layer of forest litter or raw humus, (2) an acid leached layer but not a gray layer, and (3) the layer of weathered parent soil materials. Soils with such a profile do not have the coffee-brown horizon but may have substituted in its place a faintly developed illuviated horizon consisting of a light accumulation of mineral colloids or clays.

Soils having this general profile constitute a large group. The forested soils of this group include the Dekalb, Lehew, and Ashe soils; and those used for agriculture, the Berks, Gilpin, Lehew, Amberson, and Ashe soils.

The profile of the Dekalb soils of the mountains represents most typically the general profile of this group of soils, both in color and profile development. In general the Dekalb soil profiles have a very thin layer of raw humus under which is a grayish-brown or yellowish-brown leached layer. Immediately below this is the parent soil material, or the C horizon. In a few places a slight accumulation of fine-textured materials or clay may occur in the upper part of the C horizon.

Following is a description of the profile of Dekalb stony fine sandy loam, as observed 1 mile southeast of the Tuscarora Mountain summit on the eastern mountain slope on the southern side of the highway connecting Mercersburg and McConnellsburg. This area lies at an elevation of about 1,750 feet. The vegetation consists of an oak-

chestnut hardwood forest with an undergrowth of mountain-laurel and huckleberry.

1. 0 to 1½ inches, the first one-half inch of which consists of forest litter and raw humus, below which is a mixture of dark-gray and black organic material.
2. 1½ to 12 inches, yellowish-brown loose fine sandy loam material which constitutes the eluviated layer.
3. 12 to 60 inches, brownish-yellow to yellow sandy loam parent soil material.
4. 60 inches +, geologic material consisting of unweathered Tuscarora sandstone. This soil contains many detached angular sandstones.

The Dekalb soils as mapped on South Mountain possess the same general profile characteristics as those on the Appalachian Valley Ridges but are developed from different parent materials, which, when weathered, are gray or brownish gray instead of brownish yellow or yellow as in the Dekalb soils of the Appalachian Valley Ridges. On South Mountain the parent materials are brown, brownish gray, or gray, and are weathered from Cambrian sandstone, quartzites, or quartzite conglomerates, whereas the Dekalb soils of the Appalachian Valley Ridges are developed from grayish-brown, brownish-yellow, or yellow parent materials weathered from the upper Ordovician and Silurian red and yellow sandstones and shales. Descriptions of the Dekalb soil profiles of South Mountain are given in the section on soils and crops. In general the Dekalb soils of South Mountain show more evidence of podzolic leaching than those of the Appalachian Valley Ridges.

The profile of Lehew stony loam is brown or reddish brown throughout, because of the reddish-brown color of the parent rock. Following is a description of the profile of Lehew stony loam as observed on the south side of the Lincoln Highway 2 miles northwest of Fort Loudon, opposite Cape Horn. The vegetation on this area consists of an oak-chestnut forest with an undergrowth of mountain-laurel and low blueberry.

1. 0 to 1½ inches, forest litter underlain by a layer of raw humus about 1 inch thick.
2. 1½ to 3 inches, light reddish-brown sandy loam.
3. 3 to 12 inches, dull-colored reddish-brown to purplish-brown sandy loam mixed with red shale fragments. This is the leached horizon.
4. 12 to 60 inches +, rich reddish-brown to purplish-brown gravelly loam. The material consists of about 85 percent of subangular gravel and shaly material.
5. The geological material, consisting of the Juniata formation of red sandstones and shales (9).

The Lehew soil materials are all very resistant to leaching and have very little if any gray development in the surface of the mineral soil.

A group of soils of the lower mountain and higher valley lands are characterized by a faintly developed B horizon, or zone of illuviation. The B horizon is not a coffee-brown horizon but is a zone in which clays and colloidal aluminum silicates have begun to accumulate. The next and most important difference is the C horizon, or parent material, which is not residual but consists of transported materials that have been deposited either as talus slopes or alluvial fans and

terraces. These materials consist of sands, clays, and gravels, all of which are relatively heavy and compacted. The third important difference is that these soils occupy lower elevations, ranging from 700 to 1,000 feet above sea level. This group of soils includes soils used both for agriculture and forest, and is represented by the Lycoming, Buchanan, and Chandler soils, and the deep phase of Murrill gravelly coarse sandy loam. The general profile of the soils of this group is probably best represented by the profile of the Lycoming soils.

Following is a description of the profile of Lycoming stony sandy loam as observed along the Appalachian Valley Ridges, 1 mile west of Fort Loudon, on the south side of the Lincoln Highway. The vegetation on this area consists of a mixed hardwood forest, principally oak and chestnut, with an undergrowth of mountain-laurel and huckleberry.

- A. 0 to 1 inch, a layer of black raw humus over which is undecomposed forest litter. The material is strongly acid.
- A. 1 to 1½ inches, very thin gray leached loamy sand which is considerably stained by black organic matter. The material is highly acid.
- A. 1½ to 12 inches, brownish-yellow to pale-yellow friable and porous structureless stony sandy loam.
- B. 12 to 30 inches, pale-yellow to slightly reddish brown gravelly sandy clay loam. An accumulation of colloidal clay is noticeable in this horizon, and the sand grains are grouped in clusters which are easily broken.
- C. 30 to 70 inches, reddish-brown sandy clay that is streaked and spotted with rust-brown and black iron and manganese sesquioxide stains coating the fragments or aggregates of parent materials consisting of sand, silt, clay, and rounded stones or gravel. The material of the entire solum is acid.

Large areas of agricultural land in the county have soils developed from shale materials. This group includes the Berks, Gilpin, and Amberson soils, of which the Berks soils are the most extensive and important agriculturally.

Following is a description of the profile of Berks silt loam as observed 1½ miles southeast of St. Thomas. The vegetation on this area consists of a red oak and hickory hardwood forest.

- 1. Partly decomposed forest litter.
- 2. 0 to 1½ inches, dark-gray or very dark gray mineral and organic soil material, the organic matter being incorporated with the mineral soil. The structure is faintly granular. The acidity is near pH 5.0.
- 3. 1½ to 10 inches, yellowish-drab silt loam that contains numerous weathered small shale particles about the size of wheat grains.
- 4. 10 to 16 inches, light-brown silt loam containing numerous fragments of partly weathered shale materials.
- 5. 16 inches +, partly weathered geological material of Martinsburg shale.

The Ashe series includes soils developed from weathered pre-Cambrian aporhyolite materials, and for some reason they are very resistant to podzolic leaching even though they are developed on mountains where climatic and vegetal conditions were very favorable for the development of a Podzol soil. These aporhyolites are composed mainly of a fine-grained aggregate, or ground mass, of quartz and feldspar. Possibly the feldspar minerals contain basic elements that tend to resist podzolic leaching. Descriptions of the Ashe soils are given in the section on Soils and Crops.

A rather distinctive variation of the Gray-Brown Podzolic soils includes those soils that have been developed from soil materials

weathered from massive limestones. This group includes the Hagerstown, Duffield, Frankstown, and Ryder soils. The profile of the Hagerstown soils is representative of this group of soils.

Following is a description of the profile of Hagerstown silt loam as observed $2\frac{1}{2}$ miles southeast of Browns Mills. The vegetation of this area consists of a virgin white oak, hickory, and walnut forest.

1. 0 to $\frac{1}{2}$ inch, very loose granular or crumby mixture of organic matter, leafmold, and mineral soil, all of which are thoroughly worked by insect activity. Over this layer is forest leaf litter. The pH value of this material is 7.5+.
2. $\frac{1}{2}$ to $1\frac{3}{4}$ inches, a very dark brown mineral and organic soil mixture that is very loose and possesses a highly developed crumby structure.
3. $1\frac{3}{4}$ to 5 inches, loose mellow dark-brown silt loam. The soil granules are well coated with organic matter and organic stains. The pH value is 7.2.
4. 5 to 12 inches, yellowish-brown loose mellow silt loam having a single-grain structure but no granulation. The material when crushed has a floury feel. The pH value is 5.0.
5. 12 to 24 inches, reddish-yellow silty clay loam grading into silty clay at a depth of 24 inches. It is compact and slightly granular. The pH value is about 5.2.
6. 24 to 36 inches, yellowish-brown to reddish-brown medium-granular silty clay to clay that is compact but not especially plastic when wet. The pH value is 5.4.
7. 36 to 38 inches, weathered clay material overlying limestone. It is dark reddish brown and only slightly acid, the pH value being 6.8.
8. The geological material consisting of Conococheague limestone (9).

The profile characteristics of the Duffield and Frankstown soils are very closely related to those of the Hagerstown soils. The Duffield soil material is more yellow, and the B horizon is much less developed. The Frankstown soil represents a more advanced stage of podzolic leaching. Its surface soil is strongly acid, its pH value being 4.5. The surface is covered with a mat of moss and organic materials about 1 inch thick. The A horizon of the Frankstown soil is brownish-yellow or yellow cherty loam.

It is generally observed that the soils that are least podzolized are very closely associated with those limestones that possessed the greatest percentage of lime carbonate.

The Montalto soils, even though developed from fine-grained igneous rocks, possess profile characteristics almost identical to those of the Hagerstown soils, and the physical structure and chemical characteristics of the Montalto and Hagerstown soils are nearly the same. The Montalto soils are reddish yellow or brownish yellow, whereas the Hagerstown soils are brown or reddish brown. The soil granules of the Montalto soils are rounded or spherical, but those of the Hagerstown soils are sharp-angular and have slick glossy colloidal gel surfaces.

Not all of the soils mapped have been described in this section, but those soils developed from residual materials that have been omitted and a number of soils of the bottom lands and terraces that have practically no profile development are described in a previous section of this report.

In general, the soils have been developed from residual soil materials.

The factors of climate, moisture, and vegetation have been favorable to the development of Podzol soils over the higher lands of the

county and of Gray-Brown Podzolic soils in the valleys. True Podzol soils have developed only from sandstones or quartzites and occur mainly on the more level high mountain areas. They are represented chiefly by the Leetonia soils. The least podzolized soils are those developed from limestones and calcareous shales. These soils are represented by the Hagerstown and Ryder soils.

SUMMARY

The area covered by Franklin County includes 490,240 acres of land in the Appalachian Valley division and comprises two distinct physiographic subdivisions: (1) The Appalachian Valley Ridges, with which is included South Mountain, an extension of the Blue Ridge Mountains of Virginia; and (2) the main valley, or Cumberland Valley, which comprises the greater part of the county. Several small valleys lie west of the great Cumberland Valley and between the Appalachian Valley Ridges.

The relief of the main valley floor ranges from smooth to gently rolling. It is underlain by massive beds of sedimentary limestones and shale that furnished the material from which the principal soils of the valley have been formed; and narrow belts of more recently deposited materials, consisting of sands, clays, and gravels of Tertiary age, occur near the bases of North Mountain and South Mountain. The geologic materials of the Appalachian Valley Ridges consist mainly of sandstones and shales; and quartzites, aporhyolites, and altered metabasalts are the dominant materials of South Mountain.

The climate is continental, with generally prevailing westerly winds; rainfall is well distributed and abundant; and temperatures are moderate, with warm summers and fairly cold winters. It is favorable to a diversified agriculture based on general farming and dairying. Corn, wheat, rye, and oats are the main grain crops; timothy, clover, and alfalfa are the main hay crops; and timothy and Kentucky bluegrass are the leading pasture grasses. The commercial production of fruit, mostly apples and peaches, and of vegetables has recently become very important.

The soils belong to two important intermingling groups that occupy the northeastern section of the United States. The soils of the mountains belong to that group designated as Podzol soils, which occupy the humid, cool, forested areas of northeastern United States. They are variable but show strong evidence of vigorous podzolization and in general have definite horizons, with gray and white very acid and heavily leached surface soils that are usually covered with a mat of black raw humus over which is the forest litter. The soils of the valleys belong to a great group designated as Gray-Brown Podzolic soils that occupy much of the midlatitude of the United States from the Atlantic coast to western Indiana. These soils show evidence of podzolic leaching and have been leached of their lime carbonate. In addition they are generally low in organic matter, nitrogen, and phosphorus, all of which are essential to plant growth.

The valley soils developed from limestone were high in lime carbonate and for this reason were very resistant to the podzolic leaching process. Because these brown or reddish-brown soils have excel-

lent drainage and have resisted leaching they are naturally the most fertile and most productive upland soils in the county. They respond readily to good management and soil treatments consisting of applications of barnyard manure, lime, or commercial fertilizers. High yields of corn, wheat, oats, rye, barley, clover, alfalfa, timothy, and grasses are produced on these soils.

Throughout the valleys large areas of comparatively shallow grayish-brown soils have been developed from noncalcareous mud shales. The shale material, being lower in lime, has been more heavily leached than the soils from limestone. These soils are low in organic matter, nitrogen, and phosphorus. Under the present land-erosion cycle they are being rapidly dissected by a dendritic drainage system that favors soil erosion. The general type of agriculture and the soil-management practices are the same as on the soils developed from limestone. Crop yields, especially of corn, are generally lower on these soils, as they are naturally less fertile, shallower, and less drought-resistant; but the yields of wheat, oats, rye, barley, and hay are nearly as good as those on the soils developed from limestone.

The soils that have been developed from the unsorted sands, clays, and gravels have heavily leached, grayish-brown or yellowish-brown surface soils and loose gravelly materials throughout the entire soil mass. They generally have well-drained subsoils. Because of heavy leaching and their gravelly character, these soils are naturally poorly adapted to general farm crops. They are, on the other hand, very productive soils for tree fruits and are the most important fruit-growing soils. Commercial orchards for the production of apples and peaches have become well established on these soils. Fertilizers, especially nitrogen and phosphorus, are generally applied. The supply of organic matter and nitrogen is naturally low, but this may be increased by liming the soils and growing grasses or legume crops to be plowed under. Fair yields of such crops as wheat, corn, timothy and clover, and grass may be obtained on these soils by proper crop rotation and by the use of manure, lime, and fertilizers.

Although some of the mountain lands are devoted to agriculture, they are, for the most part, covered with second-growth hardwood forests, in which oaks are the dominant trees. Chestnut was very abundant previous to its destruction by the chestnut blight disease. Some pine timber is scattered throughout most of the forest land but is more abundant on the more level areas where the soils are sandy, strongly acid, and heavily leached. Most of the forest land is now included in State-owned forests.

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