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Soil Survey

Washington County Indiana

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UNITED STATES DEPARTMENT OF AGRICULTURE
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CONTENTS

	Page
County surveyed	1
Climate	4
Agricultural history and statistics	5
Soil-survey methods and definitions	9
Soils and crops	11
Well-drained agricultural soils	14
Hagerstown silt loam	16
Hagerstown silt loam, shallow phase	17
Frederick silt loam	17
Frederick silt loam, colluvial phase	18
Bedford silt loam	18
Orleans silt loam	19
Cincinnati silt loam	20
Gibson silt loam	20
Zanesville silt loam	21
Tilsit silt loam	21
Wellston silt loam, colluvial phase	21
Princeton fine sandy loam	22
Elk silt loam	22
Pekin silt loam	23
Markland silt loam	23
Huntington silt loam	24
Huntington silt loam, colluvial phase	24
Genesee silt loam	24
Genesee fine sandy loam	24
Genesee silty clay loam	25
Pope silt loam	25
Pope very fine sandy loam	25
Imperfectly drained agricultural soils	25
Lawrence silt loam	26
Avonburg silt loam	26
Guthrie silt loam	27
Bartle silt loam	27
Calhoun silt loam	28
McGary silt loam	28
Lindside silt loam	28
Philo silt loam	29
Philo very fine sandy loam	29
Eel silt loam	29
Stendal silt loam	30
Stendal silty clay loam	30
Waverly silt loam	30
Poorly drained agricultural soils	31
Burgin silty clay loam	31
Montgomery silty clay loam	31
Soils and crops—Continued.	
Grazing and forest soils	32
Wellston silt loam	32
Wellston silt loam, slope phase	32
Muskingum silt loam	33
Muskingum silt loam, eroded phase	33
Orleans silt loam, steep phase	33
Orleans silt loam, eroded phase	33
Orleans silt loam, gullied phase	33
Frederick silt loam, steep phase	33
Frederick silt loam, gullied phase	33
Frederick silt loam, eroded phase	34
Hagerstown silt loam, steep phase	34
Hagerstown silt loam, gullied phase	34
Corydon silt loam	34
Cincinnati silt loam, steep phase	34
Cincinnati silt loam, eroded phase	34
Princeton fine sandy loam, steep phase	34
Elk silt loam, steep phase	34
Morphology and genesis of soils	35
Management of the soils of Washington County	48
Plant nutrients in Washington County soils	49
Soil management	53
Light-colored silt loam soils of the uplands and terraces	53
Drainage	53
Control of erosion	54
Liming	55
Organic matter and nitrogen	55
Crop rotation	56
Fertilization	58
Sandy soils of the uplands and terraces	60
Organic matter and nitrogen	60
Crop rotation	60
Fertilization	61
Dark-colored soils	61
Bottom lands	61
Liming	62
Organic matter and nitrogen	62
Crop rotation	62
Fertilization	63
Nonagricultural land	63
Summary	63
Map.	

SOIL SURVEY OF WASHINGTON COUNTY, INDIANA

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United States Department of Agriculture, Bureau of Chemistry and Soils, in cooperation with the Purdue University Agricultural Experiment Station

COUNTY SURVEYED

Washington County is in the southern part of Indiana (fig. 1). It is approximately 25 miles square and comprises an area of 519 square miles, or 332,160 acres. The northern boundary is about 70 miles south of Indianapolis, and the northwestern corner is approximately 15 miles southeast of Bedford. The county is bounded on the north by Muscatatuck River and East Fork White River.

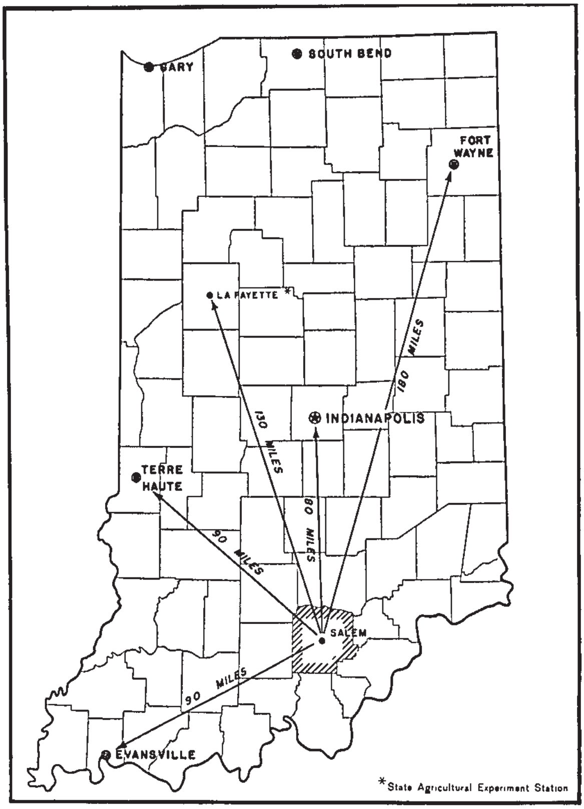

FIGURE 1.—Sketch map showing location of Washington County, Ind.

It includes four main physiographic units: The Norman upland, the Scottsburg lowland, the Mitchell plain, and the Crawford upland.[1]

The Norman upland, a rough hilly section locally known as the "knobs," covers a narrow belt in the northwestern corner of the county, extending eastward along East Fork White River and Muscatatuck River, and a short distance upstream along their small tributaries. In the vicinity of Plattsburg, its bound-

[1] MALOTT, CLYDE A. THE PHYSIOGRAPHY OF INDIANA. Ind. Dept. Conserv. Pub. 21: 59–256, illus. 1922.

ary turns southward around the headwaters of Delaneys Creek, thence southeastward to the vicinity of New Philadelphia, thence northeastward, crossing the county line along the old Scottsburg-Salem road, thence southward along the county line for about 2½ miles, thence westward to Pekin, and thence southeastward into Clark County. A small projection of the Scottsburg lowland extends westward over the Scott County line into northeastern Washington County and continues as far west as Monroe Township. The Mitchell plain occupies the parts of the county west and south of the Norman upland, with the exception of a small narrow area of the Crawford upland which extends northward along the western county line from the southern part.

The relief of the county is closely associated with the natural drainage system. The wide somewhat flat valleys of East Fork White River, Muscatatuck River, and their tributaries extend along the northern side of the county.

The part of the Scottsburg lowland in Washington County was covered by the old Illinoian glacial drift. Along the outer edges of this lowland the relief is strongly rolling and, in many places, the glacial drift has been completely removed, and the soils have developed directly from thin-bedded sandstone and shale, which outcrop in many places on some of the steeper slopes. Around Little York, where the glacial drift is thicker, the relief is more nearly flat or only gently undulating.

The Illinoian drift occurs about halfway up the knobs escarpment and extends as a valley train several miles down the broad upper valley of South Fork Blue River. Distinct traces of still older drift are scattered over the entire northern and northwestern parts of the Mitchell plain but not in sufficient amounts to justify their recognition in mapping soils on the plateau.

The Norman upland consists of a series of very narrow flat-topped ridges from ½ to 5 miles long, in which the range in relief is between 150 and 300 feet. The tops of some of these ridges are capped with limestone, and the sides are composed of thin-bedded easily eroded sandstone and shale formations. Rapid geologic erosion is responsible for the strong relief in this section.

The Mitchell plain is underlain predominantly by limestone. This physiographic unit has rolling relief except in the vicinities of Smedley and Saltillo where the land surface is only slightly undulating, and fairly large areas are imperfectly drained. The greatest relief in the Mitchell plain is in places along the branches of Blue River, where the streams have cut through the more resistant limestone into the underlying sandstone and shale formations.

The Crawford upland consists of a series of narrow-topped hills capped with sandstone and lying above the Mitchell plain.

The three forks of Blue River drain the greater part of the county. They all rise within the county and unite northeast of Fredericksburg to form the main stream which leaves the county southwest of Fredericksburg. The Blue River bottoms range considerably in width, in some places being broad, flat, and imperfectly drained, and in others being narrow and well drained. Extensive imperfectly drained terraces are in the vicinity of Pekin and eastward along South Fork Blue River.

Subterranean streams drain much of the land northwest of Fredericksburg. This part of the Mitchell plain is characterized by numerous limestone sinks.[2] A few large sinkholes, such as the one northeast of Hardinsburg, are several miles long and have wide bottoms. The depth of these sinkholes and the degree of slope of their sides differ considerably. Streams may run for considerable distances in them, then empty into crevices in the limestone and continue underground. The bottoms of some of the larger sinks are slightly undulating, and most of the sinks are well drained.

Both Lost River and South Fork Lost River rise within the county and drain a small area around Smedley and Claysville.

The elevation of the county above sea level ranges from less than 500 feet in the northwestern part in the East Fork White River bottom, to more than 1,000 feet in the east-central part. The greater part of the upland ranges in elevation between 700 and 900 feet. Some small isolated hills rise to an elevation of more than 950 feet. The elevation at Campbellsburg is 837 feet; at Pekin, 713 feet; at Salem, 723 feet; at Saltillo, 800 feet; and at Smedley, 878 feet.[3]

The virgin forest of Washington County consisted chiefly of heavy stands of white oak (*Quercus alba*), red oak (*Q. rubra*), black oak (*Q. nigra*), white walnut or butternut (*Juglans cinerea*) black walnut (*J. nigra*), ash (*Fraxinus americana*), yellow poplar (tuliptree) (*Liriodendron tulipifera*), black cherry (wild cherry) (*Prunus serotina*), American elm (*Ulmus americana*), and hickory (*Hicoria* sp.). The original forest has been destroyed or cut for timber, but practically all farms have wood lots of second-growth trees which consist principally of hard maple (*Acer saccharum*), beech (*Fagus grandifolia*), dogwood (*Cornus florida*), white oak, red oak, and hickory. These second-growth woods are, in many places, accompanied by a growth of underbrush consisting of blackberry (*Rubus* sp.), dewberry (*Rubus* sp.), wild rose (*Rosa carolina*), commonly known as rose brier, small sassafras (*Sassafras varifolium*), persimmon (*Diospyros virginiana*), honeylocust (*Gleditsia triacanthos*), black locust (*Robinia pseudoacacia*), and smilax vines (*Smilar rotundifolia*). Kentucky bluegrass (*Poa pratensis*) is the most common wild grass. On abandoned fields broomsedge (*Andropogon virginicus*) and three-awn (poverty grass) (*Aristida dichotoma*) are abundant.

The first settlement in Washington County was established in 1805 in Posey Township. Settlements in other parts followed rapidly, and in 1812 the county was organized. The early settlers were of English, Scotch, Irish, French, and German descent and came through Kentucky, Virginia, and the Carolinas. The population in 1930, according to the Federal census, was 16,285, of which 13,091 people were classed as rural and 3,194 as urban. Nearly all of the people are white, and practically none are foreign-born. The 1935 census reports the farm population as 10,657. The density of the rural population in 1930 was 25.2 persons a square mile.

Salem, the county seat, had a population of 3,194 in 1930, and it includes the entire urban population. Smaller though important

[2] These sinks are caused by the solution of a part of the underlying limestone formation by ground water. The result is a cave-in of the upper part of the formation and soil.

[3] Elevations determined along the Chicago, Indianapolis & Louisville Railway, by the U. S. Coast and Geodetic Survey.

towns are Campbellsburg, with a population of 558 in 1930; Pekin, 356; Saltillo, 160; Canton, 218; Hardinsburg, 254; and Fredericksburg, 216.

The Chicago, Indianapolis & Louisville Railway crosses the county and has stations at Saltillo, Campbellsburg, Smedley, Hitchcock, Salem, Harristown, Farabee, and Pekin. Truck and bus lines operate from Salem to Louisville, Ky., and a bus line operates between Salem and Seymour, Jackson County. Compared with surrounding counties, Washington County ranks high in the number of miles of improved roads. Two State roads intersect at Salem, and another crosses the southwestern corner, passing through Hardinsburg and Fredericksburg. About one-half of these roads is hard surfaced, and the rest is improved. Improved county roads radiate from Salem to all parts.

Rural mail delivery service reaches every section. With the exception of the extreme southwestern part and the knobs of the Norman upland, the county is well supplied with telephones. Several high schools are conveniently located, and most of the children living in rural districts are transported to and from centralized schools in busses. A few one-room schoolhouses are in use in some sections. It is estimated[4] that 66⅔ percent of all rural children finish high school, and that one-third of the high-school graduates enter college. Churches are distributed at convenient intervals.

Two large limestone quarries at Salem produce dehydrated lime and some agricultural lime. Limestone for road material and for agricultural use is obtained from a number of small quarries scattered over the county. A few marl pits are operated. A large tool-handle factory, a radio-cabinet factory, and a cheese factory are located at Salem, and numerous small sawmills are scattered over the county. Canneries are operated in Pekin and Campbellsburg. Most of these industries employ some farmers at certain seasons of the year, and they directly or indirectly furnish a market for farm products.

CLIMATE

Washington County has a continental climate in which the extremes of heat and cold are of short duration. It receives a favorable amount of available sunshine, and few days are gloomy or cloudy. The average annual rainfall of 44.24 inches is well distributed throughout the year. Occasionally, lack of rainfall may reduce the yields of some crops, but a complete crop failure is practically unknown. Dry weather in July and August frequently reduces the amount of available pasture, and continued spring rains in some years delay planting of the spring crops. Snow commonly stays on the ground for only a few days at a time and furnishes little protection for winter wheat. In some years, prolonged periods of freezing and thawing in the spring severely damage the wheat.

Late spring frosts often reduce peach and apple yields, and early autumn frosts sometimes damage late-planted corn. The average frost-free period is 170 days, from April 26, the average date of the latest killing frost, to October 13, the average date of the earliest. Frost has been recorded at Salem as late as May 25 and as early as September 14.

[4] Estimates furnished by the county superintendent of schools.

Table 1 gives the more important climatic data, as compiled from the records of the United States Weather Bureau station at Salem, near the center of the county. These data are fairly representative of climatic conditions over the county.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Salem, Washington County, Ind.*

[Elevation, 717 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1924)	Total amount for the wettest year (1927)	Snow, average depth
	° F.	*° F.*	*° F.*	*Inches*	*Inches*	*Inches*	*Inches*
December	33.9	70	−23	3.98	2.01	6.36	4.2
January	32.2	75	−26	4.31	3.75	7.01	6.7
February	33.3	74	−27	2.86	1.51	1.96	6.0
Winter	33.1	75	−27	11.15	7.27	15.33	16.9
March	43.8	88	−1	4.38	2.16	6.91	2.5
April	53.6	91	11	3.75	3.69	5.75	.7
May	63.3	96	26	4.16	4.51	10.23	(1)
Spring	53.6	96	−1	12.29	10.36	22.89	3.2
June	71.6	102	36	3.84	3.56	2.58	.0
July	76.0	112	42	3.22	2.12	2.87	.0
August	74.4	103	37	3.66	2.72	3.01	.0
Summer	74.0	112	36	10.72	8.40	8.46	.0
September	68.5	105	25	3.42	3.85	5.36	.0
October	56.4	98	20	3.33	.19	3.90	.1
November	44.7	80	−1	3.33	1.39	7.45	.6
Fall	56.5	105	−1	10.08	5.43	16.71	.7
Year	54.3	112	−27	44.24	31.46	63.39	20.8

1 Trace.

AGRICULTURAL HISTORY AND STATISTICS

The pioneers of Washington County carried on a general type of farming, which included both the growing of crops and the raising of livestock. The livestock consisted of horses, cows, sheep, and hogs. The more common crops were corn, wheat, oats, rye, timothy, clover, flax, and tobacco. Orchards of apple, peach, pear, cherry, and plum trees were established on almost every farm. Most of the farmers either planted a field to corn for several years in succession, or rotated their corn with wheat and timothy. The livestock were allowed to run at large.

Although considerable land is covered by second-growth forest on many farms, the process of clearing has been carried too far, and a great deal of unproductive land has been cleared, which is better suited to forestry. Practically every farm has either land which is too steep and erosible for the profitable growing of crops, or land that is too flat and imperfectly drained for crop production.

Lumbering was an important industry in the early days, but since the original growth of timber was cut, the importance of this industry has declined gradually, and, although several small sawmills are still operating, the supply of good timber is very much depleted.

The present agriculture is a combination of general farming and livestock farming, especially dairying in some sections, and the crops grown are principally those used to support livestock, although some wheat is grown as a cash crop and smaller acreages of tobacco and vegetables are sold for cash. The principal income of the farmers, however, is derived from livestock and livestock products.

Table 2, compiled from the reports of the Federal censuses, gives the acreages of the principal crops grown in the county and shows the general trend of agriculture during the last half century.

TABLE 2.—*Acreage of the principal crops in Washington County, Ind., in stated years*

Crop	1879	1889	1899	1909	1919	1924	1929	1934
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Corn for grain	36, 852	34, 709	40, 724	44, 397	44, 668	24, 880	30, 486	34, 495
Wheat	17, 848	22, 091	26, 890	20, 442	26, 832	13, 839	11, 325	13, 351
Oats threshed	16, 763	16, 581	15, 262	9, 401	15, 146	7, 557	8, 793	5, 035
Rye	250	44	63	804	2, 006	1, 061	454	562
Potatoes	--------	584	519	576	540	189	348	526
Tobacco	76	43	23	34	27	49	323	126
Hay, all kinds	20, 671	28, 257	28, 068	25, 663	23, 368	28, 025	20, 114	18, 740
Timothy and clover	--------	--------	--------	22, 382	17, 768	18, 983	13, 284	11, 909
Clover	--------	--------	9, 532	1, 074	3, 480	2, 166	3, 280	244
Alfalfa	--------	--------	3	34	156	202	576	1, 290
Other tame grasses	--------	--------	18, 187	2, 093	1, 388	1, 315	953	[1] 1, 088
Wild grasses	--------	--------	180	--------	25	262	52	--------
Grains cut green	--------	--------	166	80	282	322	638	409
Legumes for hay	--------	--------	--------	--------	269	4, 775	1, 331	3, 800
Silage crops	--------	--------	--------	--------	3, 354	--------	1, 735	--------
	Trees	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*
Apples	--------	135, 841	185, 477	112, 000	65, 853	49, 622	35, 808	26, 923
Peaches	--------	53, 125	137, 024	36, 515	33, 098	44, 109	32, 123	25, 469
Pears	--------	--------	--------	12, 267	5, 567	4, 091	2, 477	1, 142
Plums	--------	--------	--------	5, 862	3, 720	3, 022	1, 448	682
Cherries	--------	--------	--------	6, 570	7, 193	--------	733	1, 036
	Vines	*Vines*	*Vines*	*Vines*	*Vines*	*Vines*	*Vines*	*Vines*
Grapes	--------	--------	20, 507	6, 281	4, 082	6, 098	4, 742	5, 371
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Strawberries	--------	--------	120	100	81	102	150	202
Raspberries	--------	--------	80	63	102	--------	37	--------
Blackberries	--------	--------	142	85	125	--------	14	--------

[1] Includes all other tame and wild grasses.

Corn always has been the most important farm crop, and in most years it occupies from 40 to 45 percent of all the land in crops. This dominance of corn is not because the soils are especially adapted to corn, but because corn is a necessary crop to support the livestock which provide the greater part of the income of the farmers. Hay is the next crop in acreage, and it also is used as feed for livestock. These two crops dominate the agriculture, and practically all of them are fed to livestock on the farms where grown, very little of either being sold.

A considerable acreage is devoted to wheat, and most of the wheat is sold for cash, thereby augmenting the income from livestock and livestock products. Other cash income on some farms is received from tobacco, vegetables for city markets and for canneries, orchard fruits, especially apples and peaches, and small fruits, especially strawberries.

The 1930 Federal census reported 2,181 farms occupying a total of 271,607 acres, or 81.8 percent of the total area of the county, and had an average size of 124.5 acres. On the average-sized farm, 60.4

percent of the land, or 75.2 acres, was classed as improved land, which included cropland and plowable pasture. The 1935 census reported the number of farms as 2,483, with an average size of 118 acres, of which 66.3 acres was classed as improved land. In this year the census reported 292,882 acres in farms, or 88.2 percent of the total area of the county, of which 164,696 acres were classed as improved land.

The 1930 census reported the average value of all property a farm as $4,954.17, of which 50.3 percent represented the value of the land, 28.2 percent the value of the buildings, 6.2 percent the value of implements and machinery, and 15.3 percent the value of domestic animals. The average acre value of land was reported as $20 and of land and buildings as $31.25. The 1935 census reported the average acre value of land and buildings as $22.12.

According to the 1935 census, of the 2,483 farms in the county in that year, 1,797 ranged in size from 30 to 174 acres; 158 included less than 30 acres; and 447 contained more than 174 acres, 4 of which included more than 1,000 acres.

Table 3 gives the number and value of all domestic animals, poultry, and bees on April 1, 1930, as reported by the Federal census.

TABLE 3.—*Number and value of domestic animals, poultry, and bees in Washington County, Ind., Apr. 1, 1930*

Livestock	Number	Value	Livestock	Number	Value
Horses	4,121	$281,274	Goats	72	$234
Mules	1,776	148,847	Swine	19,110	188,656
Asses and burros	13	1,300	Chickens	199,310	167,420
Cattle	16,795	779,229	Other poultry	7,575	15,535
Sheep	11,277	84,936	Bees (hives)	879	3,340

The 1930 Federal census reports 8,073 cows milked in 1929, which produced 3,257,866 gallons of milk. Of this quantity of milk, 1,446,991 gallons were sold as whole milk valued at $303,868; 52,803 pounds of butter were churned on farms, valued at $22,705; and 451,716 pounds of cream were sold as butterfat, valued at $198,755. Chicken eggs produced amounted to 1,541,019 dozen, valued at $464,896; 31,058 pounds of wool were clipped, valued at $11,491; and 8,741 pounds of honey were produced, valued at $1,888.

Table 4 gives the value of all agricultural products produced in the county in 1929, as reported by the Federal census.

TABLE 4.—*Value of agricultural products by classes in Washington County, Ind., in 1929*

Crop	Value	Livestock products	Value
Cereals	$830,577	Dairy products sold and butter churned	$528,303
Other grains and seeds	26,640	Poultry and eggs	733,365
Hay and forage	320,016	Wool	11,491
Vegetables (including potatoes and sweetpotatoes)	147,640	Total	1,273,159
Fruits and nuts	77,691	Total agricultural products	2,864,747
All other field crops	53,525		
Forest products	135,499		
Total	1,591,588		

Of the 2,181 farms in the county reported by the 1930 Federal census, 1,748 were operated by owners and part owners, 415 by tenants, and 18 by managers. The 1935 census reported 2,483 farms, of which 1,920 were operated by owners and part owners, 547 by tenants, and 16 by managers.

The farms are rented on a livestock basis. Under this system, the landlord furnishes one-half of all livestock except horses and one-half of all feed bought, and the tenant furnishes the horses and the farm implements. Generally the farms are leased by the year, but it is the common practice for a tenant to remain on the same farm for several years.

Fertilizer is used universally. In 1929, $135,159 was spent for fertilizer on 1,602 farms, an average of $84.37 a farm. Practically no home-mixed fertilizer is used. The principal fertilizer mixture bought is 2–12–6.[5] Most of the fertilizer is applied in the corn rows at a rate of about 125 pounds an acre. Land for wheat is fertilized at about the same rate as that for corn, but the fertilizer used generally contains more nitrogen. Some truck crops are given much heavier applications. Orchards, and occasionally truck crops and tobacco, are top-dressed with a high-nitrate fertilizer. Lime has been used by about 25 percent of the farmers and is applied at the rate of about 2 tons an acre.

According to the 1930 census, operators of 829 farms reported the employment of labor in 1929. On most farms, the employment of labor is seasonal and men are hired for only a few days at a time, but on a few of the larger farms, laborers are employed throughout the year at a rate ranging from $35 to $50 a month, with board. Day laborers are paid $2 with board. The total expenditure for hired labor was $125,757 in 1929.

According to the Federal census, feed was purchased on 1,765 farms in 1929, at a total cost of $379,443, an average of $215 a farm reporting such expenditure. Most of the feed purchased is fed to dairy cattle and poultry.

On some of the less productive soils, the farm buildings are in bad condition and many of the houses are constructed of logs, but on the more productive soils most of the farms are well improved with good houses, barns, outbuildings, and woven-wire fences.

Most of the farm work is performed with two-horse teams, but in the preparation of the seedbed, four or more horses commonly are worked together. Tractors are used on the larger farms. Most of the farms are well equipped with farm machinery which is carefully stored in sheds when not in use. Several farmers have the equipment for grinding feed for livestock, and a few have equipment for grinding limestone for agricultural use.

The draft horses are predominantly Percheron or Belgian grades, and they are well cared for. A few registered Percherons and Belgians are raised. Most of the cattle are of the dairy breeds, grade Jerseys predominating, but some farmers have registered Jersey cattle. Only a few beef cattle are raised, principally Aberdeen Angus, Hereford, and Shorthorn breeds, and some of them are registered. The principal breeds of hogs are Duroc-Jersey, Poland China, Chester White, and Hampshire. The most common breed of

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

sheep is the Shropshire. Leghorn, Rhode Island Red, Plymouth Rock, and Wyandotte chickens are raised extensively, and on practically every farm some poultry is raised.

The 1930 Federal census reported 1,634 automobiles on farms, 288 motortrucks, 308 tractors, 25 electric motors for farm work, and 265 stationary gas engines. The same census reported 1,138 farm homes equipped with telephones, 136 farms with water piped to the dwelling, and 148 farm homes lighted by electricity.

Although general farming is the chief agricultural activity, many farmers specialize in dairying, poultry raising, or fruit production where markets and other conditions are favorable. The farm income is derived from various sources. The sale of hogs, butter, and eggs constitutes the main source of income from livestock; on most farms wheat is the main cash crop; and other sources of income are from the sale of calves, chickens, turkeys, fruit, sorgo, potatoes, pumpkins, and miscellaneous products.

Where milk routes are established, and the farmer can sell whole milk, dairy farming is an important branch of agriculture. A large proportion of the land on dairy farms is devoted to pasture and hay crops, but many of these farms do not produce enough corn for the cattle. Therefore additional corn must be bought. A minor source of income on the dairy farms is from the sale of poultry products and hogs.

Most poultry farms are either in the rough hilly section in the southeastern part of the county, where Wellston, Muskingum, and Zanesville silt loams are the dominant soils, or north of Fredericksburg, where Orleans silt loam is the dominant soil. On these farms most of the feed is purchased. In the southwestern part of the county, poultry raising is carried on in combination with the production of truck crops and fruit. On a few farms, the sale of turkeys furnishes an important source of income, and flocks of 25 or more turkeys are rather common.

Louisville, Ky., is the chief market for poultry products. Some farmers sell their produce directly to merchants in Louisville, and others sell to dealers in Salem, who, in turn, truck the produce to Louisville. Most of the fruit is sold locally or in Louisville. Strawberries are trucked or shipped to Louisville or to Chicago. Snap beans, pumpkins, and tomatoes are sold to the canneries at Pekin and Campbellsburg, or trucked to the cannery at Scottsburg, which is located a few miles east of Washington County.

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 soil [6] and its content of lime and salts

[6] 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.

are determined by simple tests. Drainage, both internal and external, and other external features, such as 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. On the basis of these characteristics soils are grouped into mapping units. The three principal ones are (1) series, (2) type, and (3) phase. Areas of land, such as riverwash or bare rocky hillsides that have no true soil, are called (4) miscellaneous land types.

The most important group 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, and to a slight extent the texture of the subsoil, may vary within a series. The soil series are given names of places or geographic features near which they were first found. Thus, Frederick and Stendal are names of important soil series.

Within a soil series are one or more soil types, defined according to the texture of the upper part 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, Stendal silt loam and Stendal silty clay loam are soil types within the Stendal 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 it 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 important practical significance. Differences in relief, stoniness, and the degree of accelerated erosion are frequently shown as phases. For example, within the normal range of relief for a soil type there may be areas that are adapted to the use of machinery and the growth of cultivated crops and others that are not. Even though there may be no important difference 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 crops. In such instances the more sloping parts 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 [7]

The utilization of the soils of Washington County presents three striking features: [8] (1) About 30 percent of the county is in second-growth forest or cut-over land, (2) about 50 percent is under cultivation, and (3) the remaining 20 percent is largely idle land. Closer investigation shows that definite natural features of the landscape are responsible for these characteristics. The forests occupy large continuous tracts, either of soils developed on slopes too steep for cultivation or of soils which are imperfectly drained, swampy for long periods, and subjected to floods. These soils have little value, except for the production of timber. The cropland dominantly comprises soils occurring on relatively smooth land and includes most of the total area of the more productive soils and considerable areas of the less productive soils. The idle land formerly was used for crop production but either was not suited for this purpose or has been so badly eroded that it can no longer be farmed economically.

Washington County is one of the southern hill counties of Indiana, where the dominant type of farming is known as southern hill farming,[9] in which a number of different farm crops are produced on every soil and the area in specialized crops is very small. Climatic conditions in this county are favorable for the production of many different crops, but with the exception of a few of the less extensive soils which are especially adapted to the production of corn, the soils are not particularly adapted to any special crop, and yields of most crops are not so high as they would be on soils to which they are well adapted.

Owing to their undulating and hilly relief, the soils must be farmed in comparatively small areas which are not adapted to the use of large machinery. The influence of this factor is emphasized by the predominance of farms ranging in size from 40 to 160 acres.

Various cropping systems are used on different farms, but under general farming methods, where the chemical and physical conditions of the soils are favorable, a 3-year rotation of corn, wheat, and timothy and clover is followed. On some farms oats are substituted for wheat, and on other farms clover or alfalfa is substituted for timothy and clover. Only a small proportion of the soils are naturally suited to this rotation because most of them have an acid reaction, and the farmers find it necessary to apply lime in some form to the soil before they can obtain satisfactory stands of clover or alfalfa, and on other soils artificial drainage must be provided before these crops can be grown. A 3-year rotation of corn, wheat, and timothy is common on land which does not produce satisfactory stands of clover. On some farms, little attention is given to the rotation of crops and a field is planted to corn or some other single crop for a number of years in succession.

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[7] The soil map of Washington County, Ind., does not join perfectly with either the soil map of Scott County on the east or Lawrence County on the northwest. Since Scott County was mapped, soil classification has been refined so that several soil series not recognized in Scott County are mapped in Washington County. The apparent failure to join exactly with the Lawrence County map is chiefly because the use of aerial photographs in the soil mapping of Washington County afforded more detail and greater accuracy than was possible with the methods used in mapping Lawrence County.

[8] Estimated from aerial photographs, soil maps, and observations made while making a detailed soil map of the county.

[9] YOUNG, E. C., and ELLIOTT, F. F. TYPES OF FARMING IN INDIANA. Ind. Agr. Expt. Sta. Bull. 342, 72 pp., illus. 1930.

Some fields are planted to corn, wheat or oats, and timothy; and then allowed to remain in timothy for pasture for a number of years, until the timothy is driven out by broomsedge, poverty grass, small persimmon, sassafras, and post oak sprouts, and smilax vines. On a few farms, tomatoes are included in the cropping system, and on these farms the common rotation consists of corn, tomatoes, wheat, and timothy and clover.

Corn is the most important cereal crop grown in this county, and the acreage of corn is larger than that of any other single crop. It is grown extensively on almost every soil. The climatic conditions are suitable for corn, but, with the exception of the Genesee and Huntington soils, the soils are not particularly favorable for this crop and do not produce high yields; but, as corn is the chief grain fed to livestock, and livestock or livestock products furnish the most important source of farm income, corn is the most important crop on most farms. Many farmers use fertilizer to increase the yields of corn, but even when this is done, not enough corn is produced to meet the local demand for feed. About 125 pounds an acre of a 2–12–6 fertilizer is applied in the rows at the time the corn is planted.

Wheat ranks next to corn in importance as a cereal crop, but it does not produce very high yields. It is grown because it fits well in the rotation, furnishes a suitable nurse crop for young clover and timothy, prevents the soil from washing badly in the winter, and can be sold as a cash crop. Many farmers report that wheat does not repay the cost of production on many soils because of low yields.

Oats rank third in importance as a cereal crop, and, although the acreage of oats is somewhat smaller than that of wheat, the total yield commonly is larger. Oats produce low yields on most of the soils, and climatic conditions are not well suited for this crop which, in many years, is used as a catch crop to replace wheat that has been killed by prolonged periods of freezing and thawing. Oats are grown also for hay or pasture and as a nurse crop for timothy and clover. As a cash crop, they are rarely profitable.

Rye is a minor cereal crop, grown largely for early or late pasture or as a nurse crop for timothy and clover.

Red clover is the most important legume. It is grown for hay or pasture and as a soil-improvement crop. Clover does not grow well on acid or poorly drained soils, and on a large number of the soils in this county one or both of these conditions must be corrected before clover can be grown satisfactorily. Less extensively grown legumes are alfalfa, soybeans, and lespedeza. Timothy is grown for both hay and pasture, and it is adapted to a large number of soils and a wide range of conditions.

A number of minor crops are grown in small areas throughout the county, largely because they can be sold locally and provide some cash income. They include orchard fruits, small fruits, truck crops, and tobacco. The orchard fruits consist of apples, peaches, and some pears and cherries. Most of the orchards are on the well-drained and well-aerated soils, such as the Hagerstown, Frederick, Orleans, Bedford, and Zanesville silt loams. Many orchards are given heavy applications of fertilizer high in nitrogen. Orchards generally give profitable returns, but occasionally the fruit is severely damaged by spring frosts. A few raspberries, blackberries, and strawberries are grown as cash crops and furnish a profitable means of utilizing the narrow ridge tops of Zanesville silt loam in the knobs. Truck crops and tobacco are grown because they can be sold as cash crops in nearby markets. Tomatoes on some soils, particularly the Hagerstown and Huntington silt loams, which have received heavy applications of fertilizer, produce well and are sold to nearby canneries. Many of the farmers plant pumpkins in the cornfields as an auxiliary crop and sell them to the canneries. Snap beans also find a ready market at the local canneries and are grown by a few farmers as a special crop. Cabbage is grown chiefly in the knobs country on small areas of Stendal silt loam or Wellston silt loam, colluvial phase.

Tobacco is grown in small areas in various parts of the county, chiefly on small areas of Stendal, Philo, and Pope silt loams, and Wellston silt loam, colluvial phase, in the knobs section.

On the basis of their present use the soils are divided into two main groups: (1) Agricultural soils, which are devoted mainly to crop production, and (2) grazing and forest soils, which include soils used mainly for pasture or for growing timber, or which are largely idle land.

The first group includes soils having fairly smooth relief, that are not, in most places, subject to serious erosion, and that can be cultivated easily with farm machinery. This group includes a number of soils of diverse soil characteristics, and they differ considerably in their productivity and utilization. The soils of this group are discussed under the following three headings: Well-drained agricultural soils, imperfectly drained agricultural soils, and poorly drained agricultural soils.

In the following pages, the soils of Washington County are described in detail, and their agricultural relationships are discussed; their location and distribution are shown on the accompanying soil map; and their acreage and proportionate extent are given in table 5.

TABLE 5.—*Acreage and proportionate extent of the soils mapped in Washington County, Ind.*

Type of soil	Acres	Per-cent
Hagerstown silt loam	20,672	6.2
Hagerstown silt loam, shallow phase	3,904	1.2
Frederick silt loam	59,008	17.8
Frederick silt loam, colluvial phase	1,216	.4
Bedford silt loam	26,752	8.1
Orleans silt loam	23,744	7.1
Cincinnati silt loam	3,072	.9
Gibson silt loam	1,152	.3
Zanesville silt loam	9,920	3.0
Tilsit silt loam	192	(1)
Wellston silt loam, colluvial phase	768	.2
Princeton fine sandy loam	64	(1)
Elk silt loam	1,408	.4
Pekin silt loam	3,776	1.1
Markland silt loam	640	.2
Huntington silt loam	12,352	3.7
Huntington silt loam, colluvial phase	1,216	.4
Genesee silt loam	1,472	.4
Genesee fine sandy loam	256	(1)
Genesee silty clay loam	128	(1)
Pope silt loam	3,264	1.0
Pope very fine sandy loam	2,176	.7
Lawrence silt loam	8,512	2.6
Avonburg silt loam	896	.3
Guthrie silt loam	576	.2
Bartle silt loam	4,224	1.3
Calhoun silt loam	448	.1
McGary silt loam	960	.3
Lindside silt loam	2,432	0.7
Philo silt loam	6,592	2.0
Philo very fine sandy loam	768	.2
Eel silt loam	704	.2
Stendal silt loam	9,984	3.0
Stendal silty clay loam	4,032	1.2
Waverly silt loam	640	.2
Burgin silty clay loam	960	.3
Montgomery silty clay loam	1,856	.6
Wellston silt loam	2,240	.7
Wellston silt loam, slope phase	16,768	5.0
Muskingum silt loam	28,928	8.7
Muskingum silt loam, eroded phase	1,408	.4
Orleans silt loam, steep phase	6,848	2.1
Orleans silt loam, eroded phase	2,240	.7
Orleans silt loam, gullied phase	1,600	.5
Frederick silt loam, steep phase	29,760	9.0
Frederick silt loam, gullied phase	4,544	1.4
Frederick silt loam, eroded phase	2,240	.7
Hagerstown silt loam, steep phase	5,184	1.6
Hagerstown silt loam, gullied phase	320	.1
Corydon silt loam	5,952	1.8
Cincinnati silt loam, steep phase	1,728	.5
Cincinnati silt loam, eroded phase	960	.3
Princeton fine sandy loam, steep phase	384	.1
Elk silt loam, steep phase	320	.1
Total	332,160	------

[1] Less than 0.1 percent.

WELL-DRAINED AGRICULTURAL SOILS

The well-drained agricultural soils include all those soils which have brown or yellowish-brown surface soils in cultivated fields, and brown, reddish-brown, yellowish-brown, or yellow subsoils. This group includes soils of the uplands, terraces, and bottom lands.

The soils of the uplands and terraces, which belong to this group, are the silt loams of the Hagerstown, Frederick, Bedford, Orleans, Cincinnati, Zanesville, Gibson, Tilsit, Elk, Pekin, and Markland series, Princeton fine sandy loam, and Wellston silt loam, colluvial phase. These soils are well drained or moderately well drained, and they occupy undulating to rolling relief. They are easily worked with farm machinery and warm early in the spring. With the possible exception of Princeton fine sandy loam, they respond well to fertilization and are resistant to drought. These soils differ greatly in their ability to produce crops.

Hagerstown silt loam is considered the most desirable well-drained soil of the uplands. It is locally known as red, reddish-brown, or oölitic soil. It has a friable grayish-brown silt loam surface soil, and a heavier friable brown silt loam subsurface soil. The subsoil is crumby reddish-brown silty clay loam and is underlain by waxy reddish-brown clay which extends to limestone.

The Hagerstown soils occupy a belt extending from the southeastern part northward across the central part of the county. This belt reaches its maximum width of approximately 8 miles in the vicinity of Salem. North of Salem the belt narrows, turns westward around the edge of the Mitchell plain and crosses the western county line in the northwestern corner of the county. Hagerstown silt loam comprises about 30 percent of the soils in this belt. The other soils associated with it are Frederick silt loam which has a grayish-brown surface soil and a brown subsoil, Bedford silt loam which has a yellowish-brown surface soil and a yellow subsoil, and a few areas of Lawrence silt loam which has a grayish-brown surface soil, a mottled grayish-brown, yellow, and gray subsoil, and occupies somewhat flat imperfectly drained areas.

Hagerstown silt loam is distinguished from Frederick silt loam and Bedford silt loam by its darker brown surface soil, friable reddish-brown subsoil, and its better internal drainage. The Hagerstown soil warms earlier in the spring than the Frederick and Bedford soils, is easier to work, and produces higher yields. The presence of Hagerstown silt loam makes the belt in which it occurs the outstanding agricultural section of the county. This belt is characterized by a higher proportion of cleared land and less abandoned land than the other upland sections of the county.

Frederick and Bedford silt loams are widely distributed over the Mitchell plain in Washington County. Both soils occur in small areas in some sections, and in other parts they occupy large areas and are the dominant soils. Frederick silt loam is the most extensive soil in the more rolling parts of the Mitchell plain where stream drainage has developed, and in these sections Bedford silt loam occupies narrow areas on the tops of ridges where drainage is not quite so good as on the slopes. In the less rolling parts of the Mitchell plain, particularly in the vicinities of Smedley and Saltillo, Frederick silt loam occurs only in small areas. In this section, Bedford silt loam is the dominant soil and is associated with fairly extensive areas of Lawrence silt loam.

Where Frederick silt loam is the dominant soil outside the Hagerstown soils belt, there are considerable areas of Frederick silt loam, steep phase, which are used largely for pasture. These parts of the county are characterized by a large acreage of pasture land and by numerous slopes which have been abandoned because of erosion. In the sections where Bedford silt loam is the dominant soil, erosion is slight, a much larger proportion of the land is under cultivation, and the idle land consists largely of imperfectly drained soils, such as Lawrence silt loam and Guthrie silt loam.

Frederick silt loam is distinguished from Bedford silt loam in the field by the grayish-yellow surface soil and yellow subsoil of the Bedford soil in contrast to the grayish-brown surface soil and brownish-yellow subsoil of the Frederick soil. Bedford silt loam also occupies the more gently sloping areas, such as the somewhat flat tops of ridges or those at the heads of small drains. Both the Frederick and Bedford are good agricultural soils but are not valued so highly as is Hagerstown silt loam. As Frederick silt loam is slightly better drained than Bedford silt loam, it warms a little earlier in the spring and can be worked sooner after rains. It is also a little more productive than Bedford silt loam for most crops.

The Orleans, Cincinnati, Gibson, Zanesville, and Tilsit silt loams are moderately well drained fertile upland soils which, under good management, in favorable years, produce satisfactory yields. The cultivated acreage of each of these soils varies from year to year, according to economic conditions. During periods when farm produce and crops can be sold at high prices, rather large areas of these soils are cultivated, but during periods of depression large areas are temporarily abandoned. Because of the low yields, and because all these soils are acid and do not produce clover well without being limed, little attention is given to their improvement. They are planted to corn for a number of years in succession, or to corn, wheat, and timothy in rotation. When yields begin to decline, the land is temporarily abandoned. The percentage of delinquent taxes is higher in sections where these soils predominate, and the population is less dense.[10]

Cincinnati silt loam and Gibson silt loam are well-drained soils which occur in the northeastern part of Washington County on the more rolling areas of the Scottsburg lowland. Cincinnati silt loam has a grayish-brown surface soil and a brownish-yellow subsoil, similar to the corresponding layers of Frederick silt loam, and Gibson silt loam has a yellowish-brown surface soil and a yellow subsoil similar to these layers of Bedford silt loam. Both soils are developed from weathered glacial drift. Gibson silt loam is developed on more gently sloping land than Cincinnati silt loam, and it occurs on the tops of many ridges flanked by steeply sloping areas of Cincinnati silt loam. Although these soils are correspondingly as well drained as the Frederick and Bedford soils, are as easily worked, and warm as quickly in the spring, they apparently are not so productive.

Elk silt loam, Markland silt loam, and Pekin silt loam are well-drained soils of the terraces.

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[10] Based on State census data.

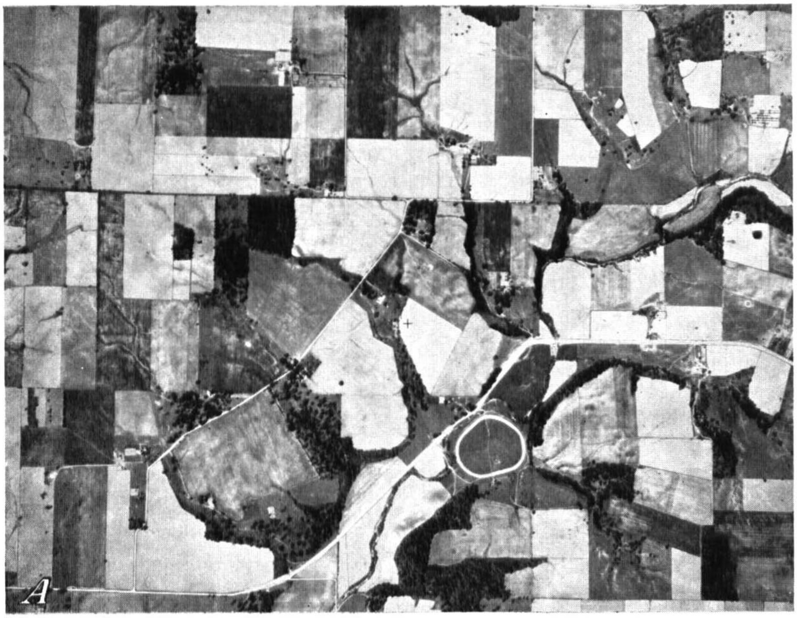
Elk and Pekin silt loams are typically developed in other sections from deposits of water-laid materials of limestone origin, but in this county their parent materials are also derived partly from sandstone, chert, and shale, both from the residual uplands and old glacial drift materials. These soils are closely associated and are distinguished by the colors of their surface soils and subsoils. Elk silt loam has a grayish-brown surface soil and a reddish-brown subsoil, whereas Pekin silt loam has a grayish-yellow surface soil and a yellow or brownish-yellow subsoil slightly mottled with gray below a depth of 20 inches. Both are good agricultural soils and are largely under cultivation. They are managed similarly to Frederick silt loam. Elk silt loam is considered a little more desirable than Pekin silt loam for farming because of its slightly better surface and internal drainage. On these soils, corn averages about 30 bushels an acre and wheat about 16 bushels. As the surface soils and subsoils of both are mildly acid, most farmers find it necessary to apply lime before clover and alfalfa can be grown. These soils are well suited to bluegrass and the native white clover. Approximately 75 percent of these soils is under cultivation, and the rest is in open woodland and bluegrass pasture.

As mapped, the Elk and Pekin silt loams include small areas of Holston and Monongahela silt loams, respectively.

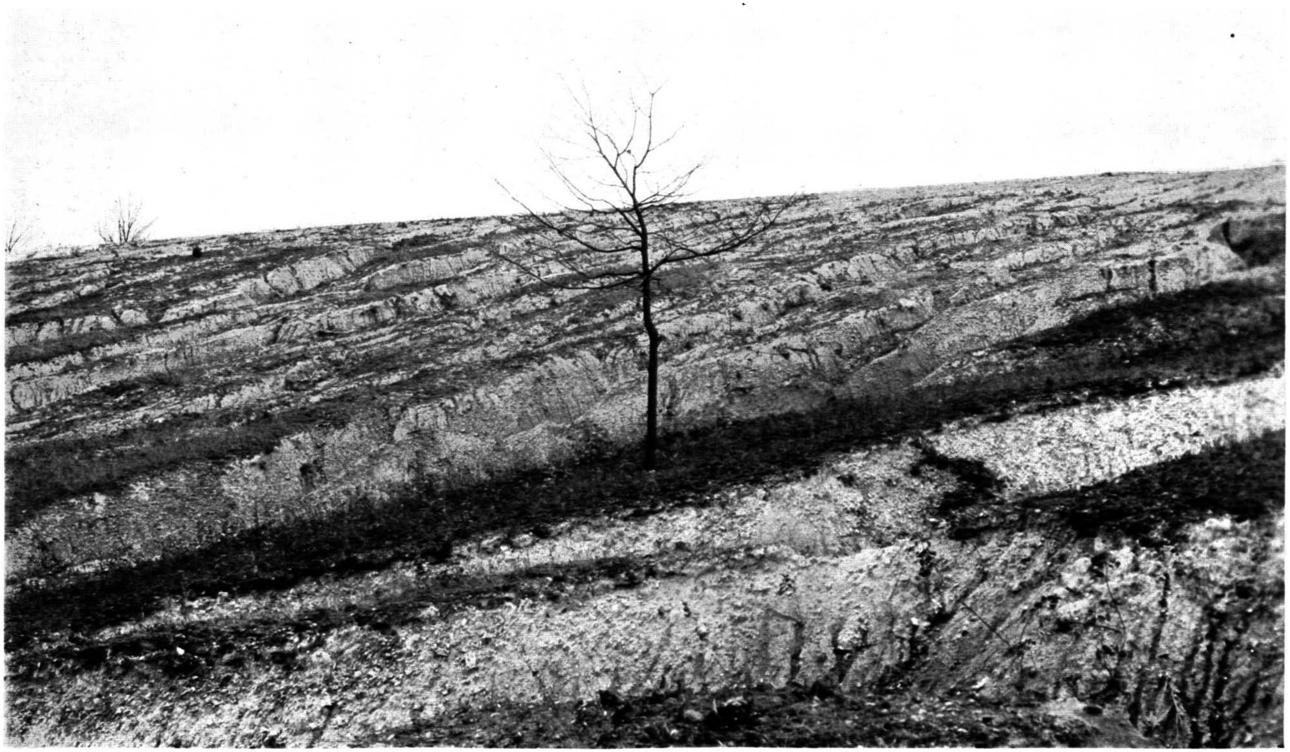
The well-drained agricultural soils of the bottoms are Huntington silt loam, Genesee silt loam, Genesee fine sandy loam, Genesee silty clay loam, Pope silt loam, Pope very fine sandy loam, and Huntington silt loam, colluvial phase. These soils are brown and well oxidized to a depth of 36 or more inches, and, with the exception of the last named, they occupy positions along the immediate banks of streams. Huntington silt loam, colluvial phase, is a well-drained soil developed from colluvial materials in depressions. All the well-drained agricultural soils of the bottoms are subject to overflow but are flooded for comparatively short periods and are well drained between floods. A large proportion of each is under cultivation. Corn is the most important crop and, on many farms, is grown several years in succession. Huntington silt loam is the most extensive of these soils.

Hagerstown silt loam.—The cultivated surface soil of Hagerstown silt loam consists of a 12-inch layer of grayish-brown silt loam. It is underlain by heavier brown silt loam or silty clay loam, which extends to a depth of about 20 inches. Below this is reddish-brown silty clay loam which, at a depth ranging from 36 to 40 inches, grades into friable reddish-brown clay that is slightly waxy when wet. This layer, in turn, is underlain by limestone at an average depth of about 10 feet. The freshly worked moist surface soil has a dark-brown cast, and spots from which the surface soil has been removed by erosion are reddish-brown.

Hagerstown silt loam follows roughly the outcrops of the Salem and Upper Harrodsburg limestone formations but is not entirely limited to them. It occupies long gentle slopes which give it excellent surface drainage. Because of the friable condition of the surface soil and subsoil, water penetrates the ground easily. The soil, however, is not subject to excessive drainage, nor is it inclined to be



A, Aerial view of Hagerstown and associated soils. Blue River Friends Church near the center. Note he high proportion of cultivated land and lack of serious erosion. *B*, Aerial view of Bedford and Lawrence soils. Saltillo in central part. Note the rather flat or gently undulating relief evidenced by the very small amount of erosion and gullying and the predominance of rectangular fields. There is a high proportion of cultivated and pasture land and a small amount of woodland.



Severely gullied area of Frederick silt loam.

droughty. It is an easy soil to work, is the most productive upland soil in the county, and is fairly well suited to the production of a wide range of farm crops.

Corn yields from 35 to 40 bushels an acre in ordinary years, with occasional yields of 50 or more bushels. Yields of wheat range from 15 to 30 bushels, with a probable average of 22 bushels. Oats and rye are other cereal crops frequently grown. The common rotation consists of corn, wheat, and timothy and clover. As this soil is slightly acid, it is greatly benefited by applications of lime. Where the soil has been limed it is well adapted to alfalfa, and a few small fields of alfalfa are grown for permanent pasture or hay. Excellent bluegrass grows on this soil. Tomatoes are grown as a special crop. Small areas are used for permanent pasture, building sites, orchards, and miscellaneous purposes.

Hagerstown silt loam, because of its good internal drainage and its location on fairly gentle slopes, is not subject to serious erosion, and very little of the land has been seriously damaged by surface washing or gullying (pl. 1, *A*.) Practically all of it is cleared and is under cultivation.

Hagerstown silt loam, shallow phase.—Hagerstown silt loam, shallow phase, has a profile similar to that of the typical soil, except that the soil layers are not so thick, and the depth to the underlying limestone in few places is more than 5 feet. In many places on the steeper slopes, limestone outcrops in small areas. This shallow soil occupies somewhat steeper slopes than the typical soil, with which it is closely associated, and in many places the boundaries between the two soils are arbitrary. The slopes of Hagerstown silt loam, shallow phase, are more subject to both the gully and sheet types of erosion than the typical soil, and the steeper slopes make cultivation more difficult. The soil material throughout the profile commonly is not so acid as is typical Hagerstown silt loam.

This soil is adapted to the same crops as those grown on typical Hagerstown silt loam. It produces slightly lower yields and is about 75 percent as valuable as the typical soil. About 75 percent of the land is under cultivation. Stony areas of Hagerstown silt loam, shallow phase, indicated on the map by stone symbols, are used for forest or pasture.

Frederick silt loam.—The surface soil of Frederick silt loam in plowed fields is light-brown or yellowish-brown silt loam to a depth of about 10 inches. It appears somewhat darker when moist. It is underlain by a yellowish-brown silty clay loam subsoil containing streaks or mottlings of yellowish gray below a depth of 24 inches. At a depth of about 36 inches, this material grades into yellowish-brown or red waxy clay which continues downward to limestone. In few places is the limestone less than 7 feet below the surface. Both the subsoil and the waxy red clay contain various quantities of cherty rock fragments ranging from less than 1 inch to more than 5 inches in diameter. Pieces of chert are also common on the surface of the slopes.

This soil is developed on gently rolling land and has good surface and internal drainage. The surface water drains partly into streams and partly into sinkholes in the underlying limestone. It is the

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most extensive upland soil in the county. It warms early in the spring and is well suited to the production of the cereal crops commonly grown.

Corn yields range from 20 to 40 bushels an acre, with an average yield of about 30 bushels; and wheat yields from 10 to 25 bushels, with an average yield of about 16 bushels. The common rotation on unlimed soil is corn, wheat, and timothy. The entire soil mass is acid, and clover does not grow very satisfactorily without the aid of lime. This soil responds well to fertilizer, and the results of its use are apparent on succeeding crops. Where the land has been limed, the common rotation consists of corn, wheat, and timothy and clover. Sometimes oats and rye take the place of wheat, but generally they are not so profitable. Some alfalfa is grown in the limed fields, for permanent pasture or hay. Large acreages are left in bluegrass and white clover for permanent pasture. Because it is developed on sloping land, this soil is well adapted to fruit trees, and a few commercial apple, peach, and pear orchards are planted on it.

Frederick silt loam provides excellent locations for building sites. At present about 85 percent of the land is cleared. Considerable areas have been used for the production of corn year after year, until the yields have greatly decreased. They have then been allowed to remain fallow and have sustained serious losses of plant nutrients through erosion of the surface soil (pl. 2). Many of such fields are now completely abandoned.

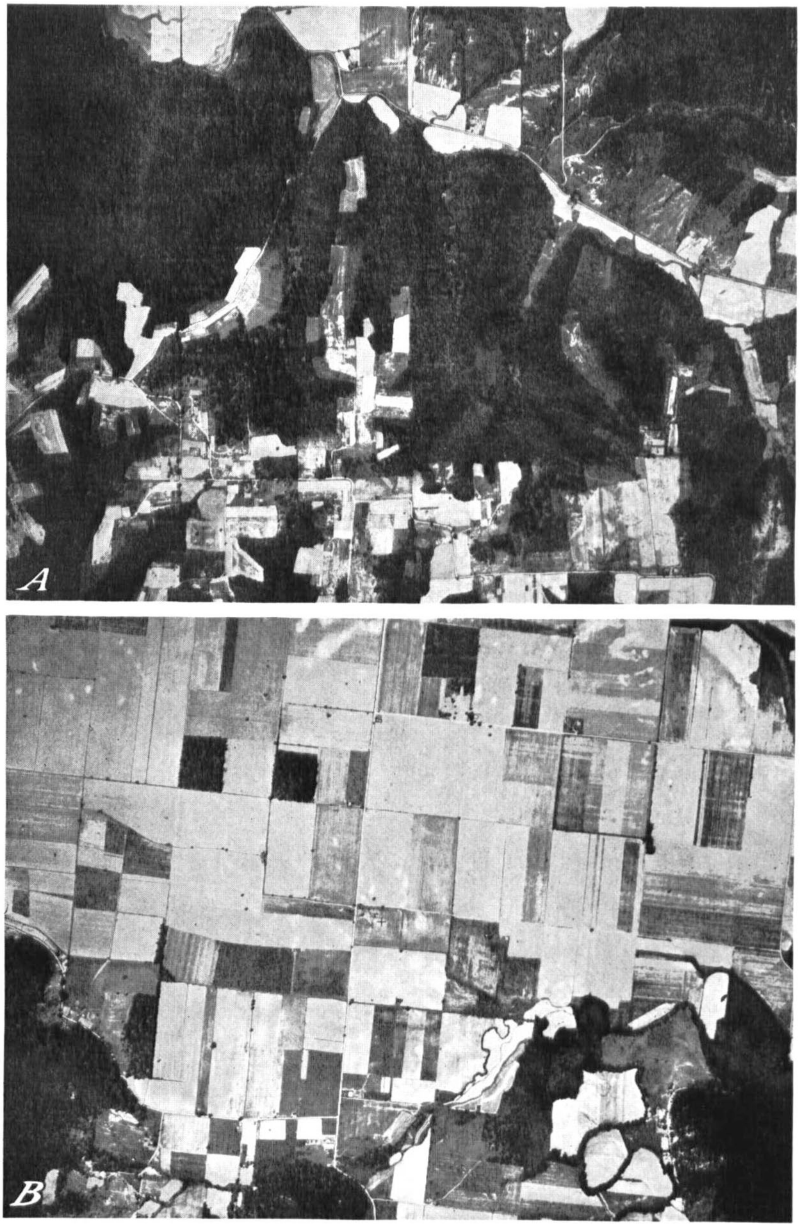
Frederick silt loam, colluvial phase.—Frederick silt loam, colluvial phase, differs from typical Frederick silt loam only in the surface layer which consists of light-brown silt loam 20 or more inches thick. This colluvial soil is developed on the lower parts of long slopes, from material washed from the hillsides. It produces yields similar to, or slightly higher than, those obtained on typical Frederick silt loam. Soil of this phase occupies only a few small areas.

Bedford silt loam.—The 12-inch surface soil of Bedford silt loam is light yellowish-brown silt loam. It is underlain by a pale-yellow or yellow silty clay loam subsoil which passes, at a depth of about 23 inches, into highly mottled grayish-yellow and yellow silty clay loam that is not quite so heavy as the overlying material. The lower part of this layer is very compact and contains vertical streaks of gray material. The material in this layer breaks into roughly vertical columns 1 inch or more in diameter. At a depth ranging from 36 to 40 inches, the silty clay grades into heavy waxy reddish-brown or red clay which extends to a depth of 10 feet or more to the underlying limestone. In many places the heavy waxy clay contains chert fragments.

Bedford silt loam is developed on gently sloping land. It has fair surface and internal drainage, but drainage generally is not so good as that of Frederick silt loam or Hagerstown silt loam, with which the Bedford soil is associated. Most of the surface water runs off into streams, but some drains into sinkholes.

Bedford silt loam is well suited to the farm crops commonly grown, but it is not so productive as Frederick silt loam. Acre yields of corn range from 15 to 35 bushels, with an average yield of about 27 bushels; and of wheat from 10 to 22 bushels, with an average yield of about 15 bushels. Sometimes wheat is damaged severely by prolonged periods

A, Aerial view of Orleans silt loam west of Organ Springs. Note the eroded slopes of the limestone sinks, shown by light-colored circles. The dark-colored fields are largely abandoned *B*, Aerial view of the Cincinnati, Gibson, and Avonburg soils. Little York is in the east-central part. Note the amount of erosion along the streams, on slopes of Cincinnati soils, and a few areas of Gibson soils. In the central part, where the relief is flat, Avonburg and Guthrie silt loams are developed. Most of the Gibson, Avonburg, and Guthrie silt loams are in pasture. Most of the Cincinnati soils are cleared but have been abandoned because of erosion.



A, Aerial view of Muskingum and Zanesville soils southeast of Blue River along the county line. The steep wooded slopes are Muskingum soils, and the cultivated ridge tops are Zanesville silt loam. *B*, Aerial view of Montgomery and McGary soils in the Muscatatuck River Valley northeast of Plattsburg. Note the high proportion of cultivated land. The greater part of the soil is Montgomery silt loam, and most of the small light-colored spots are McGary silt loam. The wooded areas in the lower part of the picture are the steep slopes of the upland.

of freezing and thawing in the winter and spring. This soil produces good yields of timothy and, when limed, is suited to clover and alfalfa. It makes good pasture land when seeded to bluegrass or lespedeza.

The common rotation on unlimed land consists of corn, wheat, and timothy. On some farms the timothy is left for several years for pasture but eventually is crowded out by broomsedge. In fields which have been limed and have had better management, the common rotation consists of corn, wheat, and timothy and clover. The land responds well to fertilizer and warms fairly early in the spring.

As this soil occupies gently sloping land, it is not subject to serious gullying, but a number of areas have been damaged by surface washing (pl. 1, *B*). In its virgin condition Bedford silt loam supported a heavy forest growth. About 75 percent of this soil has been cultivated and some of it later abandoned. Its current value is about 65 percent of that of Hagerstown silt loam.

Included on the map with Bedford silt loam are areas of a brown phase of that soil, which are associated with areas of Hagerstown silt loam. The soil in these areas is characterized by a light-brown silt loam surface soil 10 or 12 inches thick underlain by a brownish-yellow silty clay loam subsoil. The lower part of the subsoil is slightly mottled with gray and, at a depth ranging from 30 to 35 inches, grades into gray compact silt loam. This layer is only 3 or 4 inches thick and is underlain by waxy red clay which rests on limestone at a depth of 10 feet or more. This included soil is developed chiefly on the Salem and Upper Harrodsburg formations. It produces higher average yields than typical Bedford silt loam. The current selling price of this land is about 80 percent of the price of Hagerstown silt loam.

Orleans silt loam.—Orleans silt loam occurs in broad extensive areas and is the dominant soil in a large section of the county north and northwest of Fredericksburg, and also in a smaller section in the vicinity of and south of Halo in the south-central part of the county. These sections are locally known as "sinkhole country," as practically no surface streams drain them, but the surface water drains into numerous sinkholes which range in depth from 1 to 50 feet (pl. 3, *A*). The area of the sinks ranges from a few hundred square feet to several acres, and they give the landscape a very rolling appearance. Numerous areas of the steep, eroded, and gullied phases of Orleans silt loam surround the sinks.

Orleans silt loam has a surface layer of yellowish-gray silt loam from 4 to 6 inches thick. This is underlain by a 2- to 4-inch layer of yellowish-red silt loam which grades into similar-colored silty clay loam. At a depth of about 10 inches the material in this layer grades into heavy yellowish-red silty clay containing a high proportion of chert fragments, some of which are 4 inches in diameter. This layer is commonly 4 or 5 inches thick and grades into compact red clay which contains a few chert fragments. The red clay is underlain by cherty limestone at a depth of 10 feet or more.

Orleans silt loam is a well-drained soil developed on sloping land having sinkhole drainage. It occurs in extensive areas and shows considerable variation in degree of profile development. In areas where the sinkholes are small and comparatively far apart, the character of the profile approaches that of Bedford silt loam or Frederick silt loam.

Orleans silt loam is best suited to the production of pasture or forage crops. The entire soil material is strongly acid and does not produce clover satisfactorily unless the soil is first limed. When the virgin soil is first brought under cultivation, corn yields about 35 bushels an acre, but after a few years of cultivation, the yields decline to 15 or 20 bushels. Yields of other crops are correspondingly low. The common rotation of crops consists of corn, oats, and timothy. Newly cleared land generally is planted to corn for two or three seasons.

A large proportion of Orleans silt loam has been cleared and improved with buildings and fences, but the productivity of this soil has so decreased that approximately 60 percent of the cleared area has been abandoned and is used to some extent for pasture. The chief vegetation on the abandoned land is broomsedge, poverty grass, smilax vines, and small persimmon, sassafras, and blackjack oak trees, all which are of little value.

Cincinnati silt loam.—Cincinnati silt loam in cultivated fields has a light grayish-brown silt loam surface soil which becomes somewhat darker brown or reddish brown under moist conditions. It is underlain by a dark yellowish-brown or reddish-brown silty clay loam subsoil, the lower part of which is slightly streaked with gray. At a depth ranging from 31 to 36 inches, this material grades into yellow silty clay loam, highly mottled with gray, containing a few cherty pebbles. This horizon extends to a depth of 10 feet or deeper and is underlain by unweathered calcareous silty clay till of the Illinoian glacial drift. Cincinnati silt loam is developed on rolling land and has good surface and internal drainage.

Average yields of corn on Cincinnati silt loam are about 23 bushels an acre and of wheat about 12 bushels. Owing to its acidity, the soil must be limed before it will produce satisfactory yields of clover. Most of this land is farmed under a 3-year rotation of corn, wheat, and timothy. Some fields were planted to corn for several years in succession, and when yields began to decrease the land was allowed to remain fallow. Such methods of farming have greatly depleted the fertility of the soil, and considerable surface soil has been lost by erosion, therefore the greater part of Cincinnati silt loam which was cleared has been abandoned (pl. 3, *B*). Under careful management and where the land has not been damaged through erosion, this soil is capable of producing good yields.

One area of Park silt loam, located on the Millport Knob, has been included on the map with Cincinnati silt loam. Park silt loam differs from Cincinnati silt loam in that it has a pronounced reddish brown subsoil whch is underlain by a highly weathered stratified deposit of gravel instead of glacial till. About one-half of this included area is cleared and farmed, and it produces yields similar to those obtained on Cincinnati silt loam.

Gibson silt loam.—The surface layer of Gibson silt loam is light yellowish-brown silt loam about 12 inches thick. It is underlain by compact pale-yellow or yellow silty clay loam which, at a depth of about 27 inches, grades into dull yellowish-brown silt loam, highly mottled with yellowish gray. Below this, at a depth of about 36 inches, is brownish-yellow silty clay which grades into calcareous silty clay at a depth of 10 feet or deeper. This latter material is unweathered Illinoian glacial till.

Gibson silt loam is developed on gently sloping land. It has fair surface and internal drainage but not so good as does Cincinnati silt loam. The Gibson soil is associated with Cincinnati silt loam, but it occupies the gentler slopes.

Acre yields of corn average about 23 bushels and of wheat about 12 bushels. The surface soil and subsoil are acid and will not produce clover without the use of lime. About 80 percent of the land has been cleared, but much of the cleared land has been abandoned.

Zanesville silt loam.—Zanesville silt loam occupies the tops of ridges in the Norman and Crawford uplands (pl. 4, *A*). This soil has a grayish-brown surface soil and a brown subsoil similar to the corresponding layers of Frederick silt loam, but it is underlain by shale and sandstone instead of limestone. It is not so productive a soil as Frederick silt loam. Much of it is farmed only during periods when farm produce and crops command high prices.

The surface soil of Zanesville silt loam is light grayish-brown or light yellowish-brown silt loam about 10 inches thick. It is underlain by a compact yellowish-brown silty clay loam subsoil, the lower part of which is slightly streaked with yellowish gray. At a depth of about 30 inches this grades into less compact brownish-yellow silt loam or silty clay loam, which is streaked or mottled with yellowish gray. This material, in turn, grades into thinly bedded sandstone and shale at a depth of 7 feet or deeper.

Zanesville silt loam is developed on rolling land and has good surface and internal drainage. It produces an average acre yield of about 20 bushels of corn and about 12 bushels of wheat. Strawberries are well adapted to this soil. Considerable areas of the cultivated land are used for the production of apples, peaches, raspberries, blackberries, and grapes. Some areas of Zanesville silt loam have been abandoned, but about 30 percent of the land is under cultivation.

Tilsit silt loam.—Tilsit silt loam is associated with Zanesville silt loam. It is developed on slightly flattened hilltops or gentle slopes at the heads of small natural drainageways. On the steeper slopes it grades into Zanesville silt loam.

Tilsit silt loam has a grayish-brown surface layer about 6 inches thick. This is underlain by a light yellowish-brown silt loam subsurface soil which grades into a yellow silty clay loam subsoil at a depth of 10 or 12 inches. The subsoil is mottled or streaked with gray and yellowish gray below a depth of 24 inches, and at a depth of 36 inches it grades into brownish-yellow silty clay loam streaked and mottled with yellowish gray. This layer is underlain by thinly bedded partly disintegrated gray sandstone and shale at a depth of 7 feet or deeper.

Very little Tilsit silt loam is under cultivation in Washington County, and, where cultivated, it is used for the same crops as Zanesville silt loam, but it produces slightly lower yields.

Wellston silt loam, colluvial phase.—Wellston silt loam, colluvial phase, consists of grayish-brown shaly silt loam to a depth of 3 feet or deeper. This material is underlain by yellowish-gray disintegrated shale and sandstone, which grades into bluish-gray unweathered sandstone at a depth of 6 feet or more. Soil of this phase occurs at the bases of slopes bordering areas of Wellston silt loam, slope phase, and Muskingum silt loam. In many places areas of the Wellston soil were too narrow to be shown on the map and were included with the Muskingum soils. In the larger areas the relief ranges from nearly level to moderately steep, and surface drainage ranges from good to rapid, depending on the degree of slope. Internal drainage is rapid, owing to the large proportion of sandstone gravel and shale fragments distributed throughout the soil. Owing to the unfavorable relief and the association of this soil with soils on steep slopes, only about 25 percent of the land is under cultivation. A rather large proportion of the cultivated land is used for the production of tobacco or of truck crops for family use. Corn, which is the most common field crop, produces about 20 bushels an acre. The uncultivated land either is forested or comprises abandoned fields. Much of the land is dissected by small temporary drainageways, and many idle fields are badly gullied.

Princeton fine sandy loam.—Princeton fine sandy loam is a soil of small extent. It is developed from wind-blown sand and occurs on both the uplands and terraces, only along the south bluff and in the valley of East Fork White River. It is developed in characteristic rolling dunelike areas.

The 13-inch surface soil is dull-brown or grayish-brown fine sandy loam or loamy fine sand. It is underlain by a compact brown fine sandy loam subsoil containing faint yellowish-brown and yellowish-gray vertical streaks and markings. The subsoil becomes less compact at a depth of about 36 inches and, with increasing depth, grades into calcareous light-gray fine sand. In most places, the entire soil material is only slightly acid or neutral.

This soil produces good yields of corn when the rainfall is normal or higher than normal and well distributed, but during dry years, corn fires badly. Most of the watermelons grown in Washington County are produced on this soil. The greater part of the land is under cultivation.

Elk silt loam.—Elk silt loam has a light-brown surface soil 10 or 12 inches thick. This is underlain by a heavier reddish-brown silty clay loam subsoil which grades, at a depth of 34 inches, into reddish-brown silty clay loam slightly streaked with yellowish brown and grayish brown. This layer may grade into material containing chert and a little limestone gravel at a depth of 42 or more inches, but the proportion of gravel in most places is low. In a few places granite and other transported rock indicate that the material in these locations is partly of granitic origin.

Elk silt loam occupies small areas along the edges of terraces, mainly along Blue River. It has good internal and surface drainage. It is managed in a similar manner and produces similar yields to those obtained on Frederick silt loam. Practically all of this soil is under cultivation.

As mapped, Elk silt loam includes a fairly large proportion of a soil more closely resembling Holston silt loam. Both soils are deeply weathered, and it is impossible to separate them accurately on the map. Typically, Holston silt loam is derived from noncalcareous material on terraces along streams which have transported these materials chiefly or entirely from sandstones and shales, whereas the parent material of Elk silt loam has been washed from limestones or from calcareous glacial drift. This transitional soil is most extensive near South Boston and Blue River, on the Middle and South Forks of Blue River, respectively, but practically all of it has been, at least slightly, influenced by limestone. Holston silt loam in virgin areas has a light-brown or yellowish-brown silt loam surface soil about 10 inches thick, but in many cultivated fields this layer is somewhat shallower because of erosion. It is underlain by a yellowish-brown silty clay loam subsoil, in many places streaked or slightly mottled with grayish yellow and gray below a depth of 20 inches. At a depth of 30 inches the subsoil grades into less compact brownish-yellow silty clay loam slightly mottled with gray.

Pekin silt loam.—Pekin silt loam occupies gently sloping areas where the surface drainage is good but not so rapid as that of Elk silt loam. In many places the Pekin soil occupies the more nearly flat areas on terraces surrounded by sloping areas of the Elk soil.

The 10-inch surface layer is grayish-yellow loam which changes to brown as areas of Elk silt loam are approached. This is underlain by brownish-yellow silty clay loam, slightly streaked or mottled with gray below a depth of 20 inches. At a depth of about 30 inches, this material, in turn, is underlain by more silty brownish-yellow silty clay loam, slightly streaked and mottled with gray. This material rests on stratified deposits of limestone and chert gravel, with some sandstone and shale in places, at a depth ranging from 48 to 60 inches.

Pekin silt loam, as mapped, includes many small areas of Monongahela silt loam, which, although very similar to Pekin silt loam, is derived from sandstone, shale, and other noncalcareous river terrace materials, mostly in the form of silt, clay, and sand.

Acre yields of corn average about 23 bushels and of wheat about 11 bushels. Both the surface soil and subsoil are acid and do not produce satisfactory yields of clover unless the land is limed. Corn, oats, and timothy, or corn, wheat, and timothy are the most common rotations. Occasionally tomatoes are grown as a special crop.

Markland silt loam.—Markland silt loam is restricted to terraces along East Fork White and Muscatatuck Rivers and their tributaries.

The surface soil, to a depth of 6 or 8 inches, is light-brown heavy silt loam, and the underlying layer is compact dull-brown silty clay loam. This is underlain, at an average depth of 30 inches, by dull grayish-brown silty clay backwater deposits of glacial origin, which contain numerous calcareous concretions. Somewhat gray colors predominate with increasing depth. This is due to lack of oxidation of the iron.

Approximately 25 percent of Markland silt loam is developed on steep slopes or on terrace escarpments. Owing to the heavy texture of the subsoil, internal drainage is much slower than in the other well-drained terrace soils, and the heavy texture of the surface soil renders it more difficult to work. Owing to these characteristics and its small total area, Markland silt loam is an unimportant agricultural soil in this county. Only about one-half of the land is under cultivation. The slight depth to calcareous material renders this soil well adapted to legumes and bluegrass. Corn yields average about 30 bushels an acre and wheat 15 bushels.

Huntington silt loam.—Huntington silt loam consists of brown silt loam to a depth of 36 inches or deeper. It is a well-drained soil close to stream channels. It is subject to overflow, and, in wet seasons, crops are damaged occasionally by high waters. This soil, in most places, is neutral or alkaline in reaction, as it is composed of sediments derived from soils developed on the limestone uplands.

This is an excellent soil for corn, which produces from 40 to 65 bushels an acre, with an average yield of about 50 bushels. Although the land seldom is planted to wheat, it produces good yields of that crop. It also produces good yields of tomatoes, timothy, and bluegrass, and is naturally well suited to clover and alfalfa. Most areas of this soil, in which limestone is within 18 inches of the surface, are left in permanent pasture. About 80 percent or more of the land is under cultivation.

A few areas of Huntington very fine sandy loam, along North Fork Blue River and Middle Fork Blue River, have been included with Huntington silt loam in mapping. These areas produce similar yields to those obtained on Huntington silt loam, and they differ from that soil only in texture.

A number of areas of Huntington silt loam occupy slightly higher elevations than the low first bottoms and are therefore not so subject to overflow. The soil in some of the higher areas is slightly acid in reaction.

Huntington silt loam, colluvial phase.—Huntington silt loam, colluvial phase, is a brown silt loam occupying the basins of limestone sinks. The reaction of this soil differs, in some areas being alkaline or neutral and in others slightly acid. Areas of the colluvial phase are small but numerous. A total of 1,216 acres was mapped, but many areas were too small to map separately. Where small areas of Huntington silt loam, colluvial phase, are surrounded by productive soils they are cropped with these soils, but in many of the sinks the surrounding slopes are too steep for cultivation, and the land has been abandoned. Corn is the chief crop in places where the bottoms of the sinks are cultivated as separate plots. Yields of corn range from 15 to 45 bushels an acre, with an average yield of perhaps 30 bushels. Small areas are devoted to truck crops, tomatoes, and bluegrass. Some areas of this soil have been damaged to some extent by a deposition of reddish-brown silty clay loam washed from the surrounding slopes.

Genesee silt loam.—Genesee silt loam consists of brown silt loam to a depth of 36 inches or deeper. It occurs along East Fork White River, where the sediments are derived mainly from glacial drift containing more or less limestone. The reaction of this soil is neutral or alkaline.

This soil produces from 40 to 70 bushels of corn an acre, with an average yield of about 55 bushels. It produces excellent yields of wheat, clover, and alfalfa but is seldom used for any crop except corn. The land is subject to severe overflow, and frequently an entire crop is lost. It is common practice to plant corn on Genesee silt loam every year and depend on the frequent overflows to renew the fertility of the soil.

Genesee fine sandy loam.—Genesee fine sandy loam is similar to Genesee silt loam except for its fine sandy loam texture. It is somewhat easier to work than Genesee silt loam and produces similar yields in normal years. During dry years, this soil does not withstand drought so well as Genesee silt loam, and yields may be greatly reduced.

In a number of areas included on the map with Genesee fine sandy loam the surface soil is medium light-gray sand which ranges from 3 to 12 inches in thickness. This is underlain by heavier textured grayish-brown silty clay loam. Both surface soil and subsoil are alkaline or neutral in reaction.

Areas of this soil occur on the bottoms of East Fork White River and Buffalo Creek. Corn is the principal crop, and some watermelons, oats, and alfalfa are grown. Crop yields are variable and depend largely on the season. In places where the sandy layer is deep, crops fire readily in dry seasons.

Genesee silty clay loam.—Genesee silty clay loam is similar to Genesee silt loam, but it is a heavier soil and consequently somewhat harder to work to a good tilth. Crop yields are not quite so high as on Genesee silt loam.

Pope silt loam.—Pope silt loam is brown or yellowish-brown silt loam to a depth of more than 36 inches. It occupies stream bottoms in which the sediments have been derived chiefly from sandstone and shale. It is subject to occasional overflow. The reaction of this soil ranges from slightly acid to strongly acid.

Corn, the principal crop, yields from 20 to 45 bushels an acre, with an average yield of about 30 bushels. Considerable areas are used in the growing of tomatoes, some of the land is used for permanent pasture, and a few small areas are used for the production of truck crops, beans, and tobacco. A few areas of Pope silt loam contain considerable gravel and are indicated on the map by gravel symbols. Most of these areas are in pasture or forest.

Some areas mapped with Pope silt loam occupy slightly elevated positions above the first bottoms and are rarely subject to overflow. This land is managed in a similar manner as is Pope silt loam, and it produces similar yields.

Pope very fine sandy loam.—The largest areas of Pope very fine sandy loam are along South Fork Blue River near Pekin. This soil is similar to Pope silt loam but has a lighter texture. It is a little easier to work than the silt loam and does not clod so readily when worked while wet. Crop yields are similar to those obtained on the silt loam.

IMPERFECTLY DRAINED AGRICULTURAL SOILS

The imperfectly drained agricultural soils include all those soils which have grayish-brown or gray surface soils and mottled grayish-brown, yellow, and gray, or gray subsoils. This group includes soils of the uplands, terraces, and bottom lands.

The soils of the uplands and terraces include the silt loam members of the Lawrence, Avonburg, Guthrie, Bartle, McGary, and Calhoun series. All these soils occupy somewhat flat or slightly undulating land. They are all imperfectly drained and during some years remain wet and soggy for long periods. Crops grown on areas of these soils not provided with sufficient artificial drainage are severely damaged

53033—39——4

either by prolonged periods of wet weather or by freezing and thawing in the spring. These soils warm late in the spring. They are acid in both the surface soils and subsoils, and they do not produce satisfactory stands of clover unless they are limed. Yields are comparatively low on all of them and some areas have been abandoned. Lawrence silt loam is the most important agricultural soil in the group.

The imperfectly drained soils of the bottom lands belong to the Lindside, Philo, Eel, Stendal, and Waverly series. Those having brown surface layers are Lindside silt loam, Philo silt loam, and Philo very fine sandy loam. These have brown surface soils to a depth ranging from 12 to 20 inches and mottled grayish-brown and gray subsoils. They are all subject to overflow but are moderately well drained between overflows. Much of the land is under cultivation. Soils of the Lindside series are neutral or alkaline in reaction, and soils of the Philo series are acid in reaction. Those soils of this group having mottled grayish-brown and gray surface soils are Eel silt loam, Stendal silt loam, and Stendal silty clay loam. All these soils have highly mottled grayish-brown and gray surface soils and subsoils. All are subject to overflow and remain wet and soggy for considerable periods. Eel silt loam is the most productive soil of this subgroup.

Lawrence silt loam.—The 12-inch surface soil of Lawrence silt loam is friable grayish-brown silt loam, containing numerous very dark brown small soft iron concretions which in places are very numerous on the surface. The material in the next layer consists of brownish-yellow silt loam, mottled or streaked with yellow, which contains considerable gray silty material along drainage lines. Below a depth of 18 inches it becomes very compact and has a tendency to break into vertical columns 1 inch or more in diameter. At a depth ranging from 40 to 44 inches, this material grades into brownish-yellow silty clay loam which is highly mottled or streaked with yellow and gray and which becomes heavier with increasing depth. At a depth of 60 or more inches, this material, in turn, grades into waxy red clay which is underlain by limestone at a depth of 10 feet or deeper. The soil material is strongly acid as far down as the waxy red clay.

Lawrence silt loam is developed in flat or only slightly undulating areas. In places where the slopes become steeper and drainage better, this soil grades into Bedford silt loam. When the spring season is abnormally wet, it is difficult to plant crops on Lawrence silt loam at the proper time, unless the land has been drained artificially, as young crops are badly damaged by excessive moisture; but when the rainfall is not excessive in the spring or the land is drained artificially, this soil produces profitable returns. Corn yields about 25 bushels an acre under favorable weather conditions. On artificially drained land, wheat yields about 15 bushels, and timothy and bluegrass yield well. Because of its acid condition, Lawrence silt loam does not produce clover satisfactorily without the addition of lime.

Avonburg silt loam.—The upper layers of Avonburg silt loam are similar to those of Lawrence silt loam, but at a depth of about 60 inches, the subsoil grades into yellow silty clay which contains a few small chert pebbles, and this material, in turn, at a depth of 120 or more inches, grades into calcareous yellow silty clay containing numerous small pebbles. This lower layer consists of unweathered Illinoian glacial till.

Avonburg silt loam is developed on flat or slightly undulating land, and it grades into Gibson silt loam in places where the slope becomes steeper and natural drainage is better.

About 75 percent or more of the land is cleared. It is used for the same crops, but does not produce such high yields as does Lawrence silt loam.

Two small areas of Clermont silt loam, northwest and west of Little York, are included on the map with Avonburg silt loam. Clermont silt loam is characterized by a 12-inch very friable light-gray silt loam surface soil underlain by compact gray silt loam containing some streaks of brownish yellow, that extend downward into the subsoil. About 60 inches below the surface, this material grades into yellow silty clay and this, in turn, into unweathered Illinoian glacial till at a depth of more than 10 feet. Clermont silt loam is developed in low flat areas, and without artificial drainage it is wet and soggy for days after every rain. In places where natural drainage is better it merges with Avonburg silt loam. Without artificial drainage, the Clermont silt loam areas can be utilized for little except pasture or forestry; but when artificially drained, the yields obtained are similar to those on Avonburg silt loam.

Guthrie silt loam.—The surface layer of Guthrie silt loam is friable light-gray silt loam. It is underlain at a depth of 12 or 14 inches, by very compact light-gray or medium-gray silt loam which grades into silty clay loam at a depth of about 40 inches. These upper layers are strongly acid. At a depth of about 64 inches, the material is medium-gray or dark-gray silty clay which grades, at a depth of 8 feet or deeper, into reddish-brown or red silty clay underlain by limestone. The soil above the waxy red clay has an acid reaction.

Guthrie silt loam is developed in flat areas where water is likely to stand for a number of days after each rain, and in wet seasons the soil remains wet and soggy for long periods. Where natural drainage conditions are somewhat better, Guthrie silt loam grades into Lawrence silt loam, and the boundaries between these soils on the map are arbitrary in some places.

Without artificial drainage, Guthrie silt loam has little agricultural value. In its natural condition it furnishes some pasture, but when drained it is suitable for the same crops as are grown on Lawrence silt loam, but it produces slightly lower yields. Some areas support a cover of second-growth trees which include considerable shagbark hickory (*Hicoria ovata*), beech, soft maple, and black gum.

Bartle silt loam.—The topmost 12-inch layer of Bartle silt loam is friable light grayish-brown silt loam containing numerous soft small very dark gray iron concretions which are especially noticeable on the surface. This layer is underlain by compact yellowish-brown silt loam, mottled or streaked with gray, which contains considerable gray silty material along drainage crevices. The upper part of this layer has a tendency to break into columns 1 inch or more in diameter. The lower part grades, at an average depth of about 60 inches, into noncalcareous water-laid material or, in a few areas, such as the upper valley of South Fork Blue River, into glacial drift. The water-laid material ranges in texture from clay to cherty gravel. The entire soil mass is acid in reaction.

Bartle silt loam occurs on stream terraces in areas of flat or slightly undulating relief. Where natural drainage conditions are better, it grades into Pekin silt loam. Although Bartle silt loam occurs along various streams in the county, it is more extensive along South Fork Blue River.

Crop yields on this soil are similar to those obtained on Lawrence silt loam, but the average is not so high. Tomatoes and some cabbage are grown as special crops on this soil. About 60 percent of the land has been cleared, and a few fields have been abandoned.

Calhoun silt loam.—The topmost 12-inch layer of Calhoun silt loam is friable light-gray silt loam. It is underlain by a slightly compact layer of medium-gray silt loam which grades into medium-gray silty clay loam, slightly streaked with brownish yellow at a depth of about 40 inches. This material, at an average depth of 60 inches, grades into noncalcareous water-laid deposits ranging in texture from clay to gravel. In many areas the material may consist partly of glacial drift. The entire soil mass is strongly acid.

Calhoun silt loam is a terrace soil. It is most extensively developed along South Fork Blue River on glacial valley trains. The land is flat and is likely to remain saturated by water for long periods. Where natural drainage conditions are better, Calhoun silt loam grades into Bartle silt loam.

Calhoun silt loam has little agricultural value without artificial drainage, but when drained it produces from 10 to 35 bushels of corn an acre, with an average yield of about 20 bushels; and wheat yields an average of about 12 bushels. As the unlimed soil is too acid for the growing of clover, the common rotation on this soil is corn, wheat, and timothy. Oats frequently replace wheat in the rotation. About 25 percent of the land is under cultivation.

McGary silt loam.—The 7-inch surface soil of McGary silt loam consists of heavy light-gray silt loam. The subsoil is compact gray silty clay loam, mottled with grayish yellow, which contains numerous soft very dark brown iron concretions. This material grades into a calcareous substratum, similar to that of Markland silt loam, at a depth ranging from 30 to 50 inches.

McGary silt loam is a terrace soil associated with the Markland and Montgomery soils along East Fork White River and Muscatatuck River (pl. 4, *B*). It is less perfectly drained than the Markland soil, and the relief ranges from flat to gently undulating.

Owing to its heavy texture, McGary silt loam is rather difficult to work. During some years it is difficult to plant crops on this soil because of the imperfect drainage, but some of it has been drained artificially. Wheat planted on this soil is sometimes damaged by prolonged periods of freezing and thawing, and floods sometimes cause total crop failures.

Corn yields from 15 to 30 bushels an acre, with an average of about 25 bushels, and wheat from 10 to 20 bushels. The soil, because of its neutral to alkaline reaction, is naturally well suited to clover.

Lindside silt loam.—Lindside silt loam has a brown silt loam surface soil underlain, at a depth ranging from 12 to 20 inches, by mottled grayish-brown and gray silt loam which extends to a depth of 60 or more inches. In some places this lower material contains more or less very fine sand.

Lindside silt loam has a neutral or alkaline reaction. It occupies areas along streams where the sediments are derived from upland soils underlain by limestone. It is associated with Huntington silt loam, occupying the less well-drained situations. Although it is not quite so desirable a soil as Huntington silt loam, it produces good crops of corn, wheat, oats, and clover. Corn, the chief crop, is frequently planted in a field for several years in succession. The average yield is about 35 bushels an acre.

Gravelly areas of this soil are indicated on the map by gravel symbols. The gravelly areas are more difficult to cultivate than the typical soil and are somewhat less productive.

Philo silt loam.—Philo silt loam has a brown silt loam surface soil underlain, at a depth of about 12 inches, by grayish-brown silt loam which is highly mottled with gray and contains yellowish-brown iron stains. This layer extends to a depth of 40 or more inches and is underlain by mottled grayish-brown and gray noncalcareous water-laid sediments which range in texture from clay to gravel.

Philo silt loam is acid in reaction. It occurs along streams where the sediments are derived from upland soils underlain by thin-bedded noncalcareous sandstone and shale formations.

Corn is the chief crop, and it is frequently grown on the same field for several successive years. It yields from 15 to 40 bushels an acre, with an average yield of about 25 bushels. Fair yields of oats and timothy are obtained but clover does not grow satisfactorily because of the acid reaction of the soil. Tomatoes, cabbage, and tobacco are grown in small areas, and a small part of the land is kept in permanent pasture or forest.

A few areas of Philo silt loam contain noticeable quantities of soft shale fragments and gravel throughout the soil mass. These are indicated on the map by gravel symbols and are not quite so valuable for the production of crops as are the gravel-free areas.

Philo very fine sandy loam.—Philo very fine sandy loam is similar to Philo silt loam, except for its slightly coarser texture, and crop yields on the two soils are about the same. The very fine sandy loam occupies only a few small areas.

Eel silt loam.—Eel silt loam has a dull grayish-brown surface soil, slightly mottled with gray. It is underlain, at a depth ranging from 10 to 15 inches, by heavy highly mottled yellowish-gray and gray silt loam which contains a few streaks of yellowish brown along old root channels. At a depth of about 60 inches, the material in this layer grades into calcareous water-laid mottled yellowish-brown and gray sediments of various textures, ranging from clay to gravel. The entire soil mass is neutral or alkaline in reaction.

Eel silt loam occupies only a few small areas along East Fork White River. It is associated with Genesee silt loam, occupying the lowest and most imperfectly drained areas. It is composed of sediments derived chiefly from glaciated sections.

Eel silt loam produces from 20 to 45 bushels of corn an acre, with an average yield of about 35 bushels. It is well suited to sweetclover and other clovers when the land is artificially drained. Most of this soil is used for the production of corn. As it is subject to overflows from East Fork White River, frequently an entire crop is lost.

Stendal silt loam.—The 10- or 12-inch surface soil of Stendal silt loam consists of highly mottled grayish-brown and gray silt loam which is underlain, in most places, by slightly heavier highly mottled grayish-brown and gray silt loam containing numerous brown iron stains and, in some places, yellowish-gray mottlings. This layer extends to a depth of 40 or more inches and is underlain by noncalcareous water-laid mottled grayish-brown and gray sediments of various textures. The entire soil mass is strongly acid.

This soil is associated with Philo silt loam along streams where the sediments are derived from upland soils underlain by thin-bedded sandstone and shale formations. A few areas mapped as Stendal silt loam include sediments from other sources.

Corn is the principal crop grown on this soil, and the yields range from 15 to 30 bushels an acre, with an average yield of 20 bushels. Some timothy and oats are grown but return comparatively low yields. A few small areas are planted to tomatoes, cabbage, and tobacco. About 50 percent of the land is in forest or pasture.

A few small areas of Stendal very fine sandy loam, most of which are along the lower course of Delaneys Creek, are included on the map with Stendal silt loam. These areas differ from Stendal silt loam only in their lighter texture. Crop yields are similar on the two soils. Gravelly areas of Stendal silt loam are indicated on the map by gravel symbols. These areas do not produce quite such high yields as the gravel-free areas, and practically all of them are forested.

Stendal silty clay loam.—Stendal silty clay loam has a gray silty clay loam surface soil mottled with grayish brown. It is underlain at a depth ranging from 12 to 20 inches, by heavy gray silty clay loam mottled with brownish gray, which grades into gray silty clay at a depth of about 36 inches. The entire soil mass is streaked with dark-brown or yellowish-brown iron stains. Stendal silty clay loam is acid to a depth of about 6 feet, but below this depth the material is alkaline or calcareous. This soil occupies extensive areas in the bottom lands of Muscatatuck River.

Stendal silty clay loam is a submarginal soil, and very little of it is under cultivation. Because of its low-lying position along Muscatatuck River, it is subject to frequent overflows and remains covered with water for long periods.

About 50 percent of this soil has been cleared, but practically none of it is under cultivation. The abandoned fields are commonly covered with foxtail, groundcherries, and smilax vines. In the uncleared areas there is a mixed stand of buttonbush, black birch, soft maple, sycamore, and some slippery elm, butternut, hickory, and water oak.

Small areas of Waverly silty clay loam are included with Stendal silty clay loam in mapping. The Waverly soil is light-gray silty clay loam, to a depth of 36 inches, and is underlain by light-gray silty clay. The soil material is acid to a depth ranging from 5 to 6 feet. None of this included soil is under cultivation.

Waverly silt loam.—Waverly silt loam is the only imperfectly drained alluvial soil with a light-gray surface soil mapped in Washington County. Both the surface soil and subsoil are light-gray silt loam with a few brownish-yellow iron stains. The subsoil grades into light-gray silty clay coarsely mottled with yellow to a depth of more than 6 feet. This material is acid to a depth ranging from 5 to 6 feet, below which it is alkaline or calcareous.

Waverly silt loam occupies extensive flat areas in the Muscatatuck River bottom land, surrounded by areas of Stendal silt loam and Stendal silty clay loam.

The principal crops are corn and oats. Corn yields from 5 to 40 bushels an acre, with an average yield of about 15 bushels, and oats yield from 15 to 30 bushels, with an average yield of about 20 bushels. Timothy is a minor crop.

Agriculturally this is a submarginal soil. It is subject to frequent overflows and remains covered with water or in a condition too wet to work for weeks at a time. Sometimes, for 2 or 3 years in succession, a crop cannot be planted because of unfavorable weather conditions in the spring, and frequently an entire crop is lost because of floods or because the land is too wet for the growing crop.

POORLY DRAINED AGRICULTURAL SOILS

The poorly drained agricultural soils are Burgin silty clay loam and Montgomery silty clay loam. These soils have several characteristics in common. Both are dark colored, neutral or alkaline in reaction throughout, naturally poorly drained, and occupy areas which remain wet and soggy practically the entire year unless they are artificially drained. Both are productive soils when artificially drained.

Burgin silty clay loam.—Burgin silty clay loam has a very dark gray, in some places almost black, silty clay loam surface soil which is underlain, at a depth of about 8 inches, by compact dark-gray silty clay loam that grades, at a depth of about 14 inches, into stiff medium-gray silty clay or clay. This layer is underlain by limestone at a depth of 12 feet or deeper. Most areas of this soil are surrounded by areas of Guthrie silt loam or Lawrence silt loam.

A few bodies having a medium-gray surface soil, and a few small areas of Algiers silt loam are included with Burgin silty clay loam in mapping. Algiers silt loam consists of a 10- or 12-inch layer of brown silt loam underlain by dark-gray silty clay loam which grades into lighter gray silty clay at a depth of 24 or more inches. This included soil is developed on the first bottoms along small streams, where the alluvial materials consist of wash from Frederick silt loam and other soils developed over limestone.

On artificially drained Burgin silty clay loam areas, corn yields from 25 to 50 bushels an acre, with an average yield, in favorable years, of about 40 bushels. When drained, the land produces good crops of wheat and is well suited to clover.

Montgomery silty clay loam.—Montgomery silty clay loam has an 8-inch dark-gray silty clay loam surface soil. It is underlain by lighter gray or medium-gray silty clay loam which extends to a depth of 18 inches. Below this depth the material consists of stiff yellowish-gray silty clay containing lime concretions.

Montgomery silty clay loam is derived from silty clay terrace materials deposited from backwaters during the early Wisconsin glacial period. It is associated with McGary silt loam along East Fork White River and Muscatatuck River (pl. 4, *B*).

In the lower parts of the Buffalo Creek bottom land, a few small areas of muck have been included with mapped areas of Montgomery silty clay loam, and their location is indicated on the map by swamp symbols. Near the small areas of muck are some small included areas of Lyles silt loam which is a dark-colored silt loam developed from calcareous wind-blown material.

Montgomery silty clay loam produces from 20 to 65 bushels of corn an acre, with an average yield of about 40 bushels. It has been known to produce 42 bushels of wheat an acre, but the average yield is about 15 bushels. The average acre yield of oats is about 25 bushels. The soil is well adapted to clover. Because of its low position, the land is subject to overflow, and in many years crops are seriously damaged or totally destroyed by floods.

GRAZING AND FOREST SOILS

The grazing and forest soils include those soil types or phases which are used dominantly for pasture and forestry. These types and phases are rarely utilized for crop production because of some unfavorable feature which makes them unsuited to this purpose. For example, soils occurring on steep slopes, or badly eroded or very stony soils, generally are not suitable for cultivated crops, and, therefore, are used for pasture or forestry.

The grazing and forest soils include Wellston silt loam; Wellston silt loam, slope phase; Muskingum silt loam; Muskingum silt loam, eroded phase; Orleans silt loam, steep phase; Orleans silt loam, eroded phase; Orleans silt loam, gullied phase; Frederick silt loam, steep phase; Frederick silt loam, gullied phase; Frederick silt loam, eroded phase; Hagerstown silt loam, steep phase; Hagerstown silt loam, gullied phase; Corydon silt loam; Cincinnati silt loam, steep phase; Cincinnati silt loam, eroded phase; Princeton fine sandy loam, steep phase; and Elk silt loam, steep phase.

Wellston silt loam.—Wellston silt loam occupies the tops of narrow ridges in association with its slope phase and with Muskingum silt loam. It has a 10- or 12-inch light grayish-brown or yellowish-brown silt loam surface soil underlain by a 2- or 3-inch layer of yellowish-brown silt loam or silty clay loam. Beneath this layer is firm yellowish-brown silt loam which grades into disintegrated and partly weathered yellowish-gray shale and sandstone at a depth ranging from 3 to 4 feet.

This soil occupies nearly level land, which occurs as narrow strips, with only a narrow transitional band between it and Wellston silt loam, slope phase, or Muskingum silt loam. Practically all of Wellston silt loam is forested.

Wellston silt loam, slope phase.—Wellston silt loam, slope phase, has a light-brown or light yellowish-brown surface soil 12 or 14 inches thick. Below this is slightly heavier yellowish-brown silt loam, about 2 inches thick, underlain by platy firm yellow or brownish-yellow silt loam which grades into partly disintegrated yellowish-gray shale at a depth ranging from 4 to 5 feet. Unweathered thin-bedded bluish-gray sandstone and shale lies from 6 to 10 feet below the surface.

This soil is developed on rolling land. Practically all of it is forested, and only small areas along the lower slopes are planted to tomatoes or tobacco. A small acreage is used for pasture, but, as the land does not support a good stand of bluegrass, little pasture is available for livestock. Small areas are utilized for home sites and gardens. This land is best utilized for forestry, and its value depends largely on the condition and size of the trees growing on it.

Muskingum silt loam.—Muskingum silt loam occurs on long very steep slopes, on which the soil is very shallow and includes many outcrops of sandstone and shale. This soil is almost entirely forested, and its value is largely dependent on the value of the timber growing on it. (pl. 4 *A*). A few small areas of Muskingum stony silt loam are included in mapping.

Muskingum silt loam, eroded phase.—Muskingum silt loam, eroded phase, consists of areas of Muskingum silt loam which have been severely damaged by erosion. In some places only the surface soil has been removed by sheet erosion, but in other places gullies have been cut down to the parent rock. Areas of this soil are for the most part abandoned land, although some of them are forested.

Orleans silt loam, steep phase.—Orleans silt loam, steep phase, consists of Orleans silt loam which occupies steep slopes. Under cultivation, this steep soil erodes severely and is soon ruined by the removal of the surface soil. Soil of this kind is best suited to pasture or forestry.

Orleans silt loam, eroded phase.—Orleans silt loam, eroded phase, consists of areas of Orleans silt loam, in which the surface soil has been largely removed by erosion, leaving the cherty red silty clay or clay exposed on the surface. Such areas occur mainly around the edges of sinkholes, where the soil has been cultivated on comparatively short steep slopes.

Areas of this soil in abandoned fields are bare of vegetation; they produce practically nothing under cultivation; and they are of little value even for pasture or forestry.

Orleans silt loam, gullied phase.—Orleans silt loam, gullied phase, is Orleans silt loam which has been practically ruined by gullying. These areas occur mostly on short steep slopes around the edges of sinkholes, and they are of no value except for forestry.

Frederick silt loam, steep phase.—Frederick silt loam, steep phase, has profile characteristics very similar to those of the typical soil, but it has developed on slopes that are too steep for profitable crop production. These slopes are difficult to farm with machinery, and they gully and erode badly when placed under cultivation. Many areas of this steep soil are very stony on the surface and are used most advantageously for permanent pasture or forestry. The land supports an excellent stand of bluegrass when not overgrazed. During July and August, when the soil is unusually dry, the grass is likely to discontinue growth until the soil moisture is replenished.

Frederick silt loam, gullied phase.—Frederick silt loam, gullied phase, consists of Frederick silt loam which has been badly cut by gullies ranging from 5 to 6 feet in depth. The land is practically ruined for cultivation, and most of it is best suited to forestry, although a few of the less damaged areas are used for permanent pasture. Most of this land is abandoned, and the spaces between the gullies support a vegetation consisting of small sassafras and persimmon trees, smilax vines, broomsedge, and poverty grass.

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Frederick silt loam, eroded phase.—From Frederick silt loam, eroded phase, the surface soil has been removed by erosion, leaving patches of waxy red clay with many small fragments of chert on the surface. Most areas of this soil occur on comparatively steep slopes which have been cultivated, but in a few places the slopes are rather gentle, and here erosion is the result of allowing the fields to remain fallow without a cover crop for several winters.

The removal of the surface soil and, in some places, the subsoil, has seriously reduced the fertility of this land. It is reported that under present economic conditions crops grown on this soil do not repay the cost of production. The land is best utilized by seeding it to lespedeza for pasture or by reforesting it. Large areas have been abandoned.

Hagerstown silt loam, steep phase.—Hagerstown silt loam, steep phase, is too steep for easy cultivation with farm machinery, and the land is subject to gullying and erosion when cultivated. It produces excellent stands of bluegrass, and is best suited to pasture, or, on some of the steeper slopes, to forestry.

Hagerstown silt loam, gullied phase.—Hagerstown silt loam, gullied phase, consists of areas of Hagerstown silt loam which have been practically ruined by gullying. Most of this land occupies long steep slopes and is best suited to forestry.

Corydon silt loam.—The surface soil of Corydon silt loam is brown silt loam about 7 inches thick. This is underlain by light-brown silt loam. Below this layer is light-brown silty clay loam underlain by bedrock at a depth of about 19 inches from the surface. A reddish tint is noticeable in some of the soils included on the map with Corydon silt loam; in others the surface soil is dark-gray or very dark gray granular heavy silt loam or silty clay loam.

Corydon silt loam is developed on very steep slopes. It includes numerous outcrops of limestone, and fragments of limestone are present throughout the entire soil mass. It has a neutral or alkaline reaction. All the land, which occurs only in small areas, is in forest or permanent pasture.

Cincinnati silt loam, steep phase.—Cincinnati silt loam, steep phase, occupies steep slopes. Most of the areas are used for pasture or forest land.

Cincinnati silt loam, eroded phase.—The eroded phase of Cincinnati silt loam includes those areas of Cincinnati silt loam which have been badly damaged by surface washing and gullying. In these areas the greater part of the surface soil has been removed by erosion, leaving the heavy reddish-brown silty clay subsoil exposed at the surface. The greater part of this land has been abandoned, and it can be profitably used only for forestry.

Princeton fine sandy loam, steep phase.—The steep phase of Princeton fine sandy loam occupies steep slopes, and practically all of it is forested. A few small badly gullied areas are included with this soil on the map.

Elk silt loam, steep phase.—The steep phase of Elk silt loam occurs on the escarpments where the terraces abut on the first-bottom lands. The slopes are comparatively steep, and most of the land is used for pasture or wood lots. The soil profile varies considerably in character, owing to the effects of accelerated erosion. In some places it is much like the normal Elk profile with a well-developed heavy subsoil, and in some places it has a grayish-brown surface soil which directly overlies the parent material. In other places the heavy subsoil or parent material is exposed by erosion. A few cultivated areas produce low yields of the same crops as those produced on typical Elk silt loam. Land use on this steep soil should be confined to wood lots and pasture.

MORPHOLOGY AND GENESIS OF SOILS

Washington County is located in the region of Gray-Brown Podzolic soils. The mature soils have developed under a forest cover with ample rainfall to penetrate through the solum into the parent material. Except for short periods, a moist condition is maintained throughout the soil profile. The process of leaching is slow but almost continuous in the soil, except for short periods during the winter when the ground is frozen and during dry periods. In this section of the country, the climatic conditions allow the accumulation of only a thin layer of surface organic litter and dark-colored soil in the upper part of the profile. The mature soils are light colored, low in organic matter, and acid in reaction.

In this county, the soil parent material is derived from 10 different geological formations or sources of material.

Illinoian glacial drift is the underlying geological material in the Scottsburg lowland in the northeastern part of the county. This is dominantly a calcareous silty clay intermixed with small proportions of sand, gravel, and stone. In most places this material is unstratified. The Cincinnati, Gibson, and Avonburg silt loams are the soils developed from Illinoian glacial drift.

The thin-bedded sandstones and shales of the Knobstone formations [11] occupy practically all of the Norman upland. These are thin beds of intermixed noncalcareous soft fine-grained bluish-gray sandstones and shales. They erode easily and are responsible for the deep dissection in the Norman upland. The Chester sandstones and shales are thin-bedded, noncalcareous, and bluish gray. They occur as cappings on the hills in the Crawford upland. The Ohio River formation is a faintly cemented noncalcareous light-gray sandstone which, in some places grades into a coarse-grained brownish-red conglomerate. It occupies a few of the highest areas in the southeastern part of the county. Soils of the Zanesville, Wellston, and Muskingum series are dominant on all of these sandstone and shale formations.

The Salem formation is a massive bluish-gray limestone. It outcrops in the form of a belt extending from the southeastern part of the county, south of Martinsburg, northward to the northern edge of the Mitchell plain, thence westward along the edge of the plain. Hagerstown, Corydon, Frederick, Bedford, and Lawrence silt loams are developed upon this formation.

Both the Harrodsburg and Mitchell formations are massive bluish-gray limestones containing impurities of chert. The Harrodsburg formation lies lower than the Salem formation and outcrops most exten-

[11] Knobstone formations is a collective name for a number of intermixed sandstone and shale formations of Mississippian age, which outcrop as a continuous belt in Washington County.

sively in the eastern part of the county. The Mitchell formation lies over the Salem limestone and outcrops in the central and western parts. The Frederick, Bedford, Lawrence, and Guthrie silt loams are developed on both formations. The Hagerstown and Corydon silt loams are developed on the upper Harrodsburg, and Burgin silty clay loam and Orleans silt loam overlie the Mitchell limestone.

Calcareous backwater terrace deposits of grayish-yellow silty clay of the Wisconsin glacial period are along Muscatatuck River and East Fork White River. The Markland and McGary silt loams and Montgomery silty clay loam are developed on these deposits.

The many soil types of Washington County may be grouped according to profile characteristics as follows: (1) Gray-Brown Podzolic soils, (2) Planosols, (3) Wiesenböden, (4) alluvial soils, and (5) Lithosols.

The Gray-Brown Podzolic soils may be further subdivided into three groups. The first of these have normal ABC profiles. They have grayish-brown or brown eluviated A horizons; brown, yellowish-brown, or reddish-brown illuviated B horizons; and C horizons composed of physically weathered rock materials with some chemical weathering. The second group of Gray-Brown Podzolic soils has what has been called the ABYC profile. This terminology has been used chiefly in Indiana.[12] The A and B horizons of these soils are similar to those having normal ABC profiles. The Y horizon consists of parent material which has been strongly weathered both physically and chemically. Ordinarily, it is characterized by a fairly high content of clay and by rusty-brown, red, and yellow mottled or streaked colors with a large proportion of gray in those soils that are less well drained. In other words, the Y horizon may be described as a chemically strongly weathered parent material. The C horizon beneath it has the same general characteristics as the C horizons of the normal ABC profiles; that is to say, it consists largely of physically weathered material on which chemical action has not yet had much effect. A third group of Gray-Brown Podzolic soils shows suggestions of an X horizon characteristic of the Planosols. It represents a transition between the normal Gray-Brown Podzolic soils and the Planosols.

The second important group of soils in this county, from the point of view of soil morphology, is composed of the Planosols[13] (plano for plain, or level areas; sol for soil). The claypans, or soils having ABXYC profiles, have more or less normal A and B horizons, except in the more poorly drained members of the group, where the B horizon is strongly mottled with gray and rust. Beneath the B horizon is a thin almost white or gray silty horizon varying in thickness from a few inches to a fraction of an inch. This horizon has not been given a name or letter designation because it tends to blend with the horizons above and below. In fact, streaks of gray silt follow cracks and root holes several inches into the hard claypan, or X

[12] BUSHNELL, T. M. MAP OF SOIL REGIONS AND KEY TO SOIL SERIES OF INDIANA. Ind. Agr. Expt. Sta. 1933.

[13] The word "Planosol" was coined recently to cover soils of the claypan type, which generally are developed on nearly level areas. They are described under individual type names in many soil survey reports from the Great Plains eastward and are discussed in some detail in the following: MARBUT, C. F. SOILS OF THE UNITED STATES. In U. S. Department of Agriculture, Atlas of American Agriculture, pt. 3, advance sheets No. 8. 98 pp., illus. 1935.

horizon, which lies immediately below it. The X horizon, or claypan, in better drained positions is fairly well oxidized but everywhere is more or less mottled. In the less poorly drained members of the group, the dominant color of the X horizon is brown or rust color and is streaked and mottled with gray, yellow, and, in some places, red. The X horizon of poorly drained members is dominantly gray, with mottles of other colors. Beneath the X horizon is the Y horizon, similar to that described in the soils having ABYC profiles, and beneath the Y is the slightly weathered parent material, or C horizon.

The soils having ABXYC profiles, in many places, have composite profiles with A and B horizons developed on a very old soil profile. Evidently the X horizon develops best on flat relief after very long exposure to soil-forming processes. Marbut believed that the claypan, which in many instances resembles that of the Solonetz, is due to the influence of a high ground-water table, in conjunction with the effects of soluble salts from parent rocks. In places where the present cycle of geological erosion is encroaching on the old peneplains and developing a mature relief, there is a progressive transition from the ABXYC profile to the ABYC and the ABC profiles. In such places, there is a tendency for the X horizon to be lowered gradually by soil-forming processes so that it conforms to the slope, and for it to disappear gradually. Similarly, on the more maturely dissected areas, the Y horizon in places has been entirely removed and a normal ABC profile developed. Where slopes are so steep that geological erosion has kept pace with soil development, soils having no B horizon are characteristic. These are sometimes known as soils having AC profiles and are described as Lithosols.

Wiesenböden are dark-colored soils of poorly drained depressions and are characterized by a high humus content in the upper horizons and by a dominantly gray color in the wet subsoils. In Indiana this type of profile has been designated as the HMU profile. The H standing for the humus horizon, the M for modified mineral material, and the U for relatively unmodified underlying material. In the depressions of flat upland areas where soil materials have been in place a very long time and the profiles of the dominant soils are of claypan, or ABXYC, types, the soils having HMU profiles are somewhat more complicated, and there may be two or three distinct horizons of modified parent material. Some of these M horizons are not greatly different from the X and Y horizons of the ABXYC profiles, except that the proportion of gray is much greater. In European terminology, the M and U horizons correspond approximately to the various kinds of G, or glei, horizons. Where X-like soils are included they correspond, perhaps, to the BG, or B with G, horizon of Stremme.[14] Wiesenböden, when translated, means meadow soils, and the term meadow would be used were it not for the fact that it has been used very widely in referring to undifferentiated alluvial materials.

The alluvial soils include recent deposits of material on which soil-forming processes have not yet had time to cause the development of distinct eluviated and illuviated horizons. Most of these, how-

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[14] STREMME, HERMANN G. GRUNDZÜGE DER PRAKTISCHEN BODENKUNDE. 332 pp., illus. Berlin. 1926. See p. 169.

ever, contain more organic matter in the upper layers than in lower ones, even though there is no good evidence of eluviation and illuviation. Essentially they are AC soils. In Washington County, the alluvial soils composed of neutral or alkaline materials are more productive of cultivated crops and forage, as a rule, than those composed of acid alluvium, provided textures and drainage conditions are suitable.

The Lithosols of this county are thin soils, in general developed on steep slopes where soil-forming processes have been counterbalanced by rapid geological erosion so that the soils consist essentially of a mixture of rock fragments and a minor proportion of chemically weathered materials. Profile development is in its early stages, and AC types of profile are the rule. In other words, eluviation has not advanced far and there is little evidence of illuviation.

Natural drainage is a factor of major importance in the kind of soil profile which will develop and in the utilization of the land. In this county, six different types of drainage conditions were recognized in classifying the soils for mapping. The first includes those soils, generally of depressed areas, where drainage is very poor throughout and water stands on or near the surface much of the time. In the second, drainage is poor, both externally and internally, but the soils dry during periods of drought. This type of drainage is common on flat or slightly depressed upland or terrace areas. In the third, drainage conditions are slightly better, with imperfect drainage at the surface and poor drainage internally. In most places the relief is gently undulating or flat. Soils of the fourth drainage type are well drained externally by run-off and are imperfectly drained internally, generally because of heavy substrata or low relief. Most of the areas are undulating. Soils of the fifth drainage type are well drained throughout—both externally and internally—and the relief generally is undulating or gently rolling, except in places where the parent materials are sufficiently porous to encourage fairly rapid downward movement of water. Soils of the sixth drainage type are excessively drained, either by external means or because of an excessively porous parent material.

It must be remembered that the statements concerning the types of relief mentioned in connection with various drainage types do not hold good everywhere. Drainage conditions are influenced by the degree of porosity of substrata as well as by relief. For example, much of the Hagerstown soil is drained through cracks and caves in the underlying limestone, and some of the soils of the flat river terraces are well drained by means of porous gravel strata beneath the solums.

Geographically the soils of Washington County may be grouped in "catenas." The catena is composed of several different soil series developed on similar parent materials but having profile characteristics corresponding to differences in drainage conditions. For example, members of the Guthrie, Lawrence, Bedford, Frederick, Corydon, and Burgin series comprise a catena of soils developed on more or less cherty limestone in this county. Differences in the profile characteristics of these soils are due very largely to differences in drainage conditions and relief and their attendant effects. The concept of the catena is very useful and convenient for field identification and mapping of soils and for considering their geographical and geological relationships. The term was first used by Milne.[15]

Table 6 shows a grouping of the soil series on the basis of profile characteristics and drainage conditions.

TABLE 6.—*Soils of Washington County, Ind., grouped on the basis of their profile characteristics and drainage conditions*

Soil group and series	Drainage condition	Profile	Underlying material
Gray-Brown Podzolic:			
Markland	Well drained throughout	ABC	High-lime silts and clays.
Wellston	do	ABC	Sandstone with some shale.
McGary	Imperfect external; poor internal.	ABC (with some glei).	High-lime silts and clays.
Princeton	Well drained throughout	ABC (with some ABYC).	High-lime silts and wind-blown sands.
Orleans	Well or excessively drained.	ABC	Cherty limestone.
Hagerstown	Well drained throughout	ABYC	Limestone.
Frederick	do	ABYC (with some X).	Cherty limestone.
Cincinnati	do	ABYC (with little X).	Illinoian till (calcareous).
Zanesville	do	ABYC	Siltstone and sandstone.
Elk	do	ABYC	Old alluvium (terrace materials of mixed origin).
Pekin	Imperfect internal	ABYC (with some X).	Do.
Planosols:			
Bedford	Good external; imperfect internal.	ABXYC	Limestone.
Lawrence	Imperfect external; poor internal	ABXYC	Do.
Guthrie	Poor external and internal.	ABXYC	Do.
Tilsit	Good external; imperfect internal.	ABXYC	Siltstone and sandstone.
Avonburg	Good to imperfect external; poor internal.	ABXYC	Illinoian till (calcareous).
Bartle	Imperfect external, poor internal.	ABXYC	Old alluvium, high in silt.
Calhoun	Poor external and internal	ABXYC	Do.
Wiesenböden:			
Montgomery	Very poor throughout	HMU	High-lime silts and clays.
Burgin	do	HMU	Limestone.
Alluvial:			
Huntington	Good throughout	AC	Sweet alluvium from limestone materials.
Genesee	do	AC	Sweet alluvium from glacial materials.
Pope	do	AC	Acid alluvium, chiefly from sandstone and shale materials.
Eel	Imperfect	AC	Sweet alluvium from glacial materials.
Lindside	Imperfect to poor	AC	Sweet alluvium from limestone materials.
Philo	do	AC	Mixed acid alluvium
Stendal	Poor	AC	Do.
Waverly	Very poor	AC	Do.
Lithosols:			
Muskingum	Excessive external	AC	Sandstone with some shale.
Corydon	Good to excessive external	AC [1]	Cherty limestone.

[1] Includes some Brown Forest soil and a little Rendzina.

Elk silt loam (including areas of Holston silt loam), Pekin silt loam (including areas of Monongahela silt loam), and Calhoun silt loam are developed on terrace materials which range in texture from clay to gravel. The Holston, Monongahela, and Calhoun soils are developed from noncalcareous water-laid deposits from sandstone and shale uplands with an admixture in a few places of materials of glacial origin, whereas the Elk and Pekin are developed from materials of limestone origin and more or less mixed sandstone, shale, and glacial materials.

[15] MILNE, G. PROVISIONAL SOIL MAP OF EAST AFRICA. 34 pp., illus. London. 1936.

Some of the well-drained soils are well developed, but others occur on steeply sloping land where soil-forming processes are held in check by rapid geological erosion. Mature soils are those well-drained and well-developed soils, in which an approximate balance has been reached between the soil and its climatic and biological environment. They are developed on smooth well-drained land which normally is not subjected, under natural conditions, to extensive removal of surface material through erosion.

The better drained soils of this county are included in the Hagerstown, Corydon, Frederick, Orleans, Bedford, Zanesville, Tilsit, Wellston, Muskingum, Cincinnati, Gibson, Elk, Pekin, Markland, and Princeton series.

Members of the Hagerstown series are mature soils developed on comparatively pure limestone. Following is a description of a profile of Hagerstown silt loam, as observed 2 miles northeast of Salem, along the north side of the Salem-Canton State road, in the SW¼ sec. 10, T. 2 N., R. 4 E.:

A_0. A one-fourth-inch layer of surface litter composed of deciduous leaves, twigs, bark, and other organic remains.

$A_{1\,1}$. 0 to one-half inch, very dark brown silt loam containing an accumulation of organic matter.

$A_{1\,2}$. One-half inch to 1½ inches, dark grayish-brown silt loam with some very fine darker brown organic stains or penetrations. This layer contains a mass of small fibrous roots.

$A_{2\,1}$. 1½ to 4 inches, brown silt loam with slight phylliform structure and a few very fine organic penetrations or stains of grayish brown.

$A_{2\,2}$. 4 to 13 inches, yellowish-brown silt loam with slight pylliform structure.

B_1. 13 to 15 inches, friable brown silt loam with thin brownish-gray streaks along drainage lines and as linings of worm holes and cracks. The material in this layer is slightly heavier textured and has a tendency to break into angular fragments.

$B_{2\,1}$. 15 to 20 inches, heavy brown silt loam with faint coatings of yellowish brown or brownish gray along the sides of worm holes, root channels, and other openings. This layer breaks into angular fragments averaging more than 1½ inches in diameter.

$B_{2\,2}$. 20 to 26 inches, heavy brown silt loam with an increased amount of brownish gray along the drainage lines and other openings.

Y_1. 26 to 30 inches, light reddish-brown silty clay loam with lighter reddish brown on the inside of the particles and with a few small very dark brown manganese stains. Only a few of the larger tree roots penetrate this layer.

Y_2. 30 to 39 inches, friable reddish-brown silty clay loam with some manganese stains.

Y_3. 39 to 52 inches, friable heavier reddish-brown silty clay loam with darker reddish brown on the outsides of the particles and a few small manganese stains.

Y_4. 52 to 100 inches, friable reddish-brown silty clay, coarsely mottled with grayish yellow and yellowish brown. Dark-colored soft manganese concretions with a maximum diameter of one-half inch. This layer also contains a few chert fragments.

C_1. 100 to 120 inches, brownish-yellow silty clay which contains many chert fragments with a maximum diameter of 2 inches, coated with reddish-brown clay.

C_2. 120 to 280 inches, waxy brownish-yellow clay with reddish brown on the outsides of the particles. The fragments of chert are larger than in the layer above, but the manganese concretions are slightly smaller.

C_3. 280 to 286 inches, brownish-yellow clay, with nodules of reddish-brown clay which break in concentric layers and with reddish-brown coatings on the outsides of the chert fragments.

286 inches +, limestone.

The shallow phase of Hagerstown silt loam is similar to typical Hagerstown silt loam, except that it is developed on steeper slopes. Consequently the individual soil horizons are much thinner. Bedrock ranges from 3 to 6 feet below the surface.

The Corydon soils are developed on very steep slopes and from similar parent material as the Hagerstown soil. The profile is variable in its stage of development, but in most places it consists of a thin A horizon, a very thin B horizon, and a thin C horizon. Essentially these are AC soils. Bedrock is generally within 3 feet of the surface, and outcrops are numerous. As mapped, the Corydon soils include some Brown Forest soils and some Rendzina.

Frederick silt loam is developed from impure limestone which in places is cherty. Normally it is an ABYC soil, but as here described it has some indication of an X development. Following is a description of a typical profile of Frederick silt loam situated approximately 6 miles southwest of Salem, in the SW¼NE¼ sec. 28, T. 2 N., R. 3 E.:

A_0. A one-fourth-inch layer of surface litter consisting of deciduous leaves, bark, twigs, and other forest debris.

A_{11}. 0 to one-fourth inch, very dark brown silt loam which contains an accumulation of highly decomposed organic matter. This layer is of phylliform structure and at certain times of the year contains a mass of mold mycelium and other simple forms of plant life. It is inhabited by bacteria, protozoa, small insects, and worms.

A_{12}. One-fourth inch to 4 inches, light grayish-brown silt loam with penetrations of darker grayish brown along root channels and other openings. This layer contains a mass of small fibrous roots which penetrate freely through the soil.

A_2. 4 to 10 inches, yellowish-brown slightly phylliform silt loam with yellowish-gray linings along the sides of root channels and other openings.

B_1. 10 to 12 inches, yellowish-brown silt loam which is slightly heavier than the material in the layer above and breaks into small angular particles averaging one-fourth inch in diameter. Roots, which are not nearly so plentiful as in the layer above, penetrate between particles and not so freely through the soil.

B_2. 12 to 24 inches, yellowish-brown silty clay loam with brown on the outsides of the particles and with a few yellowish-gray coatings along the sides of the larger root channels. The material in this layer breaks into large angular particles 1½ inches in diameter.

B_3. 24 to 26 inches, light yellowish-brown silty clay loam with yellowish brown on the outsides of the particles and with grayish-yellow streaks from one-sixteenth to three-eighths inch in diameter along drainage lines which penetrate downward into the next lower horizon.

Y_1. 26 to 30 inches, yellowish-brown silty clay loam with brown or reddish brown on cleavage faces. The grayish yellow along drainage lines grades into yellowish gray in this horizon. This layer contains some highly weathered chert fragments one-half inch or less in diameter, some purplish-red splotches which presumably are the remains of former chert fragments, and many small pieces of chert in the last stages of decomposition. This layer also contains small very dark brown manganese stains. It approaches the X horizon in character.

Y_{12}. 30 to 39 inches, stiff light yellowish-brown silty clay loam with reddish brown or brown on the outsides of the particles, and containing splotches of grayish yellow. Some gray silty material is along the drainage lines which extend through this layer. This horizon has some suggestion of X characteristics.

Y_{13}. 39 to 45 inches, stiff reddish-brown clay with darker reddish brown along the cleavage planes. The gray silty material reaches its maximum thickness in this layer, and along some of the larger drainage lines it reaches a thickness of one-half inch or more. The drainage lines practically disappear in the horizon below. This horizon contains a few fragments of chert.

Y_{1}. 45 to 96 inches, stiff reddish-brown clay with splotches or coarse mottles of yellowish red, grayish yellow, and dark reddish brown. This layer contains some highly weathered red chert fragments and some small manganese concretions.

C. 96 to 112 inches, stiff yellowish-red silty clay loam with darker yellowish red along cleavage faces and with a few streaks of yellowish gray.

D. 112 inches+, limestone.

Orleans silt loam is developed under conditions of excessive drainage, so that the accumulation of considerable fine material in the upper horizons of the soil profile is prevented. It occurs on undulating land and is drained by numerous small sinkholes. Presumably a considerable part of the fine material, during the course of soil profile development, has been carried away by erosion to caverns in the underlying cherty limestone.

The upper part of the A horizon consists of a dark-colored layer, one-fourth inch thick, which contains an accumulation of organic matter and which is in most places about neutral in reaction. The lower part of the A horizon is highly leached acid light yellowish-gray or light grayish-brown silt loam. This layer ranges from 4 to 8 inches in thickness and has a slightly phylliform structure.

The B horizon is slightly heavier brown or reddish-brown silt loam which has a tendency to break into angular fragments. This horizon is very acid and ranges from 2 to 7 inches in thickness. The material is not nearly so heavy as in the corresponding horizon of Frederick silt loam. Only a comparatively small amount of the fine material removed from the A horizon has been deposited in this horizon.

The upper 4- to 6-inch layer of the C horizon is reddish-brown silty clay loam which contains considerable chert. Below this layer the subdivisions of the C horizon are similar to those of Frederick silt loam. The substratum is more highly siliceous than the limestone underlying Frederick silt loam.

Bedford silt loam is closely associated with the Frederick soils and is developed from the same kind of rock. It occurs on smoother slopes where drainage conditions are not quite so good, and, as a consequence, it has developed a pale-yellow or yellow B horizon. The X horizon consists of very stiff pale-yellow silt loam with dull brownish yellow on the outsides of the particles. This layer has a slightly vesicular structure and breaks into vertical columns 1 or 2 inches in diameter. Considerable gray silty material is in the upper part of this layer at the tops of the columns and along the natural cleavage lines between the columns. Gray silty material also occurs in considerable quantities in the vesicularlike openings. The Y and C horizons are similar to the corresponding horizons of the Frederick soils.

Zanesville silt loam is developed on thin-bedded sandstone and shale formations. It is similar to Frederick silt loam except in the Y horizon, the upper part of which is brownish-yellow compact silt loam with broad stains of yellowish brown along the drainage lines. These stains extend irregularly downward through the material. This layer contains a few soft dark-brown manganese concretions. It is underlain at a depth of about 43 inches by a similar-colored heavy silt loam which extends downward to a depth of about 54 inches. Below this depth is light reddish-yellow silty clay loam slightly mottled with grayish yellow. This layer contains many highly weathered yellow chert fragments and grades into weathered sandstone or shale at a depth of about 70 inches. In areas of Zanesville silt loam developed over the Ohio River formation, the C material is fine sandy clay loam.

Tilsit silt loam is closely associated with Zanesville silt loam and is derived from the same kind of rock. It occurs on smooth land and is not quite so well drained as is Zanesville silt loam. It is similar to the Zanesville soil, except that it has a pale-yellow B horizon underlain by a silty gray layer, similar to that in Bedford silt loam, covering the X horizon.

Muskingum silt loam is a Lithosol associated with Zanesville silt loam and derived from the same kind of rock but developed on steep slopes. There is little or no development of the B horizon, and the total depth to bedrock is much less. It is essentially an AC soil.

Wellston silt loam is intermediate, in the development of an illuvial horizon, between Zanesville silt loam and Muskingum silt loam. The B horizon in the latter soil ranges from 2 to 4 inches in thickness.

Cincinnati silt loam is the mature soil developed from Illinoian glacial till. It is similar to Frederick silt loam, except below a depth of 31 inches.

Following is a detailed description of the lower horizons of a profile of Cincinnati silt loam, as observed one-half mile west of the Scott County line along the State road in the northeastern part of the county in the SE¼NW¼ sec. 30, T. 3 N., R. 6 E.:

Y_{11}. 31 to 43 inches, yellow silty clay loam mottled with grayish yellow, and with yellowish brown on the cleavage faces. The upper part of this layer contains considerable gray silty material which extends downward along drainage lines, root holes, and worm tunnels; and in this respect it approaches the character of an X horizon. This layer contains a few small chert pebbles and particles of highly weathered limonite and hematite, also a few very dark brown soft manganese concretions with a maximum diameter of three-eighths of an inch.

Y_{12}. 43 to 54 inches, mottled brownish-yellow and grayish-yellow silty clay with gray streaks, averaging one-eighth of an inch in diameter and spaced about 3 inches apart, along drainage lines. There are only a few root channels and other openings in this layer, and a few manganese concretions, but the material contains a few chert and quartzite pebbles, which are surrounded by thin coatings of gray silty material.

Y_2. 54 to 73 inches, heavy yellow silty clay with brownish yellow along cleavage faces and with a few dark-colored manganese stains.

Y_{22}. 73 to 76 inches, heavy yellow silty clay mottled with grayish yellow, and with brownish yellow along some cleavage planes.

C. 76 to 192 inches, yellow silty clay mottled or streaked with yellowish gray. This material is underlain by calcareous unoxidized Illinoian drift.

Gibson silt loam is associated with Cincinnati silt loam and is derived from the same kind of parent material, but it has a well-developed ABXYC profile. It occurs on smooth relief and is not so well drained as the Cincinnati soil. Consequently it has a yellow or pale-yellow B horizon. The X horizon is similar to that of Bedford silt loam, and the Y and C horizons are similar to those of Cincinnati silt loam.

Elk silt loam is a well-drained soil of the terraces, with A and B horizons similar to those of Frederick silt loam. The Y horizon consists of reddish-brown silty clay loam. This is underlain by water-laid deposits including some chert and limestone gravel. As mapped, it includes areas of Holston silt loam which has a similar profile but is derived from noncalcareous terrace materials.

Pekin silt loam is a soil associated with Elk silt loam and is derived from the same kind of parent material. It has a pale-yellow or yellow B horizon and is underlain by a gray silty layer similar to the X horizon of Bedford silt loam. This is underlain by yellowish-brown silty clay loam which grades into underlying water-laid deposits including chert and limestone gravel. As mapped, it includes areas of Monongahela silt loam—a similar soil—derived from noncalcareous terrace deposits.

Markland silt loam is a shallow well-developed soil derived from calcareous backwater terrace deposits of the Wisconsin glacial epoch. Following is a description of a profile of Markland silt loam, as observed in the northwestern part of the county in Twin Creek Valley, in the northwest corner of the SE¼SE¼ sec. 26, T. 4 N., R. 2 E.:

A_0. A one-fourth-inch layer of surface litter consisting of deciduous tree leaves, bark, and twigs.
A_1. 0 to 4 inches, light grayish-brown silt loam.
B_1. 4 to 7 inches, light grayish-brown silty clay loam.
B_2. 7 to 21 inches, very stiff brown silty clay loam.
B_3. 21 to 30 inches, stiff brown silty clay loam, neutral or slightly alkaline in reaction.
C_1. 30 to 34 inches, yellowish-brown silty clay containing numerous gray calcium carbonate concretions.
D. 34 inches +, gray calcareous silty clay.

Princeton fine sandy loam is a mature soil developed from calcareous wind-blown fine sand. It has smoothly undulating relief. The profile shows a thin dark-colored A horizon underlain by light grayish-brown loamy fine sand or fine sandy loam, which extends to a depth of 12 or more inches. The B horizon consists of brown fine sandy loam which contains a few streaks of yellowish brown and extends to a depth of more than 40 inches. The Y horizon consists of yellowish-brown fine sandy loam that grades into yellowish-gray calcareous fine sand at a depth of 9 feet or deeper. The entire soil mass is neutral or alkaline in most places. In some places the B horizon grades directly into the C.

In the imperfectly and poorly drained soils of Washington County, soil development has been markedly influenced by excess moisture. These soils occupy flat or only gently undulating land, and in many places the water table is at or very near the surface for long periods. These soil are light colored and are low in organic matter. They are leached and are acid in both surface soil and subsoil and have developed eluviated gray or grayish-brown A horizons underlain by heavier gray, or brownish-yellow mottled with gray, horizons. Below this is the parent material.

Lawrence, Guthrie, Avonburg, Bartle, Calhoun, and McGary silt loams belong to the group of imperfectly and poorly drained soils. Lawrence silt loam is associated with the Frederick and Bedford silt loams and is derived from the same kind of rock.

Following is a detailed description of a profile of Lawrence silt loam, as observed along the county line west of Saltillo, 200 feet north of the southwest corner of the NW¼ sec. 28, T. 3 N., R. 2 E.:

A_0. A one-fourth-inch layer of surface litter consisting of deciduous tree leaves and other dead organic matter.

A_1. 0 to one-half inch, very dark brown silt loam which contains an accumulation of very highly decomposed organic matter.

A_2. One-half inch to 6 inches, light grayish-brown silt loam mottled with yellowish gray, with brown stains along small root channels and other openings.

B_1. 6 to 12 inches, light grayish-brown silt loam mottled with brownish yellow. This layer contains numerous small soft very dark brown iron concretions.

B_2. 12 to 18 inches, light-gray silt loam mottled with yellowish gray, with gray silty material along drainage lines and root channels.

X_1. 18 to 24 inches, compact yellowish-gray silt loam mottled with brownish yellow. The material has a well-developed vesicular structure and breaks into vertical columns three-fourths inch in diameter. This layer contains considerable gray silty material along drainage lines and in some of the vesicular openings.

X_{12}. 24 to 28 inches, compact highly mottled yellowish-gray and light brownish-yellow silt loam, with considerable gray silty material along drainage lines.

Y_1. 28 to 58 inches, brownish-yellow silty clay loam mottled with grayish yellow and containing some dark-colored manganese stains.

Y_2. 58 to 256 inches, waxy red clay mottled or streaked with grayish yellow and grayish brown.

C. 256 inches to limestone, red waxy clay.

Guthrie silt loam is closely associated with Lawrence silt loam and is derived from the same kind of rock, but it is more poorly drained than the Lawrence soil. Guthrie silt loam has a light-gray surface soil and a gray subsoil, with a few brownish-yellow iron stains. It has a strongly developed X horizon.

Avonburg silt loam is an imperfectly drained soil associated with Cincinnati silt loam and Gibson silt loam and is developed from similar material. It is similar in appearance to Lawrence silt loam in the upper 30 inches of the profile but below this depth consists of weathered Illinoian glacial drift.

Bartle silt loam is an imperfectly drained soil associated with Elk silt loam and is developed from the same kind of soil-forming material. The upper 30 inches of Bartle silt loam is similar to the upper 30 inches of Lawrence silt loam, but below this depth it consists of yellow silty clay loam mottled with gray. This layer at a depth of 40 or more inches grades into water-laid terrace deposits or, in a few areas, glacial till.

Calhoun silt loam is associated with Bartle silt loam and derived from similar material. It is more poorly drained than the Bartle soil. Calhoun silt loam has a light-gray surface soil and a gray subsoil, with a few stains of brownish yellow.

McGary silt loam is associated with Markland silt loam. It is developed from the same parent material but has more gently sloping relief and slower surface drainage than the Markland soil. McGary silt loam has a light-gray silt loam A horizon and a mottled light grayish-yellow and brown B horizon.

The very poorly drained soils are developed in depressions which formerly were covered with water for considerable periods. These soils have dark-colored (H) surface horizons which contain accumulations of organic matter. They have undergone practically no leaching and are alkaline in reaction or actually calcareous, owing, in some instances, to lime that has come in with seepage water. Burgin and Montgomery silty clay loams belong to this group—the Wiesenböden (meadow soil) great group. Small areas of these soils are developed under a marsh vegetation including *Equisetum*, waterlilies, and other water-loving plants.

Burgin silty clay loam is developed over limestone and is associated with the Frederick, Bedford, Lawrence, and Guthrie silt loams. Following is a detailed description of a profile of Burgin silty clay loam, as observed approximately 2 miles east of Livonia, 60 rods south of the northwest corner of sec. 31, T. 2 N., R. 3 E.:

1. A one-fourth-inch layer of surface litter consisting of deciduous tree leaves, twigs, bark, and other forest debris.
2. 0 to 1¾ inches, very dark grayish-brown silty clay loam which contains numerous small fibrous roots.
3. 1¾ to 6 inches, dark-gray silty clay loam, with numerous small roots freely penetrating the soil.
4. 6 to 15 inches, heavy dark silty clay which has a tendency to break into vertical columns approximately 1 inch in diameter.
5. 15 to 26 inches, heavy gray silty clay which breaks into larger columns.
6. 26 to 36 inches, heavy gray silty clay containing a few yellowish-brown iron stains.
7. 36 to 42 inches, light-gray silty clay, with light reddish-yellow iron stains along root channels.
8. 42 to 66 inches, light-gray silty clay, with light reddish-brown iron stains along root channels and other openings.
9. 66 to 110 inches, light-gray silty clay, with considerable staining of reddish yellow.
10. 110 to 172 inches, light-gray silty clay stained with reddish yellow.

Montgomery silty clay loam is a poorly drained soil associated with McGary silt loam and derived from similar parent material. It has a very dark gray silty clay loam surface layer underlain by dark-gray silty clay loam which extends to a depth of about 12 inches. Below this depth is light-gray silty clay loam stained with light reddish yellow or yellow, which grades into calcareous silty clay at a depth of 18 or more inches.

The alluvial soils consist of recently deposited water-laid material in which no soil profile has developed, other than a change in color due to drainage conditions. With a few minor exceptions, these soils differ in reaction according to the kind of material from which they have developed. In general, where the sediments which form the alluvial soils have been derived from limestone or glacial drift materials the soils are sweet or neutral, and where the sediments are derived from sandstone or shale formations the soils are acid.

The soils of the Stendal and Waverly series in the Muscatatuck River bottoms range from slightly acid to medium acid to a depth of about 75 inches but have developed no textural horizons. Below this depth the material is alkaline or slightly calcareous. These conditions may be ascribed to any one of the following three interpretations: (1) The Stendal and Waverly soils of the Muscatatuck River bottoms represent old alluvial soils which are developed from calcareous material but have undergone enough leaching to become slightly or medium acid to a depth of about 75 inches; (2) the material below 75 inches consists of slightly calcareous backwater deposits; or (3) sweet alluvium, such as that now found along Muscatatuck River in Jennings County, may have been covered by sediments from local streams. These deposits presumably were laid down during the Wisconsin glacial epoch and represent a continuation of the low terraces farther downstream, upon which the Markland, McGary, and Montgomery soils are developed. The material above a depth of 75 inches represents the deposition which has occurred since the Wisconsin glacial epoch and is composed of a mixture of sediments coming from the glacial upland regions (Illinoian age) and still more local sediments of the noncalcareous sandstone and shale formations of the knobs.

Table 7 gives the results of determinations of the pH values of a number of soils, as determined in the laboratories of the Bureau of Chemistry and Soils by the hydrogen-electrode method.

TABLE 7.—*pH determinations of several soils from Washington County, Ind.*[1]

Soil type and sample No.	Depth	pH
	Inches	
Montgomery silty clay loam:		
284801	0 - ⅛	6.6
284802	⅛ - ¼	6.7
284803	¼ - 1	6.3
284804	1 - 12	6.7
284805	12 - 18	7.4
284806	18 - 36	7.8
284807	36 - 60	8.0
284808	60 - 120	8.2
Guthrie silt loam:		
284809	0 - ¼	6.0
284810	¼ - ½	5.2
284811	½ - 1	5.0
284812	1 - 6	5.1
284813	6 - 12	4.6
284814	12 - 16	4.7
284815	16 - 21	4.8
284816	21 - 41	4.9
284817	41 - 64	5.0
284818	64 - 84	5.4
284819	84 - 96	6.7
284820	96 - 104	6.6
284821	104 - 133	6.4
284822	133 - 144	6.1
284823	144 - 154	6.2
Lawrence silt loam:		
284824	0 - ¼	5.9
284825	¼ - 1	6.1
284826	1 - 6	6.2
284827	6 - 12	4.8
284828	12 - 18	5.1
284829	18 - 24	5.4
284830	24 - 28	5.4
284831	28 - 58	6.8
284832	58 - 100	8.6
284833	100 - 256	7.5
Bedford silt loam:		
284834	0 - ¼	6.4
284835	¼ - ¾	5.9
283836	¾ - 2	5.4
284837	2 - 11	4.9
284838	11 - 15	4.9
284839	15 - 19	4.8
284840	19 - 23	4.8
284841	23 - 26	4.6
284842	26 - 31	4.8
284843	31 - 61	4.9
284844	61 - 180	5.7
284845	180 - 183	6.5
Frederick silt loam:		
284858	0 - ½	7.0
284859	½ - 1	6.7
284860	1 - 4	6.7
284861	4 - 9	6.2
284862	9 - 13	5.1
284863	13 - 18	4.7
284864	18 - 27	4.6
284865	27 - 30	4.6
284866	30 - 36	4.9
284867	36 - 48	5.1
284868	48 - 78	5.9
284869	78 - 82	7.8
Hagerstown silt loam:		
284871	0 - ½	7.4
284872	½ - 1½	7.2
284873	1½ - 4	5.4
284874	4 - 13	5.0
284875	13 - 15	5.1
284876	15 - 20	5.1
284877	20 - 26	5.0
284878	26 - 30	5.0
284879	30 - 39	5.2
284880	39 - 52	4.9
284881	52 - 100	5.0
284882	100 - 120	5.2
284883	120 - 280	5.1
284884	280 - 286	7.3
Burgin silty clay loam:		
284886	¼ - 2	6.7
284887	2 - 6	6.8
284888	6 - 15	6.7
284889	15 - 26	6.8
284890	26 - 36	6.2
284891	36 - 42	5.8
284892	42 - 66	5.6
284893	66 - 110	5.7
284894	110 - 172	6.1
Wellston silt loam:		
2848105	¼ - ½	5.4
2848106	½ - 1¼	4.4
2848107	1¼ - 5	4.6
2848108	5 - 9	4.6
2848109	9 - 14	4.6
2848110	14 - 21	4.4
2848111	21 - 60	4.3
Waverly silt loam:		
2848112	0 - ⅛	6.3
2848113	⅛ - ¼	5.4
2848114	¼ - 1	5.4
2848115	1 - 3	5.1
2848116	3 - 10	4.7
2848117	10 - 78	4.7
2848118	78 - 138	7.4
2848119	138 - 170	7.3
Stendal silt loam:		
2848120	0 - 2	6.2
2848121	2 - 6	5.5
2848122	6 - 15	5.6
2848123	15 - 75	5.1
2848124	75 - 98	5.5
2848125	98 - 135	6.2
2848126	135 - 198	6.6
Zanesville silt loam:		
2848161	0 - ¼	6.2
2848162	¼ - 2	6.3
2848163	2 - 9	5.4
2848164	9 - 12	4.6
2848165	12 - 21	4.7
2848166	21 - 27	4.5
2848167	27 - 43	4.5
2848168	43 - 54	4.4
2848169	54 - 70	4.7

[1] Determinations made by E. H. Bailey, Bureau of Chemistry and Soils.

TABLE 7.—*pH determinations of several soils from Washington County, Ind.*—Con.

Soil type and sample No.	Depth	pH	Soil type and sample No.	Depth	pH
	Inches			*Inches*	
Avonburg silt loam:			Cincinnati silt loam—Con.		
2848179	¼- ⅜	6.1	2848214	31 - 43	4.8
2848180	⅜- ½	5.6	2848215	43 - 54	5.0
2848181	½- 3½	4.7	2848216	54 - 73	4.9
2848182	3½- 9	4.4	2848217	73 - 76	4.9
2848183	9 - 18	4.7	2848218	76 -152	6.4
2848184	18 - 27	4.6	2848219	152 -192	8.1
2848185	27 - 40	4.7	2848220	192 -238	7.8
2848186	40 - 45	4.7	2848221	238 -292	7.5
2848187	45 - 72	4.6	Markland silt loam:		
2848188	72 - 98	6.7	2848273	0 - ¼	6.9
2848189	98 -132	6.4	2848274	¼- 4	6.1
2848190	132 -216	7.2	2848275	4 - 7	5.1
Gibson silt loam:			2848276	7 - 21	7.0
2848192	¼- ½	5.1	2848277	21 - 30	7.9
2848193	½- 1½	4.3	2848278	30 - 54	8.2
2848194	1½- 5	4.0	Orleans silt loam:		
2848195	5 - 10	4.6	2848293	¼- ½	7.5
2848196	10 - 14	4.5	2848294	½- 1¼	5.6
2848197	14 - 23	4.4	2848295	1¼- 4½	4.8
2848198	23 - 27	4.1	2848296	4½- 8	4.6
2848199	27 - 30	4.5	2848297	8 - 11	4.5
2848200	30 - 38	4.4	2848298	11 - 13	4.6
2848201	38 - 47	4.3	2848299	13 - 17	4.6
2848202	47 - 50	4.5	2848300	17 - 66	4.7
2848203	50 - 80	4.5	2848301	66 - 96	4.6
2848204	80 -108	4.6	Stendal silty clay loam:		
2848205	108 -132	5.7	2848309	0 - 1½	5.9
2848206	132 -180	5.5	2848310	1½- 6	5.7
Cincinnati silt loam:			2848311	6 - 12	5.6
2848208	¼- ½	7.0	2848312	12 - 24	5.8
2848209	½- 2	7.0	2848313	24 - 75	6.1
2848210	2 - 12	5.0	2848314	75 -116	7.7
2848211	12 - 15	5.1	2848315	116 -162	7.8
2848212	15 - 29	4.6	2848316	162 -198	7.6
2848213	29 - 31	4.6			

MANAGEMENT OF THE SOILS OF WASHINGTON COUNTY

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The farmer should know his soil and have a sound basis for every step in its treatment. Building up the productivity of a soil to a high level, in a profitable way, and then keeping it up is an achievement toward which the successful farmer strives. As in any other enterprise, every process must be understood and regulated in order to be uniformly successful, and a knowledge of the soil is highly important. Different soils present different problems as to treatment, and these must be studied and understood in order that crops may be produced in the most satisfactory and profitable way.

The purpose of the following discussion is to call attention to the deficiencies of the several soils of the county and to outline in a general way the treatments most needed and most likely to yield satisfactory results. No system of soil management can be satisfactory unless in the long run it produces profitable returns. Some soil treatments and methods of management may be profitable for a time but ruinous in the end. One-sided or unbalanced soil treatments have been altogether too common in the history of farming in the United States. A proper system of treatment is necessary in making a soil profitably productive.

PLANT NUTRIENTS IN WASHINGTON COUNTY SOILS

Table 8 shows the approximate total content of nitrogen, phosphorus, and potassium and the weak-acid soluble or available phosphorus and potassium in the different soils in Washington County, expressed in pounds of elements in the 6- to 7-inch plowed surface soil of an acre.

TABLE 8.—*Approximate quantities of nitrogen, phosphorus, and potassium per acre of surface soil (6 to 7 inches deep) in Washington County, Ind., soils*

Soil No.	Soil type	Total nitrogen	Total phosphorus [1]	Total potassium	Weak-acid soluble phosphorus [2]	Weak-acid soluble potassium [2]
		Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
12	Avonburg silt loam	1,600	870	23,000	30	100
41	Guthrie silt loam	2,000	870	17,000	40	170
42	Lawrence silt loam	2,400	1,140	22,000	40	200
13	Gibson silt loam	1,800	790	25,000	20	170
14	Cincinnati silt loam	1,800	960	26,000	50	300
53	Tilsit silt loam	2,000	1,050	26,000	50	200
54	Zanesville silt loam	2,000	790	26,000	30	340
155	Wellston silt loam	2,400	870	26,000	70	270
43	Bedford silt loam	1,800	1,050	25,000	70	220
44	Frederick silt loam	2,400	900	25,000	30	290
144	Orleans silt loam	2,200	960	21,000	30	220
45	Hagerstown silt loam	3,000	1,310	20,000	40	290
145	Hagerstown silt loam, shallow phase	3,400	960	25,000	20	320
94	Princeton fine sandy loam	1,400	960	20,000	100	220
21	Calhoun silt loam	2,000	790	18,000	30	170
22	Bartle silt loam	2,000	1,050	16,000	40	200
32	McGary silt loam	2,600	1,220	28,000	30	170
23	Pekin silt loam	2,000	960	21,000	30	200
24	Elk silt loam	2,600	1,140	24,000	40	270
34	Markland silt loam	2,400	1,050	33,000	30	200
38	Montgomery silty clay loam	3,800	1,570	40,000	220	350
48	Burgin silty clay loam	3,000	1,310	21,000	40	270
61	Waverly silt loam	2,200	870	30,000	40	140
262	Stendal silty clay loam	2,400	870	30,000	20	170
62	Stendal silt loam	2,000	870	26,000	20	120
63	Philo silt loam	1,400	870	25,000	30	200
563	Philo very fine sandy loam	2,000	670	25,000	20	150
64	Pope silt loam	3,000	1,050	28,000	40	340
564	Pope very fine sandy loam	2,600	1,050	27,000	30	560
73	Lindside silt loam	2,200	960	30,000	30	340
83	Eel silt loam	2,200	960	29,000	20	540
74	Huntington silt loam	2,400	870	33,000	30	300
384	Genesee silty clay loam	2,000	1,050	28,000	20	720
84	Genesee silt loam	2,800	1,140	28,000	40	500

[1] Soluble in strong hydrochloric acid (specific gravity 1.115).
[2] Soluble in weak nitric acid (fifth normal).

The total plant-nutrient content is more indicative of the origin and age of a soil than of its fertility. This is particularly true of potassium. The amount of total potassium in a soil is seldom indicative of its need for potash. Some Indiana soils which have more than 30,000 pounds of total potassium to the acre in the 6-inch surface layer fail to produce corn satisfactorily without potash fertilization, because so little of the potassium they contain is available.

The total content of nitrogen is generally indicative of the need for nitrogen, although some soils with a low content may have a supply of available nitrogen sufficient to grow a few large crops without the addition of that element. Soils having a low total nitrogen content soon wear out, as far as that element is concerned, unless the supply is replenished by the growing and turning under of legumes or by the use of nitrogenous fertilizer. The darker soils are generally higher in organic matter. Organic matter and nitrogen are closely associated in the soils of Indiana, hence it is a fairly safe rule that the darker the soil, the richer it is in nitrogen.

The amount of total phosphorus in ordinary soils is usually about the same as that shown by a determination with strong acid. For this reason a separate determination of total phosphorus has been omitted. In Indiana the supply of total phosphorus usually indicates whether or not a soil needs phosphatic fertilizers.

The amount of phosphorus soluble in weak acid is considered by many authorities to be a still better indication of the phosphorus needs of a soil. The depth of a soil may modify its needs for phosphates. Everything else being equal, the more weak-acid soluble phosphorus a soil contains, the less it is likely to need phosphate fertilizers. Where the weak-acid soluble phosphorus runs less than 100 pounds to the acre, phosphates are usually needed for high crop yields.

The quantity of potassium soluble in strong or weak acid is to some extent significant. This determination, however, is not so reliable an indicator as is the determination for phosphorus, particularly with soils of high lime content. Sandy soils and muck soils are more often in need of potash than clay and loam soils. Poorly drained soils and soils with impervious subsoils usually need potash more than well-aerated deep soils.

The use of strong or weak acid in the analysis of a soil has been criticized by some, yet such analyses can more often be correlated with crop production than can analyses of the total elements of the soil. For this reason acid solutions have been employed in these analyses.

It must be admitted, however, that no one method of soil analysis will definitely indicate the deficiencies of a soil. For this reason, these chemical data are not intended to be the sole guide in determining the needs of the soil. The depth of the soil, the physical character of the horizons of the soil profile, and the previous treatment and management of the soil are all factors of the greatest importance and should be taken into consideration. Pot tests indicate that nitrogen and phosphorus are much less available in subsurface soils and subsoils than they are in surface soils. On the other hand, potassium in the subsoil seems to be of relatively high availability. Crop growth depends largely on the amount of available plant nutrients with which the roots may come in contact. If the crop can root deeply, it may be able to make good growth on soils of relatively low analysis. If the roots are shallow, the crop may suffer from lack of nutrients, particularly potash, even on a soil of higher analysis. The better types of soils and those containing large amounts of plant-nutrient elements will endure exhaustive cropping much longer than the soils of low plant-nutrient content.

The nitrogen, phosphorus, and potassium contents of a soil are by no means the only chemical indications of high or low fertility. One of the most important factors in soil fertility is the degree of acidity. Many soils which are very strongly acid will not produce well, even though there be no apparent lack of plant-nutrient elements. Although nitrogen, phosphorus, and potassium are of some value when added to acid soils, they will not produce their full effect where calcium is deficient. Table 9 shows the percentage of nitrogen and the acidity of the various soils in Washington County.

TABLE 9.—*Percent of nitrogen in and acidity of Washington County, Ind., soils*[1]

Soil No.	Soil type	Depth	Nitrogen	pH	Average depth to neutral soil	Indicated ground limestone requirement per acre
		Inches	*Percent*		*Inches*	*Tons*
12	Avonburg silt loam	0–5	0.08	5.0	150	2–4
		5–17	.05	4.7		
		17–35	.03	4.6		
41	Guthrie silt loam	0–6	.10	5.2	(2)	2–4
		6–17	.06	4.9		
		17–42	.04	4.5		
42	Lawrence silt loam	0–6	.12	6.2	(2)	2–4
		6–17	.04	4.8		
		17–33	.04	4.6		
13	Gibson silt loam	0–6	.09	5.4	150	2–4
		6–12	.07	5.2		
		12–30	.04	4.6		
14	Cincinnati silt loam	0–6	.09	6.4	150	2–4
		6–12	.05	5.9		
		12–29	.04	5.2		
53	Tilsit silt loam	0–6	.10	6.0	(2)	2–4
		6–11	.07	5.4		
		11–34	.04	4.6		
54	Zanesville silt loam	0–6	.10	5.8	(2)	2–4
		6–13	.06	5.5		
		13–38	.04	4.8		
155	Wellston silt loam	0–6	.12	6.0	(2)	2–4
		6–17	.05	5.2		
		17–35	.04	4.6		
43	Bedford silt loam	0–6	.09	5.8	(2)	2–4
		6–16	.08	5.6		
		16–35	.04	4.8		
44	Frederick silt loam	0–6	.11	5.9	(2)	2–4
		6–14	.06	5.4		
		14–36	.04	4.6		
144	Orleans silt loam	0–6	.11	6.4	(2)	2–4
		6–13	.06	5.8		
		13–28	.04	5.6		
945	Corydon silt loam	0–5	.26	7.2	0	0
		5–18	.16	7.6		
		18–36	.09	7.8		
45	Hagerstown silt loam	0–7	.15	6.4	(2)	2–4
		7–18	.10	6.2		
		18–30	.06	5.6		
145	Hagerstown silt loam, shallow phase	0–5	.17	6.4	(2)	2–4
		5–19	.11	6.0		
		19–28	.08	6.5		
94	Princeton fine sandy loam	0–8	.07	6.6	80	0–2
		8–14	.04	6.6		
		14–34	.03	6.3		
21	Calhoun silt loam	0–5	.10	5.2	(2)	2–4
		5–10	.06	5.0		
		10–35	.04	4.8		
22	Bartle silt loam	0–6	.10	5.6	(2)	2–4
		6–13	.04	5.0		
		13–36	.03	4.6		
32	McGary silt loam	0–6	.13	6.0	36	2–4
		6–14	.08	5.6		
		14–35	.05	5.3		
23	Pekin silt loam	0–6	.10	5.6	(2)	2–4
		6–13	.06	5.0		
		13–37	.02	4.6		
24	Elk silt loam	0–7	.13	5.6	(2)	2–4
		7–15	.09	5.0		
		15–38	.05	4.7		
34	Markland silt loam	0–6	.12	6.4	36	0–2
		6–11	.09	5.8		
		11–26	.07	7.0		
38	Montgomery silty clay loam	0–7	.19	6.6	0	0
		7–18	.15	7.6		
		18–34	.08	(3)		
48	Burgin silty clay loam	0–8	.15	6.2	(2)	0–2
		8–17	.14	6.1		
		17–31	.06	6.4		
61	Waverly silt loam	0–6	.10	6.0	80	2–4
		6–14	.06	5.6		
		14–36	.05	5.8		

[1] Within the same soil type the reaction varies somewhat from place to place. Some of the samples reported in this table were taken from different places from those in table 6 and hence show slight differences in reaction.
[2] Acid to all depths.
[3] Calcareous.

TABLE 9.—*Percent of nitrogen in and acidity of Washington County, Ind., soils*—Continued

Soil No.	Soil type	Depth	Nitrogen	pH	Average depth to neutral soil	Indicated ground limestone requirement per acre
		Inches	*Percent*		*Inches*	*Tons*
262	Stendal silty clay loam	0- 6	0.15	5.2	80	2-4
		6-17	.11	5.5		
		17-36	.08	4.8		
62	Stendal silt loam	0- 6	.10	5.8	80	2-4
		6-17	.08	5.8		
		17-36	.08	5.8		
63	Philo silt loam	0- 6	.07	5.8	80	2-4
		6-17	.09	6.0		
		17-36	.06	6.2		
563	Philo very fine sandy loam	0- 6	.10	6.2	80	2-4
		6-17	.07	6.0		
		17-33	.06	5.7		
64	Pope silt loam	0- 6	.15	6.0	80	2-4
		6-14	.13	6.0		
		14-31	.07	5.7		
564	Pope very fine sandy loam	0- 6	.13	6.8	80	2-4
		6-24	.07	6.0		
		24-36	.07	5.4		
73	Lindside silt loam	0- 6	.11	6.2	60	2-4
		6-21	.09	6.2		
		21-42	.06	6.0		
83	Eel silt loam	0- 6	.11	7.0	60	0
		6-10	.10	6.8		
		10-36	.10	6.3		
74	Huntington silt loam	0- 7	.12	6.8	60	0
		7-17	.10	6.2		
		17-38	.09	6.2		
384	Genesee silty clay loam	0- 6	.10	6.9	60	0
		6-18	.10	6.7		
		18-36	.06	6.5		
84	Genesee silt loam	0- 8	.14	6.8	60	0
		8-14	.10	6.6		
		14-32	.07	6.2		

The acidity is expressed as pH, or intensity of acidity. For example, pH 7 is neutral, and a soil with a pH value of 7 contains just enough lime to neutralize the acidity. If the pH value is more than 7, there is some lime in excess. From pH 6 to pH 7 indicates slight acidity, and from pH 5.6 to pH 6 shows medium acidity. If the pH value runs below 5.6 the soil is strongly acid. As a rule, the stronger the acidity the more a soil needs lime. Samples were taken from the surface soil (0 to 6 inches), from the subsurface soil, and from the subsoil. It is important to know the reaction, not only of the surface soil, but of the lower layers of the soil as well. Given two soils of the same acidity, the one with the greater acidity in the subsurface layer is in greater need of lime than the other. The slighter the depth of acid soil, the less likely it is to need lime. Those soils having the greater clay content will need a greater amount of lime to neutralize them, given the same degree of acidity. The less phosphorus, calcium, and magnesium the soil contains, the more likely it is to need lime. It is well to remember that sweetclover, alfalfa, and red clover need lime more than other crops. As it is advisable to grow these better soil-improvement legumes in the rotation, it is in many places desirable to lime the land in order that sweetclover or alfalfa will grow.

In interpreting the soil survey map and soil analyses, it should be borne in mind that a well-farmed, well-drained, well-fertilized, well-manured soil which is naturally low in fertility may produce larger crops than a poorly farmed soil naturally higher in fertility.

SOIL MANAGEMENT

For convenience in discussing the management of the several soils of this county, they are arranged in groups according to certain important characteristics which indicate that in many respects similar treatment is required. For example, several of the silt loams of the uplands and terraces, which have practically the same requirements for their improvement, may be conveniently discussed as a group, thus avoiding the repetition that would be necessary if each were discussed separately. Where different treatments are required they are specifically pointed out. The reader should study the group including the soils in which he is particularly interested.

LIGHT-COLORED SILT LOAM SOILS OF THE UPLANDS AND TERRACES

The group of light-colored soils of the uplands and terraces includes the silt loams of the Avonburg, Guthrie, Lawrence, Calhoun, Bartle, McGary, Gibson, Cincinnati, Tilsit, Zanesville, Wellston, Muskingum, Bedford, Frederick, Orleans, Hagerstown, Pekin, Elk, and Markland series, together with their phases. All the Muskingum soils and the very sloping and eroded phases of the Cincinnati, Frederick, Orleans, Hagerstown, Wellston, and Zanesville soils are so steep or dissected by erosion as to be unfit for cultivation and are classed as nonarable lands. A separate discussion of these has been made.

The arable soils of this group, although they differ greatly in appearance, owing to the relief and natural drainage, have certain important characteristics in common. They all are low in content of organic matter and nitrogen, are all acid and in need of liming, and are all low in available phosphorus. The flatter and wetter soils, such as the Avonburg, Guthrie, and Lawrence, are low in available potassium also.

DRAINAGE

The Gibson, Cincinnati, Zanesville, Wellston, Frederick, Orleans, Hagerstown, Bedford, Elk, Pekin, and Markland silt loams have good to excessive surface drainage, owing to their sloping relief. Penetration of rain water and internal drainage are slow, on account of the heavy subsoils, and in times of heavy rains there may be run-off with attendant damage from erosion. This feature will be discussed later.

The Avonburg, Guthrie, Lawrence, Calhoun, Bartle, and McGary silt loams have flat or gently undulating relief, and this feature, together with their heavy subsoils, makes them naturally wet and more or less seriously in need of artificial drainage. The flatter areas, especially those of the Guthrie and Calhoun soils, need surface furrow drainage as well as tile underdrainage. Without artificial drainage these soils cannot be managed to the best advantage, and no other beneficial soil treatment can produce its full effect. In most places where these soils are farmed, there is some provision for drainage, but it is confined mainly to surface furrows. Tile underdrainage should be installed as rapidly as possible, because this is necessary to enable these soils to respond properly to other needed treatments.

With reasonable provision for drainage, these soils respond well to lime, legumes, manure, and fertilizer and can be made highly productive. This has been fully demonstrated on the experiment fields conducted by the experiment station on these and similar soils, particularly on Avonburg silt loam and Gibson silt loam in Scott County; on Clermont silt loam in Jennings County; and on Lawrence silt loam and Bedford silt loam in Lawrence County. The results of experiments on these fields indicate that tile lines laid 30 inches deep and not more than 3 rods apart will give satisfactory results. Where the land is flat, great care must be exercised in tiling, in order to obtain an even grade and uniform fall. Unsatisfactory results in tiling these flat lands are traceable to errors in grades, which allow silting up in low spots, and to poor grades of tile which chip and break down easily. Only the best grade of tile should be used. Grade lines should not be established by guess or by rule-of-thumb method. Nothing less accurate than a surveyor's instrument should be used, and the lines should be accurately staked and graded before the ditches are dug, to make sure that all the water will flow to the outlet with no interruption or slackening of the current. The grade, or rate of fall, should be not less than 3 inches to 100 feet. The rate of fall may be increased toward the outlet, but it should never be lessened without the introduction of a silt well, or settling box, as checking the current in the line may cause the tile to become choked with silt. Silt wells may be made of brick or concrete and should be at least a foot square inside. The bottom should be a foot lower than the bottom of the tile. The well should have a removable cover, in order that it may be opened once or twice a year for the purpose of dipping out the silt that has settled in the bottom. It is an excellent plan, before filling the ditches, to cover the tile to a depth of a few inches with a layer of straw, weeds, or grass. This prevents silt from washing into the tile at the joints while the ground is settling, thus insuring perfect operation of the drains from the beginning.

CONTROL OF EROSION

On more than one-third of the soils of this group, especially the Cincinnati, Zanesville, Wellston, Muskingum, Frederick, Orleans, and Hagerstown silt loams, the problems of the control of erosion are of major importance in practical systems of soil management. Even after taking out of cultivation all the rough and very sloping land, which should never be plowed, the rest of the tillable land needs especial care in order to prevent further destructive erosion. In many places the surface soil already has gone, and further sheet erosion and gullying are constantly making matters worse. The surface soil contains the greater part of the store of fertility and should be protected against erosion by every practical means. Gradual sheet erosion, whereby the run-off of rain water moves the surface soil down the slope a little at a time and rather evenly, is the most insidious form of erosion and may not be noticed until the subsoil begins to appear. Many one-time fertile fields have been irreparably damaged in this way, and many others have only a little of the surface soil left and the plow reaches into the unproductive subsoil. Plowing and the other tillage operations should extend crosswise of the slopes wherever possible, in order to prevent the formation of watercourses down the slopes, which are sure to carry away much valuable surface soil and may start serious gullies. Contour plowing and contour strip cropping may be most practical on fields of irregular slopes, whereas terracing may be most practical on long even slopes. By rearranging fences or other field boundaries, it may be possible to arrange the cropping system in such a way as to facilitate the performance of all tillage operations crosswise of the slopes. Intertilled crops should be interspersed with small-grain and sod-forming crops. Incipient gullies, or draws, forming natural waterways down the slopes, should be kept permanently in grass with a good sod of sufficient width to allow the water to spread and thereby prevent soil cutting.

LIMING

All the soils of this group are acid and more or less in need of liming, except some areas of Markland silt loam, which are developed from backwater deposits of calcareous origin. The quantity of lime needed should be determined in each instance by tests for soil acidity. If the farmer himself cannot make the test, he may have it made by the county agricultural agent or by the agricultural experiment station at La Fayette. A very acid soil will not respond properly to other needed treatments until it has been limed. A fair example of this is to be found on the Moses Fell Annex experiment field near Bedford in Lawrence County, which is located on Bedford silt loam. Land which received 3 tons of ground limestone per acre in 1917 and 2 tons in 1931, in addition to being well fertilized, has averaged 5.6 bushels of corn, 1.7 bushels of soybeans, 2 bushels of wheat, and 552 pounds of mixed hay per acre a year more than land similarly fertilized but not limed. During the 20-year period to the end of 1936, the total acre value of the crop increases due to liming amounted to over $46. The total cost of liming is liberally estimated at $12.50. On the Scottsburg experiment field, located on Avonburg and Gibson silt loams, $10 spent for ground limestone from 1911 to 1931 returned over $48 in crop increases.

Most of the soils of this group will not produce clover without liming. Ground limestone generally is the most economical form of lime to use, and in most places a supply can be procured conveniently. As a rule, the first application should be at least 2 tons to the acre. After that a ton to the acre every second round of the crop rotation will keep the soil sufficiently sweet for most crops. Where alfalfa or sweetclover is to be grown on any of these acid soils, as might be done wherever drainage is good enough, heavier applications of limestone will be needed.

ORGANIC MATTER AND NITROGEN

All the soils of this group are naturally low in organic matter and nitrogen. Constant cropping without adequate returns to the land and more or less soil erosion on sloping areas are steadily making matters worse. In many places the original supplies of organic matter have become so reduced that the soil has lost much of its natural mellowness, and it readily becomes puddled and baked. The only practical remedy for this condition is to plow under more organic matter than is used in the processes of cropping. Decomposition is constantly going on and is necessary to maintain the productivity of the soil. Decomposing organic matter must also supply the greater part of the nitrogen required by crops. For this reason, legumes should provide large amounts of the organic matter to be plowed under. Soybeans may be used to start with, because they will stand considerable soil acidity, but the land should be thoroughly limed and put into condition to grow clover and alfalfa as soon as possible. On the naturally poor soils, liberal phosphate and potash fertilization will be necessary also, in order to produce satisfactory crops.

Clover or some other legume should appear in the rotation every 2 or 3 years; as much manure as possible should be made from the produce that can be utilized for livestock; and all produce not utilized, such as cornstalks, straw, and cover crops, should be plowed under. It must be remembered that legumes are the only crops that can add appreciable quantities of nitrogen to the soil and then only in proportion to the amount of top growth that is returned to the land, either directly or in the form of manure. Wherever cloverseed crops are harvested, the threshed haulm should be returned to the land and plowed under. Cover crops should be grown wherever possible, to supply additional organic matter for plowing under. Planting soybeans, cowpeas, or sweetclover between the corn rows at the time of the last cultivation and seeding rye as a cover crop early in the fall on cornland that is to be plowed the following spring are good practices for increasing the supply of both nitrogen and organic matter. It is important to have a growing crop of some kind on these soils during the winter, in order to take up the soluble nitrogen which otherwise would be lost through leaching. Without living crop roots to take up the nitrates from the soil water, large losses will occur between crop seasons through drainage. In this latitude the ground is not frozen much of the time during the winter, and frequent heavy rains cause much leaching and loss of plant nutrients, especially nitrates, if they are not taken up by crops. The winter rains also cause much soil erosion on slopes and hillsides where the ground is not well covered with vegetation. Both of these losses may be considerably lessened by a crop of winter rye on all land that otherwise would be bare during the winter. The rye should be run down with a heavy disk and plowed under before heading.

CROP ROTATION

With proper fertilization, liming, and artificial drainage where needed, these soils will produce satisfactorily all the ordinary crops adapted to the locality. On account of the prevailing shortage of organic matter and nitrogen, every system of cropping should include clover or some other legume to be returned to the land in one form or another. Corn, wheat, and clover, or mixed clover and timothy, constitute the best short rotation for general use on these soils after liming, especially where the corn can be cut and the ground can be disked and properly prepared for wheat. Where the prevention of erosion is an important problem, longer rotations with a large proportion of close-growing or sod-forming crops may be preferable. The corn, wheat, and clover rotation can readily be lengthened to 4 or 5 years by seeding timothy, or timothy and alfalfa, with the clover and allowing the stand to remain for 2 or 3 years to be used for either hay or pasture. On properly limed land, alfalfa may be substituted profitably for all the clover, but some timothy or other quick-growing grass should always be included, in order to make the sod more resistant to erosion.

On the more level areas, and especially on soils not well enough drained for alfalfa, a 4-year rotation of corn, soybeans, wheat, and clover, or mixed clover, alfalfa, and timothy, may prove to be satisfactory. In this rotation, rye should be seeded in the cornfields as a winter cover crop and plowed under late in the spring in preparation for the soybeans. The wheat should be seeded in the soybean stubble without plowing. On the Jennings County experiment field, on Clermont silt loam, with tile drainage, lime, and fertilization, this rotation has averaged 61.3 bushels of corn, 21 bushels of soybeans, 21.1 bushels of wheat, and 3,207 pounds of hay to the acre over a period of 15 years. At Bedford, on Bedford silt loam, the average yields have been 48.2 bushels of corn, 14.4 bushels of soybeans, 17 bushels of wheat, and 2,503 pounds of hay to the acre over a period of 19 years. The two legumes will build up the nitrogen supply of the soil. The soybean straw, or its equivalent in manure, should be spread on the wheatland in the winter. This not only will help the wheat and lessen winter injury, but it also will help to insure a stand of clover. Spring oats are not well adapted to the climatic conditions of this section of the State and, as a rule, are not a profitable crop. The soybean not only is a more valuable crop than oats, but it also adds some nitrogen to the soil and improves the land for the crop that follows, which generally should be wheat. Hardy varieties of winter oats and winter barley are being developed and may come into use more extensively on the better drained soils.

If more corn is wanted, as on livestock farms, the 5-year rotation of corn, corn, soybeans, wheat, and clover may be used satisfactorily where the second corn crop, at least, can be given a good dressing of manure. Where enough livestock is kept to utilize all the grain and roughage in this rotation, there should be enough manure produced to make a fair application for each corn crop. A cover crop of rye for plowing under the following spring should be seeded in September on all the cornland. Even though the land has been properly limed, clover may be uncertain on some of these soils, owing to climatic conditions, and it has proved to be a good plan to sow a mixture of seeds made up of about 4 pounds of red clover, 3 pounds of alfalfa, 2 pounds of alsike clover, and 1 pound of timothy to the acre. Where the seeding fails to make a satisfactory stand, soybeans make a good substitute hay crop.

Lespedeza may be used to advantage in pasture mixtures and on thin spots in old pastures that need improvement, especially where the pasture land is acid and liming is not feasible. Alfalfa and sweetclover may be grown on the better drained areas of these soils if properly inoculated and sufficiently limed to meet the needs of these crops. Alfalfa is preferable for hay, and sweetclover is excellent for pasture and for soil-improvement purposes. Special literature on the cultural requirements of these crops may be obtained from the Purdue University Agricultural Experiment Station at La Fayette.

FERTILIZATION

The soils of this group are naturally low in phosphorus, and in most of them the available supplies of this element are so very low that the phosphorus required by crops should be wholly supplied in applications of manure and commercial fertilizer. The nitrogen supplies in these light-colored soils are also too low satisfactorily to meet the needs of corn, wheat, and other nonleguminous crops, and provisions for adding nitrogen should be an important part in the soil-improvement program. The total quantities of potassium in these soils are large, but the available supplies are low, and in most places the addition of some potash fertilizer would be profitable, especially where little manure is applied. Without substantial provision for supplying all three of these fertilizer elements, the productivity of these soils is sure to decline.

The problem of supplying nitrogen has been discussed in connection with provisions for supplying organic matter. Legumes and manure are the logical and only really practical materials for supplying the greater part of the nitrogen needed by crops, and they should be employed largely for this purpose. A system of livestock farming, with plenty of legumes in the crop rotation, is best for these soils. It will pay on most farms, however, to have some nitrogen in the fertilizer for wheat, regardless of its place in the rotation. Even though wheat follows soybeans or other legumes, it should receive some fertilizer containing nitrogen at seeding time to start the crop properly, because the nitrogen in the residues of an immediately preceding legume does not become available quickly enough to be of much help to the wheat in the fall. The leguminous residue must first decay, and that does not take place to any great extent until the following spring.

Phosphorus is the mineral plant-nutrient element in which these soils are most deficient. In all, the natural supply is small and should not be drawn on further. In areas where much of the surface soil has been washed away, the greater part of the phosphorus has gone with it. The only practical way to increase the supply of phosphorus in the soil is through the application of purchased phosphatic fertilizers, and it will prove profitable in most instances to supply the entire phosphorus needs of crops in this way. In rotations of ordinary crops, producing reasonable yields, it may be considered that 20 pounds of available phosphoric acid to the acre are required each year. It will pay well to apply larger quantities at first, so as to create a little reserve. In applying phosphate, enough for the entire rotation may be applied at one time or the application may be divided, according to convenience. Where manure is applied, it may be counted that each ton supplies about 5 pounds of phosphoric acid; therefore a correspondingly smaller quantity need be provided in the commercial fertilizer.

The quantity of potash that should be supplied as fertilizer depends on the general condition of the soil and the quantity of manure used. According to the analyses in table 8, most of the soils of this group are low in available potash. In building up a run-down soil, much fertilizer potash should be used, at least until such time as considerable quantities of manure can be applied or until the general condition of the soil has materially improved. There is plenty of

A, Effects of phosphate and phosphate with potash on yields of corn on limed Bedford silt loam, Bedford experiment field, 1932. The crop rotation was corn, soybeans, wheat, and clover. The fertilizer used was 200 pounds per acre of 0–12–0 for corn and 400 pounds for wheat (*b*). The same quantity of 0–12–6 was applied to (*c*). The average acre yield with lime alone (*a*) was 33 7 bushels, with lime and superphosphate (*b*) 40.1 bushels; and with lime, phosphate, and potash (*c*) 55.8 bushels. The average acre yields of corn (1918–1936) were 25 2 bushels with lime alone, 40 bushels with lime and superphosphate, and 45 bushels with lime, phosphate, and potash. *B*, Effects of manure and phosphate on yields of wheat on limed Bedford silt loam, Bedford experiment field, 1936 The crop rotation was corn, soybeans, wheat, and clover. Manure was plowed under for corn. The fertilizer used (*c*) was 0–12–0, at the rate of 200 pounds per acre for corn and 400 pounds for wheat. The average acre yield of wheat with lime alone (*a*) was 4.5 bushels; with lime and manure (*b*) 6 bushels; and with lime, manure, and phosphate (*c*) 22.8 bushels. The average acre yield of wheat (1918–1936) was 5.4 bushels with lime alone, 7.6 bushels with lime and manure, and 15.7 bushels with lime, manure, and phosphate.

potassium in these soils for all time if it could be made available at a faster rate. As a rule it becomes available too slowly. This is particularly true of the flat gray soils of the group, and the fertilizer for these should contain more potash than that for the brown or yellow soils. The availability of the soil potash may be increased by good farm practices, including drainage, proper tillage, the growing of deep-rooted legumes, and the plowing under of liberal quantities of organic matter. The better these practices are carried out and the larger the quantity of manure applied, the less potash fertilizer need be purchased.

On the Jennings County experiment field, the results on which may be considered applicable to such soils as the Avonburg, Guthrie, Lawrence, Calhoun, Bartle, and McGary silt loams, highly profitable returns have been obtained wherever lime, legumes, manure, fertilizer, or any combination of these has been used. During the 16 years since the experiments were begun, the land without treatment, other than tile drainage, which is the same for all plots, has produced average crop yields of only 28 bushels of corn, 2.8 bushels of wheat, and 753 pounds of weedy hay to the acre. Land receiving manure alone has averaged 54.1 bushels of corn, 8.2 bushels of wheat, and 1,148 pounds of hay. The limed and manured land has averaged 64.9 bushels of corn, 12.6 bushels of wheat, and 2,166 pounds of hay. Land receiving lime, manure, and fertilizer has averaged 73.5 bushels of corn, 21.2 bushels of wheat, and 3,251 pounds of hay. In the last-mentioned instance the land received 3 tons of ground limestone to the acre in the fall of 1920 and since then has received 6 tons of manure and 100 pounds of 0–12–8 fertilizer in the row for corn and 300 pounds of 2–12–8 for wheat, in a rotation of corn, wheat, and clover.

On the Bedford experiment field on Bedford silt loam in Lawrence County, which may be regarded as representing fairly well the rest of the soils of this group, the land without treatment has averaged only 19.9 bushels of corn, 6.6 bushels of soybeans, 3.2 bushels of wheat, and 692 pounds of hay to the acre. Land receiving manure alone has averaged 35.7 bushels of corn, 8.5 bushels of soybeans, 5.2 bushels of wheat, and 1,071 pounds of hay. The limed and manured land has averaged 41.4 bushels of corn, 10.3 bushels of soybeans, 7.6 bushels of wheat, and 1,491 pounds of hay. The land receiving lime, manure, and fertilizer has averaged 48.2 bushels of corn, 14.4 bushels of soybeans, 17 bushels of wheat, and 2,503 pounds of hay.

Plate 5 shows the effects of liming and the use of fertilizers on Bedford silt loam.

In the practical fertilization of these soils, most of the manure should be plowed under for the corn crop. When the crop rotation includes wheat, as should generally be the case, a part of the manure, about 2 tons to the acre, may be applied profitably on the wheatland as a top dressing during the winter. Manure so used not only helps the wheat and lessens winter injury, but it also helps to insure a stand of clover or other crop seeded in the wheat. Unless very heavily manured, corn should receive, in addition, about 100 pounds of superphosphate to the acre in the row or hill at planting time. Without manure, corn should be given from 100 to 150 pounds to the acre of a phosphate and potash mixture at least as good as

0–14–6, applied in the row or hill. Wheat should be given from 200 to 300 pounds to the acre of a high-analysis complete fertilizer at least as good as 2–12–6. In places where the wheat is backward in the spring, a top dressing of about 100 pounds to the acre of a good soluble nitrogen fertilizer should be applied soon after growth begins. Such top dressing generally will add from 5 to 7 bushels per acre to the yield. For special crops, such as tobacco, potatoes, and tomatoes, special fertilization will be needed.

SANDY SOILS OF THE UPLANDS AND TERRACES

Princeton fine sandy loam and its steep phase are the only representatives of this group of soils in Washington County. The depth of the sandy soil material indicates good to excessive natural drainage, and a shortage of moisture develops quickly in times of drought. The water-holding capacity of the surface soil may be improved by adding organic matter whenever possible. The soil in most areas is somewhat acid and will need to be limed if such crops as clover, alfalfa, or sweetclover are to be grown.

ORGANIC MATTER AND NITROGEN

Princeton fine sandy loam is naturally low in organic matter and nitrogen, and some special provision should be made for increasing the supply of both these constituents in order to increase the productiveness of the soil. As much manure as possible, as well as all unused crop materials, should be plowed under. Special green-manure crops and cover crops, such as soybeans, cowpeas, sweetclover, rye, and winter vetch, should be planted wherever possible in order to produce nitrogenous organic matter for plowing under. Both a soil cover throughout the year and more organic matter worked into the surface soil will help to protect the soil against damage from erosion. What has been said concerning the nitrogen and organic-matter problems in the improvement of the light-colored silt loam soils of the uplands and terraces applies equally well here, and the practices recommended for those soils should be followed on these sandy soils. Their loose open texture favors more rapid decomposition of organic matter than in the heavier soils. For this reason, more than ordinary quantities of organic matter should be plowed under.

CROP ROTATION

Of the extensively grown field crops, these sandy soils are best adapted to winter small grains and legumes, especially alfalfa after the land is limed. Corn, as a rule, does well only on the more loamy and lower lying areas or in places where the sandy surface soil is shallow and is underlain by heavier material. The higher and drier areas are better suited to such crops as melons, sweetpotatoes, early potatoes, and early tomatoes. They are also suited to soybeans and cowpeas, and if the land is limed, alfalfa and sweetclover do well. Clover will not stand so much drought as alfalfa and sweetclover, and perhaps it should be replaced by those crops. Alfalfa can be used as satisfactorily in short rotations as clover, after the land is once thoroughly inoculated for this crop, and it will not suffer so much from drought as the clover.

FERTILIZATION

These sandy soils are naturally deficient in nitrogen and need special provision for building up a supply of this element. The total supply of phosphorus is so low that it should not be depleted further. As a rule, the available potash also is low. Stable manure should be applied as liberally as possible, both for its plant-nutrient constituents and for the organic matter it supplies, in order to improve the water-holding capacity of the soil as well as its productiveness. Manure, however, is seldom available in sufficient quantities; therefore, commercial fertilizers high in phosphorus and potassium must be used.

Legumes, in rotation or as special green-manure or cover crops, should be used to supply much of the needed nitrogen that is not provided in the form of manure. Early potatoes, melons, tomatoes, and other truck crops on these soils will respond to heavy applications of high-analysis complete fertilizers. Five hundred pounds or more to the acre of a 2–12–6 or closely similar mixture should be used. Where little or no manure is used, a 3–12–12 or similar mixture should be used. If wheat is grown, from 200 to 300 pounds to the acre of 2–12–6 fertilizer generally is advisable. Cornland should be given from 100 to 150 pounds an acre of 0–14–6 or 0–12–12 in the row or hill.

Where alfalfa or sweetclover is to be grown, from 300 to 500 pounds to the acre of a high-grade phosphate-potash mixture should be applied at seeding time. A continuous stand of alfalfa should receive a top dressing of phosphate and potash fertilizer every 2 years.

DARK-COLORED SOILS

This group includes the silty clay loams of the Burgin and Montgomery series and dark-gray areas included in Corydon silt loam. The latter is a hillside soil so steep as to be unfit for cultivation and is, therefore, omitted from consideration in the following discussion. The most important defect of both the Burgin and Montgomery silty clay loams is poor natural drainage caused by their depressed position. When this is remedied, these soils will produce good yields of all the crops adapted to the locality. They are well supplied with organic matter and contain more plant-nutrient elements than the adjoining higher ground. Liming is unnecessary in most places.

These dark-colored soils are especially well suited to corn, and this should be the major crop in most fields where either series predominates. Manure and fertilizer are not so necessary as on the lighter colored soils with which these soils are associated. Wheat, however, generally should receive a good complete fertilizer, such as a 2–12–6, in order to start it properly in the fall. Corn generally should receive a phosphate-potash mixture. On farms having both light- and dark-colored soils, the manure should be applied to the light-colored soils which are more in need of organic matter and nitrogen, which the manure supplies.

BOTTOM LANDS

The bottom, or overflow, lands may be divided into two general classes—the sour bottoms and the sweet bottoms. The sour bottoms, consisting of the silt loam and silty clay loam of the Stendal series, the silt loams of the Philo, Lindside, Pope, and Waverly series, and the fine sandy loams of the Philo and Pope series, have received their soil deposits from the acid soils of the uplands and terraces, and most of them are in need of liming where clovers or other lime-loving crops are to be grown. The sweet bottoms, consisting of the silt loams of the Eel, Genesee, and Huntington series, Genesee silty clay loam, and Genesee fine sandy loam, receive their deposits from the lime-bearing soils of the uplands and terraces. They are either alkaline or only slightly acid and seldom need liming. Natural drainage is limited by the periodic overflows and, in the heavier types, by tight subsoils. The latter should be underdrained with tiles wherever suitable outlets can be obtained, in order that the land may drain more quickly after floods or heavy rains.

LIMING

The soils of the sour bottoms should be limed wherever possible, so that other needed treatments may be more effective. From 2 to 3 tons to the acre of ground limestone or its equivalent in other forms of lime should be applied.

ORGANIC MATTER AND NITROGEN

What has been said about supplying organic matter and nitrogen to the light-colored soils of the uplands and terraces applies equally well to the light-colored soils of the bottom lands. On the lighter colored and poorer areas of these soils, especially, considerable quantities of organic matter should be plowed under, either directly or in the form of manure, and legumes should be included in the rotation wherever possible and largely returned to the land in one form or another, in order to increase the nitrogen content.

Where the land is periodically flooded, clover and other deep-rooted legumes, especially biennials and perennials, cannot be depended on, but certain shallow-rooted legumes, such as soybeans, cowpeas, and sometimes alsike clover and lespedeza, can be grown satisfactorily. These crops should be used largely for gathering nitrogen from the air, which they will do in large measure when the soil is properly inoculated. Here again it must be remembered that only the top growth plowed under, either directly or in the form of manure, can really increase the nitrogen content of the soil, on which grain crops must depend. Cover crops, such as cowpeas, soybeans, and rye, should be used to the fullest possible extent in the cornfields. Cornstalks should not be burned but should be completely plowed under whenever this is practicable.

CROP ROTATION

Where overflows cannot be prevented, the crop rotation must consist largely of annual spring-seeded crops and such grass and clover mixtures as will not be seriously injured by ordinary floods. For the most part, corn, soybeans, cowpeas, and in some places, where flooding is not too prolonged, wheat with a mixture of timothy and alsike clover following for a year or two, are satisfactory crops for this land. Corn should doubtless continue to predominate, but some sort of rotation is advisable to help maintain fertility. Doubtless soybeans will become more important as a rotation crop on these soils if proper inoculation is provided. Timothy and alsike, mixed, will do well on most of this land after the strongly acid areas have been limed, and this crop may be allowed to stand for more than 1 year. In places where the land is too acid for alsike, lespedeza may be used. For late seeding in emergencies, early varieties of soybeans and Sudan grass, for either hay or seed, will be found useful.

FERTILIZATION

Practically all of the bottom lands of this county are low in the important plant-nutrient elements. It should be recognized that in most instances the floodwater sediments coming to these bottom lands from the adjoining watersheds are not so rich as they were years ago. The rich surface soil has gone from much of the upland, and the present floods carry little but eroded subsoil material of low fertility.

Nitrogen should be supplied in applications of manure and by the growth of such legumes as will not be damaged seriously by floodwater. As a rule, commercial nitrogenous fertilizers will not pay on corn but may be used to advantage in the few places where wheat can be grown and as a top dressing on timothy meadows. For cornland, superphosphate or a phosphate-potash mixture, such as 0–14–6 or 0–12–12, in areas where a deficiency of potash is evident, should be drilled in the row or placed beside the hill at the rate of 100 to 150 pounds to the acre. In places where wheat is grown, a 2–12–6 fertilizer should be used for this crop at seeding time at a rate ranging from 200 to 300 pounds an acre.

NONAGRICULTURAL LAND

Considerable areas of Washington County are nonagricultural, or, at least, nontillable and undesirable for ordinary farming purposes. All the Corydon and Muskingum soils and the steep and gullied phases of the Cincinnati, Frederick, Hagerstown, Orleans, Princeton, Wellston, and Zanesville soils should be kept out of cultivation. Some of the land in this category that has been cleared may be put into permanent pasture by seeding to grass and lespedeza, but much of it should be reforested and given protection from livestock as the most practical means of saving it from complete destruction by erosion. Many thousands of acres in this county have been ruined or damaged seriously by erosion, and such damage will become progressively worse unless decisive steps are taken to prevent it. To obtain and keep sufficient vegetative cover on the land to hold the soil in place is essential. Dams and other engineering devices should be employed wherever practical, but undisturbed forest or a solid vegetative cover of some other kind should be the ultimate aim.

SUMMARY

Washington County is in the southern part of Indiana. It is nearly square and includes an area of 519 square miles. It has a large mileage of improved roads and a good public-school system.

The rainfall of 44.24 inches is well distributed.

Most farmers carry on a general type of farming which combines the raising of livestock with crop production. Corn, wheat, oats, and timothy are the leading crops. Other crops are clover,

alfalfa, tomatoes, snap beans, apples, peaches, strawberries, and blackberries.

Approximately 50 percent of the county is used for the production of crops, 30 percent is in second-growth forest, and the remaining 20 percent consists largely of idle land.

The upland soils are underlain by limestone, thin-bedded sandstone and shale, and glacial drift. In the section underlain by limestone or glacial drift, the relief ranges from slightly undulating to hilly. The sections underlain by thin-bedded sandstone and shale are characterized by long narrow ridges and steep slopes.

For purposes of discussion, the agricultural soils are divided into three groups: (1) Well-drained soils, (2) imperfectly drained soils, and (3) poorly drained soils.

Hagerstown silt loam and its shallow phase are considered the most productive well-drained upland soils. These soils are recognized by their brown surface soils and reddish-brown subsoils. They occur in a north-south belt across the central part of the county and along the northwestern edge of the Mitchell plain. This belt comprises the outstanding agricultural section of the county.

Frederick and Bedford silt loams are two other high-grade well-drained upland agricultural soils. These soils occur widely distributed over the Mitchell plain in Washington County. Frederick silt loam is the dominant soil in the more rolling parts of the Mitchell plain. Considerable areas of Frederick silt loam, steep phase, are in some sections of the county, associated with Frederick silt loam. The areas of this steep soil include a large proportion of pasture and forest land and a small proportion of cultivated land.

Bedford silt loam is the dominant soil in the flatter parts of the Mitchell plain, particularly around Smedley and Saltillo. It is associated with Lawrence silt loam—a soil that requires artificial drainage. The areas of this soil include a large proportion of crop and pasture land and only a small proportion of forest land.

Orleans, Cincinnati, Gibson, Zanesville, and Tilsit silt loams are well-drained upland soils having grayish-yellow, grayish-brown, or yellowish-brown surface soils and yellow or brown subsoils. These soils normally are not so productive as Frederick or Bedford silt loams, and in many years they produce very low yields.

Elk silt loam is a well-drained soil on the terraces which produces good crops but is inextensive. As mapped it includes some Holston silt loam—a similar soil.

Pekin silt loam is a moderately well drained soil on the terraces, which occurs in various parts of the county. It is not so productive as Elk silt loam, and in many years it produces very low yields. It includes several areas of the similar Monongahela silt loam.

Markland and McGary silt loams occur on the terraces of East Fork White River and Muscatatuck River. These soils are developed from calcareous silty clay deposits. They are not important agricultural soils but produce excellent pasture.

Huntington silt loam is a neutral or alkaline well-drained soil of the bottom lands along Blue River and its tributaries in those parts of the Mitchell plain underlain by limestone. This soil produces high yields and is commonly planted to corn.

The Genesee soils are well-drained soils of the bottom lands along East Fork White River and Muscatatuck River. These soils are alkaline or neutral in reaction and are very productive.

The Pope soils are well-drained soils of the bottom lands along streams where the sediments come largely from sandstone regions. These soils are acid and are not so productive as the Huntington soils.

The imperfectly drained upland and terrace soils—Lawrence, Guthrie, Avonburg, Bartle, and Calhoun silt loams—ordinarily do not produce such high yields as the better drained soils, such as Frederick and Bedford silt loams.

Eel silt loam is an imperfectly drained soil of the bottom lands along East Fork White River and Muscatatuck River. It is neutral or alkaline in reaction and produces good yields where artificially drained. The Lindside and Philo soils are imperfectly drained soils of the bottom lands which produce fair yields except during years when the rainfall is unusually high. The Stendal and Waverly soils are imperfectly drained soils of the bottom lands which produce low yields.

Burgin silty clay loam and Montgomery silty clay loam are poorly drained upland and terrace soils, respectively. These soils have dark-gray surface soils and lighter gray subsoils. They are neutral or alkaline in reaction and, where artificially drained, produce good yields.

Muskingum silt loam is an extensive soil in the Norman and Crawford uplands. Practically all of it is in second-growth forest. It is a nonagricultural soil.

The steep, eroded, and gullied phases of Hagerstown, Frederick, Orleans, Cincinnati, Princeton, and Muskingum silt loams are best used for forestry or pasture.

Erosion is a serious menace. Thousands of acres of the soils on slopes have been seriously damaged by either sheet or gully erosion, or both.

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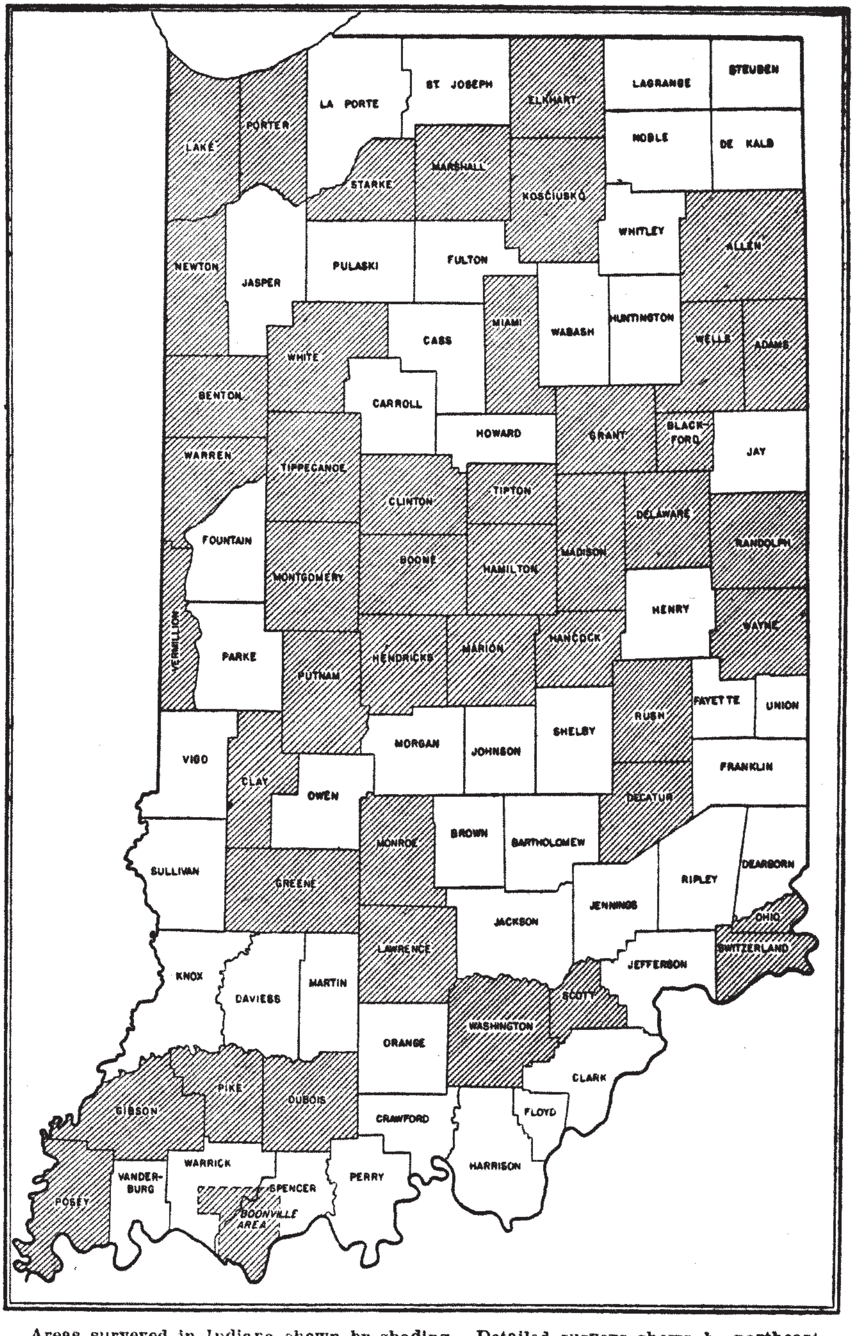
There shall be printed, as soon as the manuscript can be prepared with the necessary maps and illustrations to accompany it, a report on each soil area surveyed by the Bureau of Chemistry and Soils, Department of Agriculture, in the form of advance sheets bound in paper covers, of which not more than 250 copies shall be for the use of each Senator from the State and not more than 1,000 copies for the use of each Representative for the congressional district or districts in which a survey is made, the actual number to be determined on inquiry by the Secretary of Agriculture made to the aforesaid Senators and Representatives, and as many copies for the use of the Department of Agriculture as in the judgment of the Secretary of Agriculture are deemed necessary.



Areas surveyed in Indiana shown by shading. Detailed surveys shown by northeast-southwest hatching.

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