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Soil Survey of Butler County, Iowa

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U. S. Department of Agriculture

Bureau of Chemistry and Soils
In cooperation with the Iowa Agricultural Experiment Station

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CONTENTS

	Page
County surveyed	1
Climate	3
Agriculture	4
Soil series and types	12
Carrington silt loam	15
Carrington loam	16
Carrington fine sandy loam	17
Carrington sandy loam	19
Clyde silt loam	19
Clyde silty clay loam	20
Dickinson fine sandy loam	21
Dickinson sandy loam	23
Dickinson loamy fine sand	23
Dickinson loam	24
Floyd silt loam	25
Fayette very fine sandy loam	26
Tama silt loam	28
Dodgeville silt loam	29
Dodgeville loam	30
Lindley loam	30
O'Neill loam	31
O'Neill sandy loam	33
Waukesha silt loam	33
Waukesha loam	34
Bremer silt loam	35
Fargo silty clay loam	36
Millsdale loam	37
Wabash silt loam	37
Wabash silty clay loam	38
Wabash loam	39
Cass sandy loam	40
Lamoure silty clay loam	40
Meadow	41
Muck and peat	41
Soils and their interpretation	41
Summary	48

SOIL SURVEY OF BUTLER COUNTY, IOWA

By J. AMBROSE ELWELL, Iowa Agricultural Experiment Station, in Charge, and E. N. POULSON, United States Department of Agriculture

COUNTY SURVEYED

Butler County lies a little northeast of the center of Iowa. (Fig. 1.) It is approximately square in outline and includes an area of 581 square miles, or 371,840 acres.

The surface of the greater part of the county is that of an undulating plain, crossed from northwest to southeast by three large streams which have an easy gradient, and consequently intrenchment proceeds very slowly. Strips of alluvial land, most of which range in width from one-half to 2 miles, border the streams across the county. In most places the slope from the alluvial lands to the uplands is so gradual that it is almost imperceptible. The upland divides between the streams have a smooth and almost level or undulating drift-plain relief. The dendritic stream systems have extended into every square mile of the smooth upland. Although areas having slow drainage occur, there are no lakes or swamps. The land in the southwestern part of the county and along the northern border is rougher, and the streams have cut deeper and more well-defined valleys. Such areas have a preglacial configuration and are unmodified or only slightly planed and smoothed by ice action. From the center of Albion Township and eastward through Beaver Township is a belt about 3 miles wide, in which the rather sharply rolling hills and ridges and deep valleys are typical of a morainic relief. From near the center of Monroe Township and extending in a northwesterly direction for several miles is a series of low lenticular hills which have been given the name of pahas. Another series of these hills covering about 2 square miles lies west of Kesley, and small areas having similar surface features occur in other parts of the county.

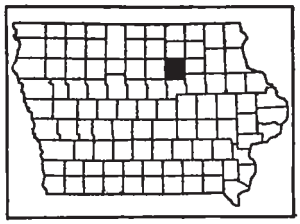

FIGURE 1.—Sketch map showing location of Butler County, Iowa

Shelves of limestone bedrock form rather steep slopes in various places along the valleys of Coldwater Creek, Flood Creek, a dry run in Fremont Township, Shell Rock River (chiefly near Greene), and Beaver Creek south and west of Austinville. The limestone seldom outcrops in a sheer ledge but usually forms a narrow strip on the shoulder of the slope below which is a rather gently sloping soil mantle and above which the slope is only slightly more abrupt than slopes on which no bedrock outcrops.

The general slope of the county is to the south and east, the direction of stream flow. The elevations above sea level of the various stations along the railroads range from 895 feet at New Hartford to 1,044 feet at Allison.

The three main streams of the county flow into Cedar River a short distance east of the east county boundary. The southern tier of townships lies in the water-sheds of Shell Rock River and West Fork Cedar River. The last-named stream is intermittent and sluggish; the other two are perennial and flow at a moderate rate, having a fall of about 2 feet to the mile. The flood plains are, as a rule, well drained, and only a few marshy areas occur, chiefly along West Fork Cedar River.

Tributary drainage ways reach into all parts of the uplands and furnish good natural drainage to practically all sections of the county. The flatter parts of the divide northwest of Allison are inadequately drained, as the upland drainage ways are sluggish in many places. Many farmers in this section have laid tile to improve the drainage. Bordering the upland drainage ways, in practically all parts of the county, are narrow strips of poorly drained, seepy spots which exist in spite of a good degree of slope. These seepy spots make drainage more difficult, and most of them are left unimproved and utilized for pasture. They occur mainly in areas of Clyde soils.

There is little gullying from erosion in the county. However, on the slopes of the rolling hills mentioned gullies are appearing, and their control is important and necessary. Sheet erosion is slowly active on most of the slopes. It goes on entirely unobserved and unchecked except on the sandy soils, such as the Dickinson soils, where erosive action is more rapid and sandy wash, in many places, buries the newly planted crops.

The first settlers found the county an expansive prairie. Hardwood timber grew only in strips along the stream valleys and in a few places on the rolling hills, notably on the range of hills north of Beaver Creek. Practically all the areas shown on the map as Fayette soils and much of those shown as Dickinson and Dodgeville soils supported a native timber growth. The principal trees are the oaks (red, scarlet, white, and bur), shellbark hickory, pignut, sugar maple, and aspen on the uplands and cottonwood, elm, chokeberry, butternut, ash, and walnut on the flood plains. Much of the walnut and hickory has been cut or crowded out by second-growth trees. The underbrush includes wild plum, wild cherry, red haw, and such shrubs as sumac, elderberry, hazelnut, blackberry, raspberry, and bittersweet. Groves, consisting chiefly of cottonwood, boxelder, maple, and some conifers such as red cedar and white, Norway, or Scotch pine have been planted around the buildings on nearly all farms. According to the 1925 Federal census, 12,534 acres, or about 3.5 per cent of the area of the county, is in woodland practically all of which is used for pasture.

The first settlements in Butler County were made near the present sites of Shell Rock and Clarksville in 1850, and in 1851 the county was organized. The population was largely native-born Americans from eastern Iowa or from States farther east. The 1925 Iowa census gives the foreign-born people as 9.9 per cent, and the native born of foreign or mixed parentage a 34.2 per cent of the total population. Germans comprise the largest number of foreign born, and Hollanders, Canadians, and Danes rank next. This same census gives the total county population as 17,990, of which 10,787 is classed as rural.

The density of the rural population is 18.7 persons to the square mile. It is rather evenly distributed, the western and northern tiers of townships probably being slightly more thickly settled.

Most of the residents of the county are engaged in agricultural pursuits and the business of the towns is built up from the agricultural sections surrounding them. The towns are well distributed and are easily accessible. Greene, Clarksville, and Parkersburg, each with a population of more than 1,000, are the largest towns.

Connecting the principal towns are several graveled highways, No. 20 of the Federal system and Nos. 10 and 14 of the State system. All the county roads are well graded, and practically all the township roads are graded.

The railroad facilities of the county provide ready access to outside markets. The main line of the Illinois Central Railroad and branch lines of the Chicago, Rock Island & Pacific Railway and the Chicago Great Western Railroad traverse the county and furnish good transportation to both the Minneapolis and Chicago markets. Other outside markets are Des Moines, Cedar Rapids, and Sioux City, Iowa; Omaha, Nebr.; and Sioux Falls, S. Dak.

Good educational facilities are provided by 106 rural schools and 4 consolidated schools.

CLIMATE

The climate of Butler County varies considerably from year to year, especially in the spring and fall, both in temperature and distribution of rainfall. The summers are usually consistently warm, with well-distributed rainfall; and the winters are uniformly cold, with snow covering the ground most of the season. The average frost-free season lasts for 146 days, from May 9 to October 3. The latest killing frost recorded was on May 25 and the earliest on September 14. The growing season is usually ushered in by moderately warm temperatures and moist conditions, which favor spring planting of crops. The warm summers with their well-distributed rainfall are favorable to good growth and maturity of all staple crops before fall frosts. Occasionally dry spells are of long enough duration to cause decreased crop yields, particularly on the lighter, sandier soils, such as the O'Neill and Dickinson. Weather conditions during the last of August and September are usually favorable for fall plowing and seeding of grain.

The seasonal variations which tend to decrease crop yields are late spring and early fall frosts, unusually wet weather during or immediately after spring planting, and protracted dry spells during summer and early fall. Open, rather snowless winters and unusually cold winters damage the tame-hay crop and fall-seeded grain. Wheat, red clover, sweetclover, and alfalfa seem most susceptible to such damage.

The prevailing winds are from the west and northwest. Occasionally a high wind or hailstorm damages farm buildings, timber, and crops, but such storms are local and the losses are not great.

Table 1, compiled from records of the United States Weather Bureau station at Allison, gives data representative of climatic conditions in Butler County.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Allison, Iowa*

[Elevation, 1,044 feet]

Month	Temperature			Precipitation		
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1925)	Total amount for the wettest year (1918)
	° *F.*	° *F.*	° *F.*	*Inches*	*Inches*	*Inches*
December	21.4	58	−27	1.20	1.15	1.07
January	15.3	55	−30	1.20	.10	1.41
February	19.3	55	−25	1.44	.78	1.10
Winter	18.7	58	−30	3.84	2.03	3.58
March	32.1	77	−5	1.80	.86	.99
April	47.3	83	16	3.04	.71	2.40
May	58.7	93	29	5.09	1.73	10.65
Spring	46.0	93	−5	9.93	3.30	14.04
June	68.1	97	43	4.95	5.46	5.18
July	72.8	101	51	3.75	2.11	6.41
August	70.5	100	41	3.40	3.59	3.04
Summer	70.5	101	41	12.10	11.16	14.63
September	63.1	95	27	3.50	5.54	2.14
October	50.7	86	16	2.50	2.81	3.12
November	34.5	74	−5	1.56	.88	1.50
Fall	49.4	95	−5	7.56	9.23	6.76
Year	46.2	101	−30	33.43	25.72	39.01

AGRICULTURE

Agriculture has been the main industry of Butler County from the time of its first settlement. During the period between 1865 and 1879 the present railroad facilities were put in operation, and this was the turning point in agricultural development. Prior to the coming of the railroads farming was of a pioneer type, consisting of the growing of small patches of corn and oats for feed for work animals, wheat and buckwheat for flour, flax for homespun articles, potatoes and other vegetables for home consumption, and sorgo for sirup. Increased railroad facilities opened up new markets for agritural products, and wheat became an important source of farm income. However, wheat farming was not carried on to the exclusion of other crops as it was farther north in Minnesota. The farmers of Butler County turned to a diversified general type of farming with a well-balanced production of crops and livestock. In 1879 the main crops were corn, wheat, hay, oats, rye, barley, and buckwheat. About three-fourths of the land in the county was in farms. Creameries were in operation at New Hartford, Shell Rock, and Clarksville.

The type of farming has not changed materially, but the comparative importance of the various crops and the relative importance of crops and livestock has shifted. The acreages of corn, oats, and tame-hay grasses have steadily increased, the wheat acreage has decreased,

and the small acreages devoted to barley and rye have remained about the same. The large acreage devoted to oats is owing to the feeding value of this crop and its suitability as a follow-up crop for corn and a nurse crop for seedings of tame-hay grasses. Rye is more productive than the other small grains on light, sandy soil. Potatoes have always been the principal vegetable crop. The acreage of tame hay has increased and that of wild hay has decreased since 1900. Timothy and clover mixed form the principal tame-hay crop. Timothy alone is grown less extensively than formerly. The acreage in red clover is increasing. In the last five years sweetclover and alfalfa have been grown on small acreages. All branches of the livestock industry have steadily increased in importance. Dairying early became an important enterprise.

The most rapid expansion of farm lands took place prior to 1880. The changes in farm acreages, the proportion of land improved, the average size and number of farms, and the percentage of tenant-operated farms in the last six census years are shown in Table 2.

TABLE 2.—*Status of farms in Butler County, Iowa, in census years*

Year	Area of county in farms	Total farms	Average size of farms	Improved land in farms	Tenant-operated farms
	Per cent	*Number*	*Acres*	*Per cent*	*Per cent*
1925	95.9	2,268	156.1	----------	53.6
1920	94.5	2,244	155.5	88.1	51.3
1910	95.6	2,226	158.5	88.0	45.1
1900	97.7	2,304	156.5	89.6	43.2
1890	90.2	2,055	162.0	86.2	35.3
1880	78.8	1,975	147.0	89.0	31.0

It will be noted from Table 2 that since 1890 little change has occurred in any item except tenancy, which shows a decided increase. Increases in the number of farms necessarily mean a decreased acreage to the farm. The rate of tenancy during a trend toward smaller-sized farms will probably not increase and may decrease.

The present type of farming in Butler County combines grain and livestock production. Most of the crops are fed to the animals and the greatest cash revenue comes from the sale of livestock products, among which dairy products constitute a considerable part. An analysis of the farm income of the county, compiled by the Iowa State census of 1925 and shown in Table 3, indicates the relative importance of the various crops and classes of livestock on the farms of Butler County.

TABLE 3.—*Value of crops and livestock products marketed in Butler County, Iowa, in 1925* [1]

Crop	Proportion sold	Value	Livestock Products	Proportion sold	Value
Corn	One-ninth	$196,876	Hogs	84,990 [2]	$1,329,269
Oats	One-fourth	324,084	All dairy products	Seven-ninths	731,412
Rye	One-half	6,860	Cattle	Less than one-third.	599,188
Buckwheat	Five-sixths	980	Eggs	Three-fourths	283,817
Barley	One-fourth	968	Poultry	Three-fifths	168,116
Wheat	One-third	913	Horses	2 per cent	30,486
Flax	Seven-eighths	184	Sheep	One-half	29,623
Total value of grain sold.		530,865	Wool		10,155
All hay	One-tenth	66,469	Honey		3,381
Tame-hay seeds (timothy.)	A little more than one-half.	3,358	Total livestock products.		3,185,447
Clover seed	One-fourth	245	Total value of all products.		3,801,040
Potatoes	One-tenth	5,730			
Sweet corn for canning.		7,965			
Pop corn	More than one-third.	901			
Total value of all grain, hay, and miscellaneous crops listed above.		615,593			

[1] Iowa State census. [2] Number sold.

From the foregoing figures it may be seen that, although most of the corn and oats are fed, these crops return the highest income of the crops marketed. Likewise dairy products return a greater income than beef. The greater part of the dairy products is sold locally to the 11 creameries in the county, an ice-cream factory at Ackley, Hardin County, and a condensary at Waverly, Bremer County. The fattened livestock are shipped mainly to Chicago, and large numbers are carried by truck to packing houses in Mason City and Waterloo, Iowa. The wool and poultry products are sold to local buyers who ship them to eastern markets. Most of the grain is handled by local elevators and shipped to Chicago, small shipments going to Minneapolis.

According to the 1925 Federal census the principal crops rank in acreage as follows: Corn, 114,477 acres; oats, 78,938 acres; timothy and clover, 26,398 acres; timothy alone, 4,590 acres; clover and alfalfa, 3,071 acres; rye, 1,596 acres; and potatoes, 1,361 acres.

Corn occupies by far the largest acreage. Of the total crop in 1924, 14,218 acres were cut for fodder, 10,046 were hogged off, 5,370 acres were cut for silage, and the remaining 84,843 acres were harvested for grain. Corn is the most important feed crop, and a considerable income is derived from the surplus marketed. Mixed home-grown seed is commonly used. Both the white and yellow dent varieties are grown, and some Calico corn is produced solely for feeding. The most popular varieties are Grundy County White, Dewey White Dent, Silver King, Moore Yellow Dent, Reid Yellow Dent, and Ioleaming. Corn is generally planted between May 1 and May 10. Some plantings for silage or fodder are made a trifle later. Corn for silage is cut the last of September. Harvesting of the grain crop

begins October 15. In 1925 silage was put up on 358 farms, or 15.9 per cent of the farms in the county.

The 1925 Federal census reported 1,954 of the 2,268 farms of the county as producing oats on an average acreage of 40.4 acres to the farm. Three-fourths of the crop is fed on the farm and the rest is sold for cash. A greater income is derived from the oats marketed than from any other crop. However, it is not a profitable cash crop but is grown chiefly because of its feed value and adaptability as a follow-up crop for corn. Mixed home-grown seed is commonly used. Early or medium-early varieties of Kherson, Iowar, and Iowa 103 are the most popular, and some medium-late Green Russian oats are grown. The oat crop is seeded during April. Harvesting of the early oats takes place from July 10 to July 20 and of late oats from July 15 to August 1.

Timothy and clover mixed was seeded on 1,456 farms in 1924. About two-thirds of the tame-hay acreage was in this crop. The average acreage was 18 acres to the farm. Timothy and clover is sown with small grains as a nurse crop and used for light fall pasturage. Two cuttings of hay are obtained the following season. The 1927 Iowa Yearbook reports 1.56 tons to the acre as the average yield in that year. Timothy is seeded alone on some farms, and a considerable acreage is cut for seed, which yields an average of about 5 bushels to the acre. Almost all the clover seeded alone is red clover, but small acreages of alsike and mammoth clover are grown. Besides the hay produced light pasturage is afforded during the fall, following seeding. In some years part of the crop is cut for seed.

Rye is grown on some farms. It is seeded during the latter part of August. Light fall pasturage is usually supplied in addition to the grain crop harvested the following summer. Of the fall-seeded crops rye suffers the least damage from winterkilling and dry spells of weather. It outyields other small grains on light sandy lands.

Potatoes were grown on 1,760 farms in 1924, mainly for home use, and on a few farms, mainly in the southwestern part of the county, large acreages were grown for market. The principal varieties are the Early Ohio, Petoskey, Triumph (Bliss), and Burbank.

Minor crops grown are barley, sweet corn, wheat, sweetclover, alfalfa, buckwheat, cabbage, flax, and watermelons. Sweet corn is grown, largely in the neighborhood of Clarksville, Ackley, and Waverly, for canning purposes. Canning factories are located in these towns. Evergreen and Early Crosby are the popular varieties of sweet corn. Wheat is grown chiefly as a cash market crop. Both winter and spring varieties are grown, the spring wheats ordinarily producing a little higher yields. Sweetclover is sown principally as a soil-improvement crop. Pasturage and hay are obtained, and in most seasons the stubble provides a good supply of organic matter to be plowed under in the fall. About 99 acres were cut for seed in 1927, and the average yield was 1.9 bushels to the acre. Alfalfa, principally of the Grimm variety, occupies small acreages. Buckwheat and flax are usually planted as catch crops on small spotted acreages where previous seedings of some other crop have failed. All the seed produced is marketed. Cabbage and watermelons are grown as truck crops.

Other minor crops grown are soybeans, millet, rape, Sudan grass, sorgo, milo maize, pop corn, and root-forage crops. Some of the soybeans are seeded with corn. When seeded alone the average yield of beans is about 11.3 bushels to the acre. However, their chief use is for hay and silage. Manchu is the most common variety. Millet is grown on small patches as a short-season hay crop. In the vicinity east of Greene large acreages were seen during 1928. Sudan grass, milo maize, and sorgo are forage and fodder crops. Some of the sorgo is used to supply the farm table with sirup. Rape is sown with corn and oats or in small patches alone for forage. Pumpkins are grown in the cornfields for forage, and root-forage crops, such as rutabagas, stock carrots, and mangels, are grown in small patches for forage. Pop corn, mainly of the Japanese Hulless variety, is grown in small patches for the local markets.

The 1925 Federal census reports 93,909 acres of pasture land in the county. Of this acreage, 12.5 per cent is classed as woodland pasture, 46.8 per cent as plowable pasture, and the remaining 40.7 per cent as brush-land pasture or pasture not plowable because of poor drainage and other drawbacks. The greater part of the plowable pasture acreage and a part of that not plowable support excellent stands of bluegrass mixed with timothy, redtop, and white, alsike, and red clover, and sweetclover. The most poorly drained pasture areas, occurring mainly on Bremer, Clyde, or muck and peat soils, support a stand of coarser water-loving grasses which crowd out the bluegrass. A firm sod is seldom maintained on these areas, as the trampling of livestock causes a hummocky surface covered with bunches or tussocks of grass. In the woodland and brush-land pastures the bluegrass stand is not so good as in the cleared pastures.

Orcharding receives little attention. Some of the orchard products are sold on local markets or to tourists along the main highways. Apples are the most common tree fruit, and some grapes, plums, pears, and cherries are grown. Most of the small farm orchards receive little attention. The county agent reports that about one-third of the farmers are spraying their fruit. The Oldenburg (Duchess of Oldenburg), Wealthy, Sweet June, Wolf River, Yellow Transparent, and Fameuse (Snow) are the favorite varieties of apples, Concord is the most common variety of grapes, and the plums grown are chiefly the common wild red plums. Patches of small fruit, mainly strawberries, blackberries, and raspberries, are grown on many farms.

The livestock enterprises engaged in rank in importance as follows: Pork production, dairying, beef production, poultry production, sheep production for mutton and wool, and colt production for local demands.

Most of the herds of hogs are composed of grade animals. The most popular breeds are Duroc-Jersey, Big-type and Spotted Poland China, and Chester White. Hog cholera causes small losses at times. Other diseases, such as "flu" and necrotic enteritis, take some toll. The greatest losses occur among the young pigs. The better breeders practice immunization against cholera and keep their hog lots and hog houses in a sanitary condition. Most of the hogs sold are shipped directly to Chicago, but large numbers are trucked to the Mason City and Waterloo packing houses.

On most farms dairying is carried on as a side line, but on a few farms it is specialized in. The Holstein is the most popular dairy animal. Much smaller numbers of Guernsey, Jersey, Brown Swiss, and Ayrshire are kept. According to the 1925 annual report of the Iowa State dairy commissioner the 11 creameries operating in the county produced 2,348,823 pounds of butter. In addition, the condensary at Waverly and the ice-cream factory at Ackley draw part of their supplies from parts of Butler County.

Practically all the beef cattle marketed are farm raised or native livestock purchased locally. A few large feeders ship in livestock from Sioux City or the Dakota ranches for winter fattening. The 1925 Iowa State census reported 6,420 cattle bought either locally or from public markets. Beef cattle are reported on 1,185 farms, and most of them are grade animals. The Hereford is the most popular breed, and Angus and Shorthorn rank next. Only a few farmers specialize in purebred stock, but most of the herds are headed by purebred sires. Washington, Monroe, Madison, and Bennezette Townships are the principal beef-producing sections of the county.

Poultry production is engaged in on 2,208 farms, according to the 1925 Federal farm census. The same census reports 154,093 chickens raised in 1924. According to the 1925 Iowa census, about three-fifths of the fowls raised and three-fourths of the eggs produced are marketed. Besides chickens, a few flocks of turkeys, geese, and ducks are kept.

Sheep raising is engaged in on 307 farms. The average-sized flock is 17 head. Three-fourths of the sheep are clipped for wool, the total production of which in 1924, as reported by the 1925 Federal census, was 34,052 pounds. According to the 1925 Iowa census about one-half the sheep are marketed. A small number of feeder sheep are purchased on the Sioux City and Omaha markets to be fed for short periods during fall and early winter. Most of the sheep are of the Shropshire breed, and a few Oxfords are raised. Little attention is given to the raising of purebred sheep.

The work animals of the county consist of fairly good draft type horses and a few mules. Colt production only slightly exceeds the local demand. Most of the sires are purebred and the mares of grade stock. The Belgian and Percheron breeds are the most popular. The 1925 Federal census reports 13,524 horses and mules in the county.

Honey is produced on a very small scale.

Most of the soils of Butler County are suited to the production of the staple crops commonly grown. The following general adaptations are recognized: On soils exceptionally high in organic matter, such as the Floyd, Bremer, Fargo, Clyde, and heavier-textured Wabash soils, small grains have a tendency to grow a rank straw at the expense of the grain, and, consequently, losses from lodging result. Corn is a better crop for such areas. The light-colored soils of the Lindley and Fayette series and the sandy soils of the Dickinson, O'Neill, and Cass series are recognized as less productive and incapable of standing the heavy cropping to which other soils of the county are subjected. Among the small grains, rye is recognized as producing the highest yields on the sandy soils. Most of the soil in the county is too acid for the production of successful stands of alfalfa and sweetclover without liming.

On the Fargo and Lamoure soils lime is seldom needed and the degree of acidity is so slight on much of the Clyde, Bremer, and Wabash soils that only small applications of lime are necessary. Wabash silt loam and Floyd silt loam are perhaps the best soils for clover, the Clyde and Bremer soils and Wabash silty clay loam rank second; Carrington loam, Carrington silt loam, Tama silt loam, and the Waukesha soils rank third; Carrington sandy loam, Carrington fine sandy loam, O'Neill loam, O'Neill silt loam, and Dickinson loam rank fourth; Fayette very fine sandy loam, Lindley loam, and the shallow phase of Tama silt loam rank fifth; the Dodgeville soils, Millsdale loam, Dickinson sandy loam, Dickinson fine sandy loam, and O'Neill sandy loam rank sixth; and Dickinson loamy fine sand and Dickinson sand are the least suitable. The soils of the first three groups are best for alfalfa, provided good drainage is obtained. Where inadequately drained these soils are inferior to soils of the fourth and fifth groups for alfalfa production. Soils of the last two groups are of little value for this crop.

Cropping practices are briefly outlined in the following paragraphs:

Most of the corn is planted on land formerly in small grain or corn. Some of the small-grain stubble is fall plowed. All the corn-stubble land to be prepared for another corn crop is plowed in the spring. Disking and harrowing complete the seed-bed preparation. After corn planting the field is cultivated from three to five times. Spring-seeded small grains usually follow corn. As a rule a thorough disking is the only seed-bed preparation for small grains. For late-spring seeding barley is better than either oats or wheat. Fall-seeded wheat or rye usually follows on small-grain stubble which is either plowed and disked or simply disked in preparation for seeding the latter part of August.

Red clover, timothy, some of the alfalfa, and sweetclover are sown with a small grain as a nurse crop. When alfalfa or sweetclover is to be sown the small-grain seed bed is generally more thoroughly disked and harrowed. Failing in a stand by this method, when again planted the seed bed is more thoroughly prepared and manured, limed, and inoculated if necessary. Alfalfa is often seeded alone in August on a seed bed prepared usually by disking and harrowing small-grain stubble a number of times and sometimes rolling or packing the soil. Timothy is much the easiest tame hay to grow and the surest producer. Winter killing, dry seasons following seeding, the run-down character of the soil, particularly with regard to acidity, all injure stands and cause poor yields of legumes. If a successful stand of legume hay is obtained, the land is usually left in hay and pasture meadow for a number of years. Sweetclover is left only 2 years, red clover 3 or 4 years, and alfalfa 5 or 6 years, sometimes longer. If the legume seeding is not successful or an older stand begins thinning out, corn is usually the following crop. Only a few farmers practice a systematic crop rotation including a legume.

No serious weed pests, insect pests, or plant diseases are prevalent. The most troublesome weeds are Canadian thistle, quack grass, horse nettle, and wild morning-glory. Weeds are most troublesome in late-maturing small grains and hay crops. The common insects are the potato beetle, cutworm, grubworm, wireworm, corn borer, timothy

head worm, codling moth, aphids, plum curculio, and scale in fruit trees. The common plant diseases are smut and dry rot in corn, smut and rust in small grains, wilt in garden crops, scab in potatoes, and fire blight in fruit trees.

The only fertilizer used by the average farmer is the manure produced on the farm. Certain commercial fertilizers are being more extensively used, chiefly superphosphate (acid phosphate). Three carloads of this fertilizer and about 20 carloads of ground limestone were shipped in during 1928. There are five lime crushers in the county which supply lime to the neighboring communities. The more expensive potash and nitrate fertilizers are not used on farm lands and only to a small extent on garden crops. According to the 1925 Federal census, 1.9 per cent of the farms of the county used fertilizers in 1924, and the average expenditure was $71.11 to the farm reporting.

The building improvements on the average farm consist of the dwelling, a combined horse and cattle barn with haymow, grain crib, and bins, a hog house, chicken house, tool or implement shed, and windmill or engine pump. The State census for 1925 reported 384 silos in the county.

The ordinary farm implements are owned individually. The more expensive machinery or implements used only occasionally are owned cooperatively by groups of farmers or are rented. The 1925 Federal census reports 334 tractors in the county, and 95 autotrucks are reported by the State census for that year.

Most of the farm labor is done by the farmer's family, with additional help hired only during small-grain harvest, haying, and corn picking. Many farmers exchange labor during rush seasons and for especially heavy work such as threshing, corn shelling, and silo filling. According to the 1925 Federal census 1,129 farms, or 49.8 per cent of the farms in the county reported an average labor expense during 1924 of $235.50 a farm. During the season of 1928 the customary pay for the various classes of labor was as follows: Day labor, $2.50 to $3; corn pickers, 6 or 7 cents a bushel; monthly summer wages, $50; and monthly year-round wages $65 for a married man and $45 for a single man. Most of the labor is supplied locally.

Under tenant operation a greater acreage of the farm is cropped, and a more continuous system of cropping to corn and small grains is practiced than under owner operation. The farm equipment is poorer on the tenant-operated farm, as a rule, and usually less livestock is kept. Certain practices which tend to lower the fertility of the soil are prevalent in the present system of tenant farm operation. According to the State census of 1925, 51 per cent of the tenant-operated farms are rented for cash, 28 per cent on a combination cash and share basis, and 21 per cent on a share basis. Cash rents range from $4 to $8 an acre. When the farm is rented on the share basis the owner furnishes the land and seed and receives half the crops, or, if he furnishes everything he receives two-thirds of the crops. Under a combined cash and share rent the pasture and hay land are usually rented for cash and the crop land on shares. There are more tenant-operated farms in the southeastern part of the county than elsewhere.

The market price of farm land varies widely throughout the county. It is, of course, influenced by the character of the soil, but in most places the farm improvements and access to local markets are the most important features in appraising farm values. In general, the higher-priced lands are well-improved farms on Carrington silt loam, Carrington loam, and on soils of the Floyd, Tama, and Waukesha series. Farms consisting mainly of the light-colored soils, Fayette and Lindley, the sandy soils of the Dickinson, Carrington, O'Neill, and Cass series, or soils of the Clyde, Bremer, Fargo, and Wabash series, which are too poorly drained for cropping, are usually the lower-priced farms. According to the 1925 Federal census the average valuation placed on land alone was $118.53 an acre.

Certain recommendations for improving the productivity of the various soils of Butler County are well recognized by the farmers. On soils of poor moisture-holding capacity, such as the sandy soils of the Dickinson, Carrington, O'Neill, and Cass series and other soils, which are low in organic matter, such as the Fayette and Lindley soils, efficient cropping, fertilizing, and soil-management systems are most necessary. A three or four year systematic crop rotation, including a legume hay crop, is the basis of the soil improvement of all Butler County soils. For continued success in systematic cropping all manure, crop residue, and the like must be returned to the land. As the supply of barnyard manure is insufficient to meet the requirements of the average farm, green manuring or the use of commercial fertilizers must be resorted to.

SOIL SERIES AND TYPES

In soil classification, all soils are classed in major groups or series, largely on the basis of the character of the parent material and the stage of development or weathering which the soil has reached. The series may be further divided into soil types, on the basis of the texture of the surface soil; that is, the proportion of different-sized particles present. In this survey, 28 soil types and 1 phase of a type, representing 16 soil series, and in addition 2 miscellaneous classes of material, meadow and muck (including peat), are mapped. A brief description of the general characteristics of the soil series follows.

Soils of the Carrington series have very dark grayish-brown surface soils with brown subsurface soils and yellowish-brown subsoils which are as heavy as or heavier than the surface soils. The subsoils are moderately plastic but not compact or impervious. As a rule they are comparatively friable. The substratum is mottled gritty silty clay loam or clay loam of mixed texture and varied structure, being in places stiff plastic clay and in other places containing pockets of loose sand or gravel. The upper part of the substratum, above a depth of 5 feet, is low in lime content. This is the main difference between the Carrington and Clarion soils, the subsoils of the Clarion soils being high in lime at a depth of 3 feet. Bowlders occur on the surface and embedded in the soil. The Carrington soils are weathered from glacial-drift deposits which were originally high in lime but are now leached to a depth of at least 3 feet and more commonly to a depth exceeding 5 feet. These soils occupy gently rolling or undulating uplands having good natural drainage.

The surface soils of the Dickinson soils are dark grayish brown or black and the subsurface soils are brownish and slightly heavier textured as a rule. The subsoils are lighter textured, being generally sandy and in many places extremely loose and porous. The content of gravel in the light-textured subsoil is extremely variable, in some places being entirely absent, and in other small areas or spots containing sufficient gravel for excavation for use in roadbeds. The Dickinson soils are leached of lime to a depth of 3 or more feet. The substratum varies in texture and structure, but it is usually sandier than the substratum of the Carrington soils. The loose-textured sandy or gravelly subsoil differentiates the Dickinson soils from the Carrington soils.

The soils of the Clyde series are characterized by black surface soils with slightly lighter-colored, heavier-textured, somewhat grayish subsurface soils. The subsoils are mottled gray, yellow, and rust-brown heavy gritty silty clays. In many places, numerous bowlders occur on the surface. The surface soils and subsoils are low in lime, and in this respect differ mainly from soils of the Webster series. The Clyde soils occupy level flat uplands, terraces, or slope depressions within the uplands. Natural drainage is poor.

The soils of the Floyd series have black surface soils, and the subsurface soils are more brownish and heavier textured. The subsoils are plastic mottled gritty silty clay loam, but are rather more friable than the Clyde subsoils. The Floyd subsoils contain less gray and more yellowish-brown mottles than the Clyde subsoils. The Floyd soils occupy better-drained land than the Clyde soils, but they are not so well drained as the Carrington soils. The Floyd soils have developed over glacial drift under conditions of somewhat restricted drainage during at least a part of the year.

The surface soils of the Tama soils are very dark grayish brown or black, the subsurface soils are brown, and the subsoils are yellowish brown and a trifle heavier textured than the soil material above or below, and they are more silty, somewhat more friable, and less compact than the Carrington subsoils. The substratum of silty friable material continues downward without change to the coarser-textured gritty drift deposits. The Tama soils occur on well-drained uplands characterized by undulating or rolling relief.

The soils of the Dodgeville series have very dark-brown or black surface soils with brown subsurface soils and yellowish-brown or, in a few places, slightly reddish-brown subsoils. Limestone bedrock underlies these soils at a depth ranging from 5 to 6 feet. In most places the surface soils and subsurface soils are silty and loesslike. In many places the subsoils contain small numbers of drift pebbles, but the substratum directly overlying the limestone is plainly weathered in place from the limestone. In places where the limestone is shaly a tough plastic clay overlies it, and where the limestone is sandy a thin layer of loose coarse sand lies above it. Except in a thin soil layer just above the limestone the surface soil and subsoil of the Dodgeville soils are low in lime and generally acid in reaction. In Butler County the Dodgeville soils occupy well-drained upland slopes above outcropping limestone beds. Most of the areas occur as narrow slope strips closely associated with Carrington or Tama soils.

All the upland soils just described have black surface soils which are common to soils on which prairie grasses were the native vegetation. Distinguished from these soils because of light-colored surface soils are the upland soils of the Lindley and Fayette series. Trees, principally of the hardwood species, formed the native growth on these soils, and large timbered areas still remain on land occupied by them. Soils of these two series differ from each other mainly in their subsoils, that of the Lindley soils being heavy, gritty, clayey, heavier textured, more compact, and more plastic than the surface and subsurface soils, and the Fayette subsoil being silty, free from grit and pebbles, comparatively friable, and of open permeable structure. The color of both subsoils is yellowish brown, and both are low in lime. As a rule the Fayette and Lindley soils occupy rolling land. The Fayette soils differ from the Tama soils mainly in their lighter-colored surface soil, and the Lindley soils differ from the Carrington soils in the same respect.

The soils occurring on terraces adjacent to stream bottoms differ in origin from the upland soils of Butler County. The terrace soils have been formed from alluvium of older deposition, and the soils of the stream bottoms are still in process of formation and are altered by each successive overflow. The terrace soils of Butler County are separated into five soil series, the Waukesha, O'Neill, Bremer, Fargo, and Millsdale. All these soils have dark-colored surface soils. The subsoils of the Waukesha soils are heavy textured and yellowish brown. The Waukesha soils, which occur on the well-drained parts of the terraces, closely resemble the upland soils of the Tama series.

The O'Neill soils have loose, porous, coarse-textured subsoils which are usually gravelly. These soils occur on well-drained terraces and because of their porous subsoils are inclined to be droughty.

The Bremer and Fargo soils occupy poorly drained parts of the terraces. They have mottled, heavy-textured, plastic, moisture-retentive subsoils. The black color of the surface soil generally extends to a greater depth in the Bremer and Fargo soils than in the O'Neill and Waukesha soils. The principal difference between the Bremer and Fargo soils is that the subsoil of the Bremer soil contains no lime, is silty, and is clayey, whereas that of the Fargo soil is high in lime and in many places gritty and clayey.

The Millsdale soils resemble the upland soils of the Dodgeville series except that they are more uniform in texture and that the soil overlying the bedrock generally shows more the characteristics of alluvium overlying the rock rather than residual formation from the rock.

The soils on the stream flood plains of Butler County have been classed in the Wabash, Lamoure, and Cass series. The first two are alike in that they have deep black surface soils and dark-brown or mottled subsoils ranging from friable to plastic in consistence. The main difference between soils of these two series is that the Wabash subsoils are low in lime, the Lamoure high. The Cass soils have black surface soils with yellowish-brown, loose, very porous, sandy subsoils. As a rule they are low in lime.

Bordering the main stream channels of Butler County are bottom lands of very spotted soils which are much cut up with old channels. These mixed bottom-land soils are classed as meadow. A small acreage of muck and peat is mapped.

In the following pages of this report the soils of Butler County are described in detail and their agricultural importance is discussed; their location and distribution is shown on the accompanying soil map; and their acreage and proportionate extent are given in Table 4.

TABLE 4.—*Acreage and proportionate extent of the soils mapped in Butler County, Iowa*

Type of soil	Acres	Per cent	Type of soil	Acres	Per cent
Carrington silt loam	115,392	31.0	O'Neill loam	16,064	4.3
Carrington loam	28,352	7.6.	O'Neill sandy loam	9,604	2.6
Carrington fine sandy loam	3,200	.8	Waukesha silt loam	12,352	3.3
Carrington sandy loam	128	.1	Waukesha loam	5,952	1.6
Clyde silt loam	59,712	16.0	Bremer silt loam	3,584	.9
Clyde silty clay loam	5,632	1.5	Fargo silty clay loam	256	.1
Dickinson fine sandy loam	15,424	4.1	Millsdale loam	192	.1
Dickinson sandy loam	1,728	.5	Wabash silt loam	17,792	4.8
Dickinson loamy fine sand	3,968	1.1	Wabash silty clay loam	8,448	2.3
Dickinson loam	640	.2	Wabash loam	5,696	1.5
Floyd silt loam	24,448	6.6	Cass sandy loam	832	.2
Fayette very fine sandy loam	2,176	.6	Lamoure silty clay loam	64	.1
Tama silt loam	6,784	2.7	Meadow	11,776	3.2
Shallow phase	3,328		Muck and peat	128	.1
Dodgeville silt loam	6,080	1.6			
Dodgeville loam	1,088	.3	Total	371,840	
Lindley loam	960	.2			

CARRINGTON SILT LOAM

The surface soil of Carrington silt loam is mellow friable black silt loam high in organic matter. It contains sufficient sand to be somewhat gritty to the feel. At a depth of about 12 or 14 inches the material becomes less friable, more granular, and a trifle lighter colored, changing at a depth ranging from 18 to 22 inches to silty clay loam which is distinctly heavier than the soil above and lighter colored, being dark yellowish brown. When wet the material in this layer is moderately plastic, but when dry it is crumbly, friable, and gritty to the feel because of the sand it contains. Between depths of 2 and 3 feet the color of the soil material is still lighter, being yellowish brown and in some places faintly stained with gray and rust brown. When wet the material is as plastic as in the layer above, but when dry it is a trifle more friable. The texture is silty clay loam containing considerable sand and some embedded gravel, giving the material a distinctly gritty feel. Below a depth of about 40 inches is sandy clay which is somewhat gravelly in small spots. This material is plastic when wet and friable and somewhat loose when dry. In places the lower soil material is compact and retentive of moisture. The color is yellowish brown and becomes mottled with depth. To a depth of 5 or 6 feet the soil is low in lime and in most places is acid, ranging from slightly to strongly acid.

The loam and silt loam soils of the Carrington series are the principal soils of the uplands of this section of Iowa. Carrington silt loam is the principal upland soil in Butler County, occupying about one-third of the total area.

Although Carrington silt loam is very uniform throughout the county, a few minor variations occur. Much of the soil in the northern half has a highly plastic mottled subsoil at a depth of about 30

inches which is heavier textured and more compact and impervious than in the typical soil. Another variation occurs in areas in which the black surface soil on the more rolling areas has been washed to the foot of the slopes. Other variations within Carrington silt loam areas are simply inclusions of other soil types in spots too small to map separately or areas near the boundary line drawn between Carrington silt loam and other soils. These included areas may be Carrington loam, Carrington sandy loam, Floyd silt loam, and Dickinson, Dodgeville, Tama, and Lindley soils. The Floyd silt loam spots are numerous in the area in northwestern Bennezette Township, and the boundaries between the two soils are arbitrarily drawn. The surface of the land in this section of the county is much less rolling than typical and in places is almost flat.

Practically all the land is under cultivation and well improved for cropping. On account of its friable surface soil, Carrington silt loam is easily maintained in good tilth for cultivated crops. Crop yields are equal to those on any other soil in the county and better than on many of them. Corn yields average about 40 bushels to the acre, with yields as high as 75 bushels frequently reported; oat and barley yields average about 35 bushels; wheat yields average about 30 bushels; and good yields of tame hay are obtained. This is one of the best alfalfa soils in the county.

The productivity of Carrington silt loam varies considerably with the method of handling and cropping. Although naturally well supplied with organic matter, manuring increases the yields on this soil. The response to manuring, however, is not so great on this as on the lighter-textured or light-colored soils of the county. The periodic seeding to legumes usually gives a marked benefit to yields of the succeeding crops. Ordinarily only the stubble is plowed under, and green manuring is seldom practiced. Except an occasional application of lime on small acreages prepared for alfalfa or sweetclover, no commercial fertilizer is used. The average farm produces too little manure for maintaining the fertility of this soil. Even if the number of livestock kept on a farm is increased, certain commercial fertilizers, especially phosphates, in addition to the farm-produced manure will be necessary in the near future. For the present it seems that green manuring and rotation of crops, including a legume, are more economical practices than the use of commercial fertilizers containing nitrates.

The farms on Carrington silt loam are well improved and well equipped. Practically all the farm work is done with the aid of machinery.

CARRINGTON LOAM

Carrington loam is practically identical with Carrington silt loam, except that the topmost 10 or 12 inches is loam which is grittier and of higher sand content than in the Carrington silt loam. It absorbs and holds moisture well. In the fifth foot below the surface the soil is gritty silty clay loam, containing small pockets, some sandy or gravelly and others clayey and very plastic. The color is grayish yellow brown, much stained with gray, yellow, and rust brown. To this depth the soil is low in lime. In many places, at a depth of 4 or 5 feet, it contains small lime aggregates or lime-coated pebbles,

but it is not high in lime above a depth of 6 or 7 feet. To depth of plowing the soil in most places is acid, ranging from slightly acid to strongly acid. The subsoils between depths of 13 and 36 inches are usually medium or strongly acid and between 37 and 60 inches are slightly acid or neutral. A few bowlders occur in the soil and on the surface.

Areas mapped as Carrington loam are uniform in texture except where spots of other soils too small to show separately and a few areas with minor differences are included. These included areas are other members of the Carrington series, and the Dickinson, Lindley, and Dodgeville soils. Minor differences in soil characteristics are chiefly as follows: A thin black surface soil associated with rather strongly rolling areas, on the slopes of which are strips of exposed yellowish-brown subsoil; an abnormally compact subsoil; and a sandy layer in the substratum. Areas having the thin black surface soils occur north of Sinclair and in smaller areas north of Aplington. Areas having compact subsoils are similar in character and mode of occurrence to similar areas of Carrington silt loam. They are mapped throughout the northern and northeastern parts of the county. Areas having a sandy substrata occur in Bennezette and Coldwater Townships, and to a small extent elsewhere in association with the Dickinson soils. In many areas the subsoil overlying the sandy layer is abnormally heavy and compact.

The largest areas of Carrington loam are along the east county boundary, on the upland divide south of Dumont between Hartgrave and Maynes Creeks, and at other points on the uplands adjacent to the main stream valleys.

Areas of Carrington loam are a trifle more rolling than areas of Carrington silt loam. Drainage is everywhere good and on some of the more strongly sloping areas is erosive.

All except some of the more sloping areas of Carrington loam are under cultivation. This soil is about equally as productive as Carrington silt loam. However, excessively drained spots are more common on the loam, and on such spots crop yields are usually lower. These spots require greater care to prevent the black surface soil from washing to the foot of the slopes. Farm practices and cultural methods are the same as on Carrington silt loam. Recommendations for soil improvement of the silt loam apply equally well to this soil.

CARRINGTON FINE SANDY LOAM

Carrington fine sandy loam is a much lighter-textured soil to a depth of 1 foot and in many places to a depth of 2 feet than either the loam or silt loam members of the Carrington series. Between depths of 25 and 36 inches, however, the subsoils are essentially the same. The surface soil to a depth of about 12 inches is moderately loose and porous black fine sandy loam, which usually contains considerable organic matter for a light-textured soil, though in most areas much less than the heavier Carrington soils. Between 13 and 24 inches is dark-brown fine sandy loam, which is a trifle heavier textured and less porous than the surface soil. From the surface downward Carrington fine sandy loam is similar to the loam and silt loam

in degree of acidity and depth to the lime in the substratum. Bowlders are present in small numbers in the soil and on the surface.

To a depth of 2 feet Carrington fine sandy loam is essentially the same as Dickinson fine sandy loam. In the Dickinson soil the subsoils are lighter textured than the surface soils, being fine sandy loam or lighter, differing greatly in this respect from the plastic heavy sandy clay lying at the same depths in the corresponding Carrington soil. Areas of these two soils are in places hard to separate on the map. As mapped Carrington fine sandy loam includes small spots of Dickinson soils as well as of the other members of the Carrington series which are too small to separate. In some areas, where this soil is closely associated with the Dodgeville soils, which are underlain by a limerock substratum, an abnormally compact, tough, and plastic clay layer occurs in the subsoil. Another variation includes areas having less intensely black surface soils of lower organic-matter content than typical. Such areas occur on the more elevated bluffs along the stream valleys which supported a native vegetation consisting of patches of oak and hazel brush and prairie grasses.

Carrington fine sandy loam is inextensive in Butler County. The larger areas are east of Packard, on the bluffs of West Fork Cedar River, and in the vicinity of Bristow. Areas of this soil are rolling or gently rolling, modified only by some steep slopes to the main stream valleys. Most of the steeper areas are in permanent pasture, and consequently are not badly gullied. Surface drainage is everywhere good, as the soil to a depth of 2 feet absorbs moisture readily and, owing to the heavier soil below, retains it fairly well.

Perhaps one-fourth of Carrington fine sandy loam is in woodland pasture, another fourth in permanent bluegrass pasture, and one-half under cultivation to grain and hay crops. This is considered a less productive soil than Carrington loam and Carrington silt loam but more productive than Dickinson fine sandy loam. Corn yields average about 35 bushels to the acre and oats about 30 bushels. It is reported that it is harder to obtain stands of clover and alfalfa on this soil than on the heavier soils, because the soil is drier, winterkilling is apt to occur on exposed crests and slopes, and the soil is very acid. Many farmers report that when once established legume stands on this soil are better than on the heavier soils, as the looser, better-aerated soil favors rapid and deep root penetration. This is not so strong a soil as the loam and silt loam members of the Carrington series and is less heavily cropped and more regularly manured than those soils.

However, Carrington fine sandy loam has some advantages over the loam and silt loam soils as it is a warmer soil, matures crops a little earlier, and is more easily worked. Measures recommended for improving the productiveness of the soil are conservation of the moisture supply, increasing the organic-matter content of the soil through manuring, returning crop residues or green-manure crops to the land, and correcting the acidity for successful legume cropping.

This soil is usually farmed in connection with the Dickinson soils and other Carrington soils.

CARRINGTON SANDY LOAM

Carrington sandy loam is similar to Carrington fine sandy loam in all respects except that the surface soil is more coarsely gritty, the sand particles being of medium rather than fine sand. The only areas of this soil large enough to map separately are along the eastern county boundary.

The same cropping practices and soil-improvement measures are recommended as for Carrington fine sandy loam.

CLYDE SILT LOAM

To a depth ranging from 4 to 6 inches Clyde silt loam consists of intensely black heavy silt loam which is underlain by silty clay loam continuing to a depth ranging from 20 to 24 inches below the surface. The content of well-incorporated organic matter is exceptionally high. To depth of plowing the soil is not especially heavy or intractable, but directly below the black surface soil the material is moderately plastic and less friable. The surface soil is underlain to a depth of 30 inches by dark grayish-brown heavy plastic silty clay mottled with spots of gray, yellow, and rust brown. Between depths of 30 and 42 inches the soil is heavy, as in the layer above, but the mottles are of more pronounced shades of gray, yellow, and rust brown. Below a depth of 42 inches the subsoil is usually more gritty silty clay loam and may contain sandy or gravelly material in pockets or thin layers. To a depth of 5 or more feet the soil is low in lime. The black surface soil and the heavy mottled silty clay subsurface soil are usually slightly or medium acid. In some places the degree of acidity may be strong but in an equal number of places the surface soil is neutral. Bowlders occur in the soil and on the surface, and in a few places the land can not be cropped until the bowlders are removed.

Clyde silt loam resembles Floyd silt loam in its deep black surface soil and mottled subsoil, but it differs from that soil in that it is heavier, more dense, and more impervious to water. Most of the Clyde soils in Butler County occupy more poorly drained lands than do the Floyd soils.

A number of areas of Clyde silt loam are mapped, which differ slightly from the typical soil. A silty clay loam surface soil occurs in some small spots. In a few places a very thin layer of black muck covers the surface to a depth of 2 inches. This muck layer usually occurs on the most poorly drained areas which are waterlogged the greater part of the time. In other areas a so-called alkali coating has formed on the surface. This has not affected the surface soil to a great depth, and the subsoils are everywhere low in lime or alkali. These alkali spots seem to be more numerous in the western part of the county than in the eastern part. The subsoils vary considerably in content of sand and gravel, and in some areas the subsoil at a depth of about 3½ or 4 feet becomes sandy and gravelly and is loose and porous. On the narrower strips of Clyde silt loam within the upland swales the sandy or gravelly subsoil occurs only in very small areas, but over the wider areas on the back bottoms or terraces of stream valleys and a few of the wider tributary drainage ways it is of general occurrence. Except in a few

places where this gravel layer is waterbearing, it is an aid to soil drainage. Some of the wider areas of Clyde silt loam have no gravelly subsoil layer, and their surface soils and subsoils are much less sandy and more silty than typical.

Clyde silt loam covers an area of 93.3 square miles in the county. The greater part of it occurs in small narrow strips along the upland drainage ways and seeped slopes. Wider areas occur on the back bottoms and terraces of stream valleys, and a few areas are on flat uplands.

Drainage over much of the Clyde silt loam is too poor for successful crop production without improvement by tiling. The few flat upland areas and many of the wider bottom lands and terraces are sufficiently well drained for fairly successful cropping. However, most areas of this soil would be benefited by tiling. Only a small amount of tiling has been done as yet. In seeped areas the removal of excess water by tile is difficult. Therefore most of these areas are fenced off for pasture or are used for wild hay. When pastured, such areas commonly become hummocky, owing to the trampling of livestock. The sod is left in raised tufts, and the result is a decreased grass-sod area and an objectionable, uneven surface. This condition would be remedied somewhat if livestock were kept off the land as much as possible during the wetter weather, but the only real remedy seems to lie in drainage improvement and plowing and leveling the surface for a new sod.[1] Redtop and alsike do especially well under poor drainage conditions and should be in every pasture on this soil.

Successful cropping is dependent on good drainage. Where properly drained, the soil is among the strongest soils of the county. Crop practices and recommendations made for improvement and productiveness are essentially the same as those for Floyd silt loam.

The alkali coating mentioned as occurring on some of the areas is rarely so concentrated as to be toxic for corn. In most places, after drainage improvement, unproductiveness, formerly supposed to be caused by alkali, disappears. In a few places, however, the alkali problem is separate from the drainage problem.[2]

CLYDE SILTY CLAY LOAM

Clyde silty clay loam differs from Clyde silt loam in having a heavier, more intractable black surface soil which is high in organic matter. The plastic mottled poorly drained silty clay subsoils are common to both Clyde soils. The thin 2-inch surface layer of muck, the slight coating of so-called alkali on the surface, and the loose sandy or gravelly subsoil layer all occur to a small extent in some areas of Clyde silty clay loam. Bowlders are not so numerous as on the silt loam areas. The degree of acidity and the depth to lime in both soils are the same.

Clyde silty clay loam occurs in only a few of the upland swales. It is more extensive in the wider drainage-way depressions on the back bottoms or terraces of stream valleys.

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[1] HECHLER, W. R. HAY AND PASTURE SEEDINGS. Iowa Agr. Expt. Sta. Circ. 30, 10 p. illus. 1917.
STEVENSON, W. H., FORMAN, L. W., and BROWN, P. E. THE PASTURE PROBLEM IN IOWA. Iowa Agr. Expt. Sta. Circ. 89, 15 p., illus. 1924.

[2] BANCROFT, R. L. THE "ALKALI" SOILS OF IOWA. Iowa Agr. Expt. Sta. Bul. 177, p. 185–208, illus. 1918.

Like Clyde silt loam only a small part of the land can be successfully cropped until drainage is improved by tile.

Clyde silty clay loam includes a total area of 8.8 square miles in the county. In sections 6 and 8 of Monroe Township are fairly large cultivated tracts of this soil. In Bennezette Township and along the southern county boundary are swales of the soil. A few of the areas in Bennezette Township are cropped, but the rest are in pasture and hay land.

Under cropping Clyde silty clay loam has the same limitations in productiveness as Clyde silt loam, and improvement practices for that soil apply equally well to the silty clay loam.

DICKINSON FINE SANDY LOAM

The surface soil of Dickinson fine sandy loam is moderately loose and porous very dark-brown or black fine sandy loam. Below a depth of 12 inches the soil material becomes gradually more brownish, heavier textured, and less porous. The soil in the next layer, though somewhat porous and loose, is heavy enough to be slightly sticky when wet, and the color is deep brown with spots or streaks of black caused by organic matter brought down from the surface soil. This is the heaviest layer of the soil, ranging to sandy clay loam in texture. Were it not for the moisture-holding capacity of this layer the soil would be very loose and porous. Below this layer at a depth of about 40 inches the soil is light yellowish-brown or pale-yellow very loose and porous fine sand or sand. In places this layer of the subsoil contains small quantities of pebbles and gravel and in other places the largest particles are coarse sand. The porous layer varies in thickness. Below it is the heavy sandy clay or silty clay pebbly substratum, which is similar to that underlying the Carrington soils. In most places it is only 4 or 5 feet deep, but in some areas it exceeds a depth of 6 feet below the surface. The change from the loose sandy subsoil to the heavy substratum is abrupt.

Dickinson fine sandy loam appears to be developed from sandy drift material deposited over the heavy drift substratum. A few bowlders are embedded in the soil and occur on the surface, and these appear to have been originally a part of the heavy drift substratum rather than of the overlying sandy-textured material. The soil is low in lime and in most places shows some degree of acidity to the lower limit of the sandy subsoil. The soil between depths of 13 and 36 inches is usually more acid than the surface soil. This soil and all the other sandy soils of the county are generally more acid than soils of the Carrington series.

Included in mapped areas of Dickinson fine sandy loam are small areas of Dickinson sandy loam, loamy fine sand, sand, and loam. The most common variation included in Dickinson fine sandy loam is a soil having a loamy fine sand surface soil with a heavier sandy subsoil between depths of 25 and 36 inches, which gives the soil a moisture-retaining capacity greater than Dickinson fine sandy loam. Another variation common in small areas is a soil in which the heavy sandy clay or silty clay substratum lies within a depth of 3 or 4 feet from the surface. Areas of this kind of sufficient size to map separately are mapped as Carrington fine sandy loam. Still another variation is a soil, occurring on the more rolling lands which sup-

ported a sparse native growth of trees and bushes, principally oaks and hazel brush, in which the surface soil is less dark and is shallower. A few such areas are used for woodland pasture.

Dickinson fine sandy loam covers an area of 24.1 square miles in the county. It occurs on the uplands adjacent to the main stream valleys and seldom extends back on the uplands more than half a mile. The largest area is southeast of Clarksville on the north side of Shell Rock River. Most areas of Dickinson fine sandy loam are slightly elevated above the general upland plain. The surface is gently rolling and seldom includes steep slopes.

Natural drainage is well regulated, and a fairly good moisture supply is maintained for crops in all except very dry weather. Surface drainage is not exceedingly rapid, and few gullies are formed. However, sheet erosion is still rather active, as the sandiness of the surface soil favors the removal, through run-off, of the soil material on slopes. All the drainage ways along the slopes contain much sandy wash, and in many places the sand-filled drainage ways form a poor strip through the field.

Dickinson fine sandy loam is mainly under cultivation. A small acreage, chiefly along the valley bluffs, is in woodland pasture. This is a warm soil on which spring plantings can be made earlier than on the Carrington and similar soils. Corn and small grains do not make such heavy growth as on the heavier soils. In seasons of well-distributed rainfall, however, grain yields are about equal to those on the heavier soils. Corn yields average about 25 or 30 bushels to the acre, and small grains 20 or 25 bushels. Of the small grains rye is best suited to this soil, and wheat returns the lowest yields. The success of seedings of red clover, sweetclover, and alfalfa is dependent on an adequate supply of moisture at seeding time and thereafter until the stand becomes well established, after which these crops can withstand periods of dry weather with little damage. Alfalfa and sweetclover root deep in this well-aerated soil and maintain their stand better than does the shallower-rooted red clover. The potatoes produced are, as a rule, of better quality than those on the heavier soils. Yields are more uncertain, however, because of the lack of moisture in dry seasons. Buckwheat is a crop especially suited to this soil, but very little is grown. Most garden crops do well.

Dickinson fine sandy loam can be worked under a wide range of moisture conditions and is therefore easily kept in good tilth. Drifting on crests exposed to the wind and washing on some of the slopes sometimes give trouble on newly planted seed beds and make replanting necessary on small areas.

Most of the Dickinson fine sandy loam is farmed in conjunction with the Carrington soils. It is considered a somewhat poorer soil than those soils. Liming has proved beneficial in obtaining good stands of the legume hays, particularly alfalfa and sweetclover. The available farm manure is used on this soil in larger amounts than on the heavier cultivated soils, such as Carrington loam. A few farmers practice green manuring.

Manuring, plowing under of crop residues, or even green manuring are very beneficial in maintaining soil moisture during dry periods. Some farmers prefer this soil to the Carrington fine sandy loam because it is possible to plant crops on it earlier in the spring, and it can be more easily kept free from weeds.

DICKINSON SANDY LOAM

Dickinson sandy loam is like Dickinson fine sandy loam except in its more coarsely gritty black surface soil, its slighter depth to the loose porous sand substratum, and its thinner heavier sandy loam layer lying at a depth of 25 inches below the surface. These differences are responsible for a little greater tendency toward droughtiness in the sandy loam than in the fine sandy loam. A few bowlders occur throughout the soil and on the surface. The soil contains no lime and is of slight to strong acidity.

Dickinson sandy loam is not extensive in this county, occurring in small areas and seldom comprising a whole field. The larger areas are in sections 8 and 36 of Butler Township and in section 25 of Beaver Township. Other areas are southeast of Packard, west and southwest of Bristow, east and south of Dumont on ridged upland crests adjoining stream valleys, and in sections 3, 4, and 10 of Pittsford Township on a low, slightly ridged upland plain. The greater part of this soil is on upland ridges or knolls, which are somewhat elevated above the general upland levels adjoining the valley bluffs. The crests are rather narrow, but not abruptly rounded. Surface run-off is more active than on most of the fine sandy loam areas, however, and the tendency to droughtiness is increased. Damage from washing and drifting are also more common. A considerable part of the Dickinson sandy loam land supports a scattered growth of oaks and a sparse stand of grass. In such areas the surface soil is lighter colored or more brownish, shallower, and lower in organic matter than in the treeless areas, and for that reason the soils are less retentive of moisture. On parts of these areas the soil is loamy sand instead of sandy loam, but, owing to the presence of a heavier sandy loam or sandy clay loam layer in the subsoil, they are not mapped with Dickinson loamy fine sand.

DICKINSON LOAMY FINE SAND

The surface soil of Dickinson loamy fine sand consists of very dark grayish-brown or almost black loose porous loamy fine sand to a depth of about 15 inches. Between depths of 15 and 27 inches the soil is brown or dark grayish-brown loamy fine sand or loamy sand and is a trifle looser and more porous than the surface layer. Below a depth of 27 inches the soil is light yellowish-brown or pale-yellow loose and very porous sand. In most areas of this soil the material from the surface downward consists of well-assorted sand which is almost free from pebbles. In places, however, a small number of pebbles and a very few embedded bowlders or small rocks occur in the soil. Tests show the soil to be medium or strongly acid and very low in lime. Below a depth of 5 or 6 feet is the heavy sandy clay drift substratum, in which are embedded large numbers of pebbles, gravel, and small rocks and a few bowlders.

Dickinson loamy fine sand areas are, in general, very uniform, but small spots having looser, coarser sand surface soils are included in mapping. Such areas occur on very small oblong knolls or ridges in sections 6 and 36 of Butler Township, section 1 of Shell Rock Township, section 2 of Pittsford Township, section 24 of Coldwater Township, section 11 of Madison Township, section 10 of Ripley

Township, and section 16 of Beaver Township. A large area is in sections 13, 14, 23, and 24 of Beaver Township. A few included spots have heavier sandy loam subsoils, and in a few areas the heavy silty clay substratum lies at a depth of 2½ or 3 feet.

Dickinson loamy fine sand is not an extensive soil in Butler County. It occurs in small areas usually on low elevated sandy upland slopes and ridges adjacent to the main stream valleys. A few areas, which occupy the elevated crests on valley bluffs, are usually underlain by ledges of limestone in the deep substratum. They occur near the town of Shell Rock, in section 33 of Jefferson Township, and in section 28 of Dayton Township. Other areas are on the elevated knolls or ridges in the upland plains of Dickinson fine sandy loam between Aredale, Dumont, and Bristow and south of Bristow. A few areas, which occupy small low elevated knolls or terraces, are in section 34 of Butler Township, section 6 of Beaver Township, and sections 25 and 36 of Pittsford Township.

Dickinson loamy fine sand is a little less retentive of moisture and less productive than Dickinson fine sandy loam. However, a small part of it is equally as good a soil. Natural drainage is too rapid in most of this soil, causing the land to be droughty. The moisture is quickly absorbed and filtered through the soil and soon lost to the feeding zone of crop roots. Losses from run-off are not great except on a few slopes and narrow crests.

A considerable acreage of Dickinson loamy fine sand is under cultivation. The soil presents more problems than most of the other soils of the county because of its droughtiness and lack of organic matter. Where drifting or washing of the surface soil must be checked it is still more of a problem, and several areas in which erosion has taken place are at present abandoned for crop production. Pasture grasses are difficult to establish as the droughtiness makes this an exceedingly difficult soil on which to obtain stands of clover and alfalfa. However, a few fairly good stands of clover and timothy mixed or of sweetclover have been obtained. The average farmer strongly questions the advisability of seeding alfalfa and sweetclover on this soil, as most attempts on this and similar soils in Butler County have failed. The soil is more suited to certain truck crops, especially melons, but few are grown. Most of the soil is cropped, together with other heavier soils, to the staple grain and hay crops or kept in a thin pasture sod. A small acreage, which is devoted to woodland pasture, remains with its original cover consisting mainly of small bur oaks. Redtop seems to be the pasture grass best suited to the soil. Bluegrass ordinarily burns out during the drier summer months, and alsike, sweetclover, white clover, and red clover usually make a very sparse spotted stand. The soil has a low pasture value.[8]

DICKINSON LOAM

To a depth of 10 inches the surface soil of Dickinson loam is gritty rather heavy loam which appears dark grayish brown when dry and nearly black when wet. It is high in organic matter, friable, and retentive of moisture. Below this layer is a heavier loam or clay loam layer which is less absorptive of moisture, but which, when wet,

[8] See footnote 1.

is much more retentive of moisture than the sandy subsoil. The color of this layer is dark brown, indicating a much smaller content of organic matter than in the surface layer, and the average thickness is about 8 inches. Underlying these layers is a dark reddish-brown loose and crumbly clayey gravel layer which is very porous in spite of its clay content. It is 6 or 7 inches thick, and underlying it is a cross-bedded layer of loose very porous coarse sand and assorted gravel. Throughout the loose gravelly subsoil are small somewhat clayey spots which resemble the thin layer above the gravel. Some bowlders, or niggerheads, occur through the soil and on the surface. With the exception of a few lime-coated pebbles in the lower part of the gravelly substratum the soil is low in lime to a depth of 5 or 6 feet and in most areas tests from medium to very strongly acid.

The most typical areas of Dickinson loam are seen in cuts where gravel pits are opened up for road use. The gravelly subsoil may not extend very far beyond the borders of the pits. The size of the areas having this loose gravelly subsoil is somewhat exaggerated on the soil map, notably areas in section 23 of Dayton Township and on Mount Nebo in section 20 of Coldwater Township.

Agriculturally Dickinson loam is unimportant. The areas are so small that they are farmed with other soils, chiefly members of the Carrington series. Like the sandy loam, this is a droughty soil.

The same crops are produced and the same farm problems are encountered as on other Dickinson soils. Crop yields average about the same as on Dickinson fine sandy loam.

FLOYD SILT LOAM

The surface soil of Floyd silt loam is mellow friable black silt loam which is slightly gritty owing to its small content of fine sand. At a depth ranging from 6 to 8 inches it becomes heavier textured and moderately plastic when wet, but is friable and crumbly when dry. At a depth of about 20 inches the color becomes dark yellowish brown, stained somewhat with gray and rust-brown specks. The material in this layer is heavy silty clay loam which is plastic when wet and coarsely crumbly or cloddy when dry. Below a depth of 28 inches the color becomes lighter yellowish brown with more mottlings of rust brown and some gray. In texture and plasticity there is practically no change from the soil layer above. Below a depth of 40 inches is yellowish-brown, more brightly mottled, less plastic, much grittier silty clay loam or sandy clay. To a depth of 5 feet the soil contains no lime and ranges from slightly to medium acid, ordinarily not so strongly acid as the Carrington soils. In many places below a depth of 4 or 5 feet lime is present. Bowlders occur in small numbers through the soil and on the surface. The surface soil closely resembles that of the Clyde and Carrington silt loams. However, the black soil is deeper in the Floyd soil than in the Carrington but not so deep as in the Clyde. The layer just below the black surface soil differs considerably in the three soils. In the Clyde it is heaviest and most plastic, in the Floyd only moderately heavy, and in the Carrington most friable and least plastic. The Floyd soil closely resembles the Muscatine soil of eastern Iowa from

the surface downward. The Muscatine, however, is siltier and contains no embedded stones or bowlders, whereas the Floyd is grittier and contains stones and bowlders.

Areas mapped as Floyd silt loam include small spots of other soils too small to show separately.

Floyd silt loam occurs mainly on gradual sloping surfaces between the Clyde soils in the basins and the Carrington soils on the uplands. The largest areas are on the flat or undulating uplands and on gradual slopes to drainage ways which are a most striking feature of the stretch of upland extending from east of Allison through West Point Township and over much of Bennezette Township. In the northwestern part of Monroe Township, lying between the higher uplands on the south and the small creek bottom on the north, is a strip of low, undulating, and very gently rolling upland, on which Floyd silt loam is the principal soil.

Natural drainage of this soil is only fairly good, and tiling is necessary for best crop production. The soil is not so poorly drained as the Clyde soils and requires much less expenditure for adequate tile-drainage improvements. Consequently much of the tiling done in the county is on this soil.

Floyd silt loam is considered one of the best soils in the county. It is the heaviest-cropped soil, and grain crops are grown more continuously than on other soils. Less manure is applied on this than on the less productive soils. Lime is rarely applied except where it is thought to be necessary for an alfalfa or sweetclover seed bed. All the staple crops return excellent yields. Small grains sometimes produce too rank a straw which is objectionable, as ripening of the grain is delayed or lodging causes loss. Corn yields average 45 bushels to the acre and small grains about 30 bushels. Excellent alfalfa stands producing 2½ or 3 tons to the acre are obtained provided the land is not too poorly drained or too acid. Clover and timothy yields average about 2 or 2¼ tons to the acre. In an average season of well-distributed rainfall Floyd silt loam can be easily worked and kept in good tilth. In abnormally wet seasons, however, more difficulty is experienced, as the surface soil is slower to dry out than the more rolling areas of the Carrington soils.

Although Floyd silt loam is naturally more productive than many other soils in the county, it does not follow that no benefit is derived from applications of manure, plowing under of crop residues, liming, and seeding to legumes in a systematic crop rotation. In fact, any one or all of these soil-improvement practices is beneficial and gives a profitable increase in yields.

FAYETTE VERY FINE SANDY LOAM

The surface soil of Fayette very fine sandy loam is very smooth, mellow, very fine sandy loam containing considerable silt. It is dark brown when wet, but plowed land dries out to a grayish-brown color. Between average depths of 7 and 17 inches below the surface the soil is very friable silt loam which is mellow when moist but slightly compact in place when dry. The color of this layer is light yellowish brown tinged with gray. Between average depths of 17 and 28 inches the material is heavy silt loam or very fine sandy clay loam which is a trifle less friable than the layer above and shows

some tendency to form clods or large soil masses. The clods break rather easily into a crumbly mass. When wet, the soil material in this layer is moderately plastic. The color is deep yellowish brown, lacking the grayish cast noticeable in the layer above. Between depths of 28 and 40 inches is lemon-yellow or light yellowish-brown more friable very fine sandy loam which is slightly gritty owing to its sand content. The clods or large soil masses formed are more fragile than those in the layer above, and on breaking they shatter into a finer soil mass. Below a depth of 40 inches is very friable very fine sandy loam which is more sandy than the layer above. It is lighter yellow or lighter yellowish brown in color, with stainings of gray, yellow, and rust-brown iron spots. The material of this layer changes little until it reaches the heavy silty clay drift substratum at a depth ranging, in most places, from 6 to 15 feet below the surface. The soil throughout is friable, of good moisture retentivity, very uniform in texture, and entirely free of coarse pebbles and rocks. The changes in color, texture, and friability from one soil layer to another are gradual. No appreciable amounts of lime occur to a depth of 5 or more feet. The degree of acidity varies from slight to strong.

Fayette very fine sandy loam originally supported only a sparse grass growth on the timbered areas, and consequently the surface soil is lighter colored and lower in organic-matter content than soils on the treeless prairies. A considerable part of the Fayette very fine sandy loam areas are still in woodland. Oak, elm, maple, butternut, and aspen are the principal trees.

Areas mapped as Fayette very fine sandy loam include soils which vary to a minor extent from the typical soil. The surface soil of some areas is fine sandy loam and of others is silt loam. On some slopes subject to erosion the surface soil is thin. Areas of Lindley loam, most of which occur on washed slopes where the drift substratum approaches within 2 or 3 feet of the surface, are included with this soil because of their small size. One included area having lime in the subsoil at a depth ranging from 2 to 3 feet is in section 27 of Madison Township.

Fayette very fine sandy loam is inextensive in Butler County. It occurs entirely on strips of rather elevated uplands in Beaver, Albion, Madison, and Washington Townships. The land is rolling or sharply rolling, and in this respect differs from the less rolling uplands surrounding it. Most of the slopes are subject to slow surface erosion, and a few are gullied.

The soil absorbs and retains moisture very well, but in many places the run-off is too rapid to allow retention of an adequate moisture supply for dry periods. However, if the run-off is not too great the soil retains sufficient moisture for crop needs.

A considerable part of Fayette very fine sandy loam in Beaver Township is in woodland, most of which supports a rather sparse timber growth and is utilized for pasture. Farther west, in Albion Township, the timber tracts do not occupy so great a proportion of the land, and the soil is cleared and under a good state of cultivation. The areas mapped elsewhere in the county are either in woodland pasture or are cultivated. Fayette very fine sandy loam is considered less productive than the dark-colored upland Carrington silt loam

and Tama silt loam, and the farms are not so well improved, stocked, or equipped.

Good average yields of all the staple crops can be obtained. Corn yields average 25 or 30 bushels to the acre, oats and barley about 30 bushels, and wheat and rye 15 or 20 bushels. Alfalfa, red clover, and sweetclover will produce good average hay yields, but there is only a small acreage in these crops.

Liming the soil to correct the acidity is beneficial. Drought damage can be minimized by plowing under manure or crop residues and by terracing the slopes to retard the run-off. The checking of slope washing and gullying is more easily accomplished on this than on the Carrington soils. Only contour plowing and makeshift damming of gullies is resorted to, and no terracing is practiced at present. The present system of farming in the county does not adapt itself to such intensive soil management and so long as sufficient acreages of other land remain it is doubtful whether any of the Fayette soil slopes will be so improved. Although little attention is paid to orcharding, apples, cherries, plums, and grapes do well on this soil, and the quality of the fruit is excellent.

TAMA SILT LOAM

The surface soil of Tama silt loam is mellow, friable silt loam thickly and deeply penetrated by grass roots in the virgin areas and easily and well penetrated by crop roots in the cultivated areas. It is a black soil of good organic-matter content, and crops can develop a good root system. At a depth of about 14 inches the soil is dark brown, becoming somewhat lighter with depth, until at a depth of about 24 inches only spots and streaks of black are present. The material in this layer is heavy silt loam less mellow and friable than in the layer above, which, when dry is cloddy rather than crumbly, but the clods are easily shattered. Between average depths of 26 and 35 inches below the surface, is dark yellowish-brown heavy silt loam, which, when broken, forms clods or large rather firm soil masses. With moderate pressure these break into a soft crumbly moderately friable mass. When dry this is the most compact layer of the soil, but when moist it is slightly plastic. Below a depth of 3 feet and extending to a depth of 4 or 4½ feet below the surface is more friable lighter yellowish-brown silt loam which contains more fine sand than the layer above. In the lower part of this layer faint gray and yellow stains and rust-brown and black iron spots are present. Below a depth of 5 feet the soil material changes very little. At a depth ranging from 4 to 15 or more feet lies the heavy drift substratum which may be plainly seen in many roadside cuts. The most noticeable difference between the substratum and the overlying soil material is the pebbly content of the drift in contrast to the uniform-textured silt. Tama silt loam contains no lime and tests from slightly to strongly acid.

The greater part of the areas of Tama silt loam in the county conform to the foregoing description. On the more rolling uplands having steeper slopes, slope washing is responsible for a thinner black surface soil, and in small strips or spots the brownish subsoil

is exposed. The larger areas of this kind are shown separately on the map as a shallow phase of Tama silt loam. On some very gentle slopes or on nearly level uplands the black surface soil is deeper and the subsoil less friable and heavier textured, resembling in places the Muscatine soil.

Areas of Tama silt loam range from very gently rolling to rolling. Natural drainage is good and only on the more rolling lands is the surface wash at all rapid.

The largest areas of Tama silt loam are between Aplington and Kesley and near Dumont. The only other areas occupy upland crests in sections 23 and 24 of Albion Township.

Practically all the land is cultivated to grain or hay crops. In productivity and agricultural usage this soil is similar to Carrington silt loam and is considered an equally desirable soil. Methods of cropping and soil management in present use or recommendations for the improvement of this land are similar to those mentioned for Carrington silt loam.

Tama silt loam, shallow phase.—Areas of Tama silt loam on slopes and narrow crests so eroded as to have a very shallow surface soil are mapped as a shallow phase. Many of the light-colored slope areas are in reality the exposed subsoil layers of Tama silt loam from which the black surface soil has been removed. These areas are about equally productive as areas on the slopes of Fayette very fine sandy loam. The heavier Tama silt loam resists sheet erosion a little more than Fayette very fine sandy loam, but gullying progresses to about the same extent. Crop yields are higher than on the Fayette soil, but lower than on typical Tama silt loam.

The shallow phase of Tama silt loam is inextensive. It occurs in the same parts of the county and in close association with typical Tama silt loam. With the exception of the area near Kesley, which is largely wooded, the land is practically all under cultivation.

DODGEVILLE SILT LOAM

To a depth of about 11 inches the surface soil of Dodgeville silt loam consists of very dark grayish-brown or almost black mellow friable silt loam. Below this layer and continuing to a depth of 19 inches is friable and distinctly crumbly dark-brown heavy silt loam, which when moist is very slightly plastic. Between depths of 19 and 30 inches is deep yellowish-brown silty clay loam which is heavier than the soil above and compact in place. Clods or large soil masses are formed which are fairly easy to break into a moderately friable crumbly mass. When wet the material is plastic and slightly sticky. Underlying this layer is very plastic and sticky yellowish-brown sandy clay about 6 inches thick. This layer, in turn, is underlain by grayish-yellow or bright-yellow disintegrated limerock flour of varying texture. When wet the material is plastic and sticky. This layer directly overlies the bedded limerock which lies below the surface at an average depth of 44 inches. To a depth extending to the layer of rock flour the soil is acid.

Dodgeville silt loam covers 9.5 square miles of the area of the county. The underlying bedrock is exposed in small spots on the slopes of all areas. In only a few places does the bare rock occupy

a whole slope or a precipitous ledge. The soil covering the rock ranges in thickness from less than 1 foot to 6 feet. The thinner soil coverings are more sandy in texture and have no definite soil layers. In places where the soil is as thick as 44 inches over the bedrock some of the characteristics of the adjacent upland soil are noticeable. For instance, near Austinville, Dodgeville silt loam occurs in association with Fayette very fine sandy loam and the areas are lighter colored and lower in organic-matter content. In association with both the Fayette and Tama soils the Dodgeville areas have a siltier soil and subsoil than where they are associated with the Carrington and Lindley soils. In many places the layer of soil directly overlying the bedrock instead of being fairly heavy rock flour is very slightly sticky coarse loose sand, and practically all of the material is medium or strongly acid.

About one-fourth of the Dodgeville silt loam is cultivated to grain and hay crops, one-eighth is in woodland, and the remaining five-eighths is in permanent pastures or brush land. The larger areas are along Coldwater Creek, near Packard, Greene, and Clarksville, and along a branch of Shell Rock River in Fremont and Butler Townships, and small areas are near Austinville along Beaver Creek.

There are no large areas of Dodgeville silt loam having a smooth level surface. As a rule, this soil occupies only the slopes and the topmost crests of bedrock outcrops.

On the steeper slopes, where the soil material is thinner, the land is used for pasture, but lack of moisture makes such slopes of low pasturage value. A large part of these areas is in woodland pasture. In numerous small spots the exposed limerock was quarried for building material in the early days, but now the small amount of quarrying done is for ground limestone.

DODGEVILLE LOAM

Dodgeville loam is similar to Dodgeville silt loam except that it has a lighter-textured sandier surface soil. The average thickness of the soil over the rock is a little less than in the silt loam areas. Many of the areas are associated with adjacent upland crests of Dickinson soils or the lighter-textured Carrington soils and they closely resemble those soils. The surface soil of Dodgeville loam contains spots of sandy loam soils which in many places extend to a depth of 2 feet before they reach the heavier subsoil layers.

Dodgeville loam is inextensive in Butler County. Practically all the land, except a part of that mapped in Fremont Township occupies slopes on which the soil covering is thin and which are rather steep. Such areas are not plowed but are kept in permanent or woodland pasture. On the small acreage of the soil devoted to grain and hay crops yields average a little higher than on Dickinson fine sandy loam and a trifle lower than on Carrington fine sandy loam. The best use for most of the land is for pasture. Lack of moisture makes the pasturage supply low on this soil during the dry spells of summer.

LINDLEY LOAM

To a depth of about 7 inches Lindley loam consists of grayish-brown friable loam which on drying in plowed fields assumes a

grayish or yellowish cast. It is low in organic matter, and in this respect and in color closely resembles the surface soil of Fayette very fine sandy loam. It is underlain by heavy loam which contains more clay than the surface layer and is a little less friable. The color is lighter than in the layer above, being grayish yellow brown with a very few dark stains caused by organic matter occurring in small spots or streaks. At a depth of about 14 inches is yellowish-brown heavy clay loam or silty clay loam which is moderately plastic when wet and crumbly and moderately friable when dry. This layer in most places is about 7 inches thick. Underlying it is more stiffly plastic silty clay loam containing considerable sand and pebbles. When dry this material is moderately friable but breaks into a mass more cloddy and less crumbly than the soil above. The yellowish-brown color becomes slightly mottled with gray and rust brown with depth. Below an average depth of 34 inches is very mottled yellowish-brown very stiffly plastic silty clay or sandy clay which, when dry, forms large sharply angular very firm clods. This layer continues with little change to a depth ranging from 4 to more than 5 feet. The soil contains no lime to a depth of 5 or more feet below the surface. As a rule, the depth to lime in areas of Lindley loam is less than in the Carrington soils. The degree of acidity ranges from slight to strong. A few bowlders are on the surface and embedded in the soil.

Lindley loam areas occur on narrow elevated crests and sharp slopes of rolling land. The run-off of surface waters is rapid and the soil lacks moisture in dry seasons. Slope washing and gullying is a problem when this soil is plowed for cropping, and it is plowed only in places where it is included in a field with other, more readily cropped soils. Practically all of it is kept in woodland or permanent pasture.

Lindley loam occupies only 1.5 square miles of the county. The larger areas are on the bluffs north of Beaver Creek between Sinclair and New Hartford and on a sharp bluff along Shell Rock River near Clarksville. Smaller areas are in section 29 of Washington Township, sections 26 and 27 of Madison Township, and section 24 of Pittsford Township.

The factors limiting crop production are the low organic-matter supply in the soil and, for some crops, such as alfalfa and sweetclover, its acidity. Much of the soil occurs on slopes which present an erosion problem, and the sooner a permanent cover crop can be obtained the better. It does not, therefore, seem advisable to clear the woodland-pasture areas, as the vegetative cover plays an important part in checking erosion.

O'NEILL LOAM

The surface soil of O'Neill loam is very dark grayish-brown or almost black friable loam which is rather gritty and easy to work. At a depth of about 11 inches it is underlain by heavier dark-brown loam which continues to a depth of about 16 inches. Below this is more coarsely gritty dark yellowish-brown heavy loam which is slightly plastic when wet and friable and crumbly when dry. At a depth of about 21 inches this material changes to yellowish-brown gravelly loam containing sufficient clay to cause the material to

become slightly sticky when wet. When dry it is loose and crumbly. This layer is usually very thin, and at a depth of about 2 feet the material changes abruptly to loose coarse sand and gravel, which is porous and has little moisture-retaining power. This sandy gravelly layer varies from pale yellow or grayish yellow to reddish or yellowish brown in color. It extends as a bedded or stratified sandy gravelly deposit to considerable depths below the surface. The soil and subsoil are low in lime and range from slightly to strongly acid to a depth ranging from 4 to 5 or more feet below the surface. No large bowlders or stones occur in the soil or on the surface.

Throughout areas of O'Neill loam are soils which vary from the typical soil in one or more minor details. In places the layer of soil beneath the black surface soil and above the loose gravel is somewhat mottled, heavier, and more moisture retentive than the typical soil. This kind of subsoil occurs commonly on low, more poorly drained terraces in which the water-table level is higher than over the greater part of the soil. In some such places the underlying gravel seems to be waterbearing most of the time. Another variation occurs in which the subsoil overlying the loose gravel is lighter textured and more porous. This kind of subsoil is usually associated with a lighter-textured surface soil, heavier than the sandy loam, but lighter than most of the loam. A very few small silt loam areas occur on flat or slightly depressed areas on O'Neill loam terraces. In these areas the dark surface soil is heavier and deeper, and the loose gravelly sandy subsoil is deeper than in typical O'Neill loam. These areas are near Greene, in sections 1 and 18 of Dayton Township, in sections 1 and 3 of Fremont Township, and in sections 14 and 32 of Shell Rock Township. The soil here is less droughty than the loam, but crops show the effects of lack of moisture during dry seasons. The included soil is a little more productive than the typical loam.

O'Neill loam occurs on terraces well above the first-bottom level, and the water table lies at a great depth in the gravelly substratum. Most of the areas are on the higher terraces along Shell Rock River.

Drainage is inclined to be excessive as a great part of the rainfall is readily absorbed by the soil and passes downward through the loose gravelly substratum. During dry spells crops suffer from an inadequate moisture supply in the soil.

Practically all the O'Neill loam is in grain, hay, and pasture land. Very little of it is wooded except small planted wood lots near the farmhouses. Because of the droughtiness of the soil, crop yields average lower than on Carrington loam. In seasons when the rainfall is well enough distributed to avoid damage from drought, crop yields are as high or higher on O'Neill loam than on the Carrington soils, and much higher than on the Floyd or Clyde soils. Corn yields average about 25 bushels to the acre and oats about 30 bushels. Among the small grains rye is best suited to this land, but it is not grown as much as oats. Potatoes do well and are of a little better quality than those grown on the Carrington and like soils. Hay yields are usually good, but in dry seasons the crop is short. Red clover is affected by drought more seriously than timothy or the deeper-rooted legumes, alfalfa and sweetclover.

O'Neill loam is handled in about the same manner as Carrington loam. Farm improvements are probably not quite so good, but the

crops grown and cultural methods on the two soils are similar. O'Neill loam should receive fertilizer treatment similar to the sandy Carrington soils. Manure, lime, and phosphates have proved to be of economical benefit. Higher-priced fertilizers, such as nitrates and potash-bearing mixed fertilizers, are at present considered economical only where used with special crops of high acre income.

O'NEILL SANDY LOAM

O'Neill sandy loam differs from O'Neill loam in being more gritty and sandy in both surface soil and subsoil. It is more porous and droughty, and the surface soil is usually lower in organic matter than the loam. The sandy loam surface soil is dark grayish brown to a depth of 12 or 14 inches. It is underlain by yellowish-brown or brown sandy loam, which is nowhere much heavier than the surface soil and in many places is lighter and more porous. The loose porous sand and gravel substratum lies at a depth of about 2 feet below the surface. The soil ranges from slightly to strongly acid to a depth of 5 or more feet.

In some areas mapped as O'Neill sandy loam the surface soil is loamy sand about 12 inches thick, and the subsoil is sandy loam which has a greater moisture-holding capacity than the surface soil.

O'Neill sandy loam is less extensive than O'Neill loam. Fairly large terrace plains of the soil occur near Clarksville and Shell Rock and along West Fork Cedar River in the southeastern part of the county. Elsewhere the areas are small. Most of the terraces on which this soil occurs lie at a higher elevation than terraces occupied by O'Neill loam, and the water table is farther from the surface. Owing to the porosity of the soil, lack of moisture is the chief drawback to crop production. When dry the surface soil is likely to drift in exposed, uncovered areas such as newly planted seed beds of grain crops.

O'Neill sandy loam is a warm soil which can be worked under practically all moisture conditions. It matures crops earlier than the heavier soils, and plantings of catch crops can be made later. To prevent drifting, deep-rooted crops, such as alfalfa and sweetclover, are well worth the added labor and expense of liming and manuring necessary to grow them. Red clover is a good combination cover and hay crop, but ordinarily it will not establish itself so well as alfalfa or sweetclover because of its shallower root system. Of the small grains, rye is the best suited to this sandy soil. In addition to the grain produced it is valuable as a fall cover crop, and as such provides a small amount of forage. Buckwheat is a catch crop well suited to the soil. The potatoes grown are of excellent quality, but yields are low because of lack of moisture in ordinary seasons.

In general, the farm buildings on O'Neill sandy loam are only fair, and the fields are not in so good a state of cultivation as farms situated on heavier soils. A few of the better farms are devoted to dairying.

WAUKESHA SILT LOAM

The surface soil of Waukesha silt loam is mellow very dark grayish-brown silt loam to an average depth of 14 inches. It contains a good amount of organic matter and maintains excellent mois-

ture conditions for crop growth in normal growing seasons. Below the surface soil and continuing to a depth of about 28 inches is dark-brown silty clay loam which is heavier than the surface soil. The material is very friable and crumbly when dry but softly plastic when wet. Between average depths of 28 and 37 inches is very dark yellowish-brown silty clay loam which differs from the above layer chiefly in being coarsely crumbly. The small soil crumbs or aggregates are more firmly formed, sharper edged, and more angular. Below a depth of 37 inches the silty clay loam becomes gritty and somewhat gravelly in places and the color is lighter, being yellowish brown with gray, yellow, and rust-brown stains. Below this depth the soil material is very uniform. To a depth of 4 or 5 feet the soil is low in lime and varies from slightly to strongly acid. No gravelly or sandy soil layers occur above a depth of 4 feet, but in places below that depth such a layer may be present.

Waukesha silt loam is not droughty. It is a well-drained productive soil and ranks in agricultural value with Carrington silt loam of the uplands. In many respects the two soils are similar, but the Waukesha soil is siltier, less gritty, and has no bowlders or rocks in the soil or on the surface as has the Carrington soil. Waukesha silt loam occurs on level or very gently sloping terraces in the larger stream valleys. The soil can be worked under a wide range of moisture conditions.

Throughout the Waukesha silt loam areas are a few included soils which differ slightly from typical. An area in section 4 of Shell Rock Township and one in section 34 of Butler Township, both of which are on high terrace lands, have an extremely smooth fine-textured soil containing no grit or sand. An area near Clarksville has a gravelly sandy porous substratum below a depth of 4 or 5 feet. In this area the heavy subsoil just above the gravel seems more compact than typical, owing no doubt to a lower moisture content and more permanent state of dryness caused by the porous gravel below. In another variation an extremely deep black soil extends from the surface to a depth ranging from 24 to 30 inches.

Waukesha silt loam includes a total area of 19.3 square miles in the county. The largest areas are on the terrace lands along Shell Rock River and its tributaries, Flood and Coldwater Creeks. Several bodies occur in the valley of Beaver Creek and in the valley of West Fork Cedar River and its tributaries.

Practically all the Waukesha silt loam is cultivated. It is considered a very productive soil. Its state of cultivation, cropping, and soil-management practices, extent of fertilization, and fertilizer needs are similar to those mentioned for Carrington silt loam.

WAUKESHA LOAM

Waukesha loam is similar to Waukesha silt loam except that the loam surface soil contains a greater quantity of sand and grit than the surface soil and subsoil of the silt loam. The soil is dark colored to a depth of about 14 inches. Below this depth the subsoil in many places contains some gravel, but nowhere within a depth of 4 feet is this layer composed of porous loose gravelly material as is the O'Neill subsoil. In places below a depth of 4 feet, however, a somewhat porous gravelly soil occurs. In such areas Waukesha loam is similar to O'Neill loam except in its greater depth to gravel. On

many of the terrace slopes the gravel layer is exposed. Some areas of Waukesha loam have a lighter-textured subsoil, but its moisture-holding capacity is about the same as that of the typical loam. The largest areas of this kind are on high terraces along Shell Rock River.

The largest areas of Waukesha loam are near Packard along Shell Rock River and Flood Creek, south of Eleanor along Beaver Creek, and in Madison and Ripley Townships along West Fork Cedar River and Maynes Creek. Much of these areas is on rather low terraces having a comparatively high water table, and the porous gravelly substratum, which is reached at a depth of 4 feet in some areas, seems to be a waterbearing layer. However, in the material above the gravelly layer moisture conditions are well regulated, and the soil is not poorly drained as are the Clyde or Bremer soils, many areas of which adjoin Waukesha loam at slightly lower levels. On well-elevated terraces the loam is a little less retentive of moisture than the silt loam, but in few places is it droughty.

Two small areas of Waukesha very fine sandy loam were included with Waukesha loam in mapping in which the surface soil differs from typical in having a very fine sandy loam texture and the subsoil is somewhat heavier fine sandy loam with good moisture-holding capacity. One of the included areas is in section 8 of Butler Township, and the other is in section 4 of Shell Rock Township.

Most of the Waukesha loam is cultivated. Fields of this soil are in a good state of cultivation and give good average yields of all the grain and hay crops commonly grown. The agricultural usage, the cropping and soil-management systems followed, and the soil-improvement practices recommended are similar to those given for the Carrington soils.

BREMER SILT LOAM

The surface soil of Bremer silt loam consists of black friable silt loam high in organic matter. It is underlain at a depth of about 15 inches by slightly grayish heavier silt loam or silty clay loam which is less friable than the surface soil when dry. When wet the material is moderately plastic. At a depth of about 24 inches is silty clay loam which in the dry crumbly state is rather difficult to break or pulverize. The soil particles are larger and more definitely formed than in the layer above. When wet the soil in this layer is plastic. It is still dark from organic-matter stains, but has a more distinct grayish cast than the layer above. It also contains small yellow stains and rust-brown iron spots or concretions. At a depth of about 30 inches the soil is silty clay loam with a little higher sand content than the layer above and is cloddy rather than crumbly. The clods become very hard when dry and are difficult to pulverize. The dark color gives way to a mottled color showing gray, yellow, and rust-brown and black iron spots. Under average seasonal conditions the soil layers are seldom dry below a depth of 15 inches, and in the moist state they are moderately plastic and of good moisture-holding capacity. This mottled soil material usually reaches a depth of 44 inches, at which depth it is underlain by lighter yellowish-brown or grayish-brown material, much stained with iron spots of yellow, rust brown, and black, which is more friable and of a lighter silt loam texture, becoming, when dry, more silty and floury with depth. Under average field conditions the deeper substratum

layers lying below the mottled layer are rather moist and soggy. To a depth of 4 or 5 feet the soil contains no lime and usually tests from slightly to strongly acid. To this depth the soil is siltier and less sandy or gritty than Clyde silt loam and has no bowlders in the soil or on the surface as does the Clyde soil. Otherwise the two soils are very similar in many places, and they occupy similarly poorly drained areas. In other areas Bremer silt loam resembles Wabash silt loam.

Bremer silt loam occurs on flat somewhat depressed rather poorly drained terraces, most of which lie only slightly higher than the adjacent bottom lands. Most areas of this soil occupying the higher terraces occur on the back terrace below the foot slopes of the uplands where small drainage ways and slope waters empty on the terrace. If it were not for these waters received from the uplands many of the back-terrace areas would not be poorly drained. Because of poor drainage most of them are kept in pasture. The larger areas of Bremer silt loam are near Shell Rock, along West Fork Cedar River and its main tributaries in Jefferson and Shell Rock Townships, and along Beaver Creek near Parkersburg and New Hartford.

All the Bremer silt loam is put to agricultural use. The land has a high pasture value except in a few very poorly drained areas in which the surface is hummocky owing to the trampling of livestock. Poor drainage is the chief drawback in the use of this soil for grain crops. Where drainage conditions are corrected, excellent crop yields are obtained, particularly of corn. Small-grain yields are often decreased by a rank growth of straw and consequent lodging. Red clover does well, the chief damage to this crop being caused by heaving of the soil and winterkilling. Alfalfa does well if drainage is good and any harmful acidity of the soil is corrected. Areas on which no great quantities of water from higher lands are carried may be tile drained for cropping, but the most practical use for most areas of Bremer silt loam, especially the back terraces, is for pasture.

Systems of cropping and soil management now in use and those recommended for soil improvement are similar to those mentioned for Floyd silt loam.

FARGO SILTY CLAY LOAM

To a depth of about 18 inches Fargo silty clay loam is black moderately friable crumbly silty clay loam which is very high in organic matter. It is underlain by silty clay which is heavier than the soil above, not so black, and stained somewhat with yellow, gray, and rust brown. When wet the material of this layer is softly plastic and somewhat sticky. At a depth of about 28 inches is gritty silty clay containing some embedded pebbles. Here the black color changes to mottled yellow, brown, gray, and rust brown. When wet this layer also is softly plastic. At a depth of about 34 inches the material is grayish or light yellowish-gray mottled silty clay containing considerable fine sand and embedded lime-coated pebbles and concretions. This material continues to a depth of 5 feet with very little change. To a depth of 12 inches the surface soil ranges from slightly acid to alkaline, between 13 and 24 inches the material is neutral or alkaline, and between 25 and 36 inches it has a high

content of lime. This soil differs from Clyde silty clay loam principally in the lime content.

Only three small areas of Fargo silty clay loam are mapped in the county. The largest is in section 18 and the others in sections 27 and 34 of Washington Township.

As in the Clyde soils small spots on which a surface coating of alkali occurs are unproductive for corn. Most of the areas are in grain and hay crops, but drainage conditions are too poor for the best yields. With adequate tiling the fields are highly productive, especially for corn. The land is considered too rich for small grains because it induces a rank growth of straw, and lodging ensues which decreases the grain yield. On the better-drained parts of the fields alfalfa and sweetclover should do well.

MILLSDALE LOAM

The surface soil of Millsdale loam is very dark-brown or black mellow loam or heavy fine sandy loam about 14 inches thick. It is underlain to a depth of about 25 inches by very dark-brown loam, having a grayish cast, which is somewhat lighter in texture than the surface soil. Between depths of 25 and 34 inches is dull grayish-brown clay loam which is somewhat sticky and plastic when wet, but which when dry is compact in place. Between depths of 34 and 41 inches is dark yellowish-brown clay loam which contains more coarse sand and is less plastic than the layer above but is still somewhat sticky. When dry it is compact in place. Between depths of 41 and 48 inches the material is moderately loose and porous light yellowish-brown sandy loam. Between depths of 48 and 50 inches is a very plastic 2-inch soil layer resting on the bed limerock. The soil above the limerock ranges from slightly to strongly acid.

Only four small areas of Millsdale loam are mapped in the county. They are in section 35 of Pittsford Township, section 2 of Coldwater Township, section 35 of Dayton Township, and section 28 of Butler Township. These areas, which occupy slightly elevated parts of the terraces, occur as small knolls or ridges.

Most of the soil is devoted to pasture land, some of which supports a scant stunted timber growth. The land is of little agricultural importance, being about as productive as Dodgeville loam.

WABASH SILT LOAM

To a depth of about 14 inches Wabash silt loam consists of black mellow friable silt loam. Between depths of 14 and 22 inches the material is black heavy silt loam which is more coarsely crumbly than the surface soil. Between depths of 22 and 34 inches is plastic very dark-brown or black silty clay loam which, when dry, is moderately friable and coarsely crumbly. Below a depth of 34 inches is heavy silty clay loam which is more gritty than the layer above. The very dark-brown material in this layer is highly mottled. There is little change in the soil material between depths of 3 and 6 or more feet. The soil is low in lime and usually from slightly to strongly acid to a depth of 6 feet.

Wabash silt loam areas, like most first-bottom soils, vary considerably in texture. They may contain small spots of loam, silty clay loam, and fine sandy loam, and the boundaries between such

soils and typical Wabash silt loam are arbitrarily drawn in many places.

Areas of Wabash silt loam are level or very gradually sloping. Where the land is naturally or artificially protected from overflow or backwater flooding from the stream, drainage is fairly good. The surface soil absorbs moisture readily and the lower subsoil layer or substratum are in a few places impervious to moisture to such an extent that the overlying soil remains soggy for any length of time. Surface waters remain on the soil only in places where the land receives surplus run-off water from higher terraces or uplands or from stream overflow or backwater.

Wabash silt loam occupies a total area of 27.8 square miles. The bottom lands along West Fork Cedar River in Ripley, Madison, and Pittsford Townships and along Beaver Creek between Parkersburg and Sinclair include the largest areas of Wabash silt loam. Near Packard in the wider bottoms of Shell Rock River are several fair-sized areas. Elsewhere Wabash silt loam occurs in narrow strips which are largely devoted to pasture. In many places in the wide stretches of Wabash silt loam east of Parkersburg along Beaver Creek and in an area near Dumont, there is a deep substratum of loose gravel at a depth of 4 or 5 feet, which gives the soil better underdrainage than in most areas. The greater part of the soil in these wider bottoms is cropped to corn. Small grains rank second in acreage, pasturage third, and hay crops fourth. North of Sinclair a small amount of diking has been done in order to protect the fields from overflow. On the narrower bottom-land strips corn, small grains, and hay grasses are grown only in small patches or where the soil occupies part of the same field with terrace or upland soils. Where well drained and protected from stream overflow or run-off from higher lands, Wabash silt loam is a strong productive soil and is particularly suited to corn. Small grains have a tendency to produce a rank straw at the expense of the grain, and damage from lodging and rust results. In places where the water table lies at a sufficient depth alfalfa and sweetclover obtain a deep root development in this soil and make an excellent growth. In many areas the acidity of the soil causes poor stands, but this condition can be very economically corrected by liming. The soil is well supplied with organic matter, and it produces better crops than soils not so well supplied with this important element. The pasture value of Wabash silt loam is high, and farmers having sufficient land of other soils for cropping purposes generally keep the Wabash silt loam land in permanent pasture.

WABASH SILTY CLAY LOAM

Wabash silty clay loam is similar to Wabash silt loam except that it is a heavier soil to a depth of 4 or more feet, ranging from silty clay loam to silty clay in the first foot and from silty clay to clay below. Underdrainage of this soil is poor, and the surface soil of areas which receive surplus run-off waters from uplands or backwaters from stream overflow remain soggy for considerable periods of time. Areas in which such swampy conditions last throughout most of the season are shown on the map by swamp symbols. About 3 square miles of this swampy soil lie along West Fork Cedar River in Ripley and Jefferson Townships. Even where the land does not

receive undue amounts of surface water it is common to find the soil soggy at a depth of 3 feet, and the water table lies but little deeper.

In some places at a depth of about 4 feet is a more porous gravelly or sandy substratum which provides a little better underdrainage than in typical areas. However, even in such places the water-table level is near the top of the gravel substratum, and, consequently, surface drainage conditions are not relieved a great deal. Much of the soil north of Dumont, which is underlain by a substratum of this kind, is largely in pasture, with small patches of the better-drained parts in crops.

Wabash silty clay loam covers a total area of 13.2 square miles in the county, the largest areas lying along West Fork Cedar River. Excellent pasturage grows on this soil, and, under present drainage and overflow conditions, the most practical use of the land is for pasture. On excessively poorly drained areas the grass growth is coarser, less nutritious, and of poorer pasturage value. The surface is hummocky as a result of trampling by livestock and the grass has a bunchy growth. Many bare muddy spots are noticeable throughout the pastures, and, lacking drainage, this is a difficult condition to remedy. The animals should be kept off the land as much as possible when the surface soil is soggy. Alsike clover and redtop do better than bluegrass and white clover, and grass mixtures should include more of these two pasture grasses.

The few patches of Wabash silty clay loam sufficiently drained for cropping produce excellent yields during normal seasons. The land is a little harder to handle than Wabash silt loam because of the heavier surface soil which clods and bakes when worked under certain extremes of moisture. When plowed at the right time, that is, when the soil is neither too dry nor too wet, a fine crumbly surface mulch results. Under such conditions all the staple grain and hay crops give excellent yields. The deep-rooted crops, alfalfa and sweetclover, are not particularly well suited to this soil, however, as their deep root systems are restricted by the poor underdrainage of most areas. Red clover does exceptionally well, occasional winterkilling being the only serious damage to this crop.

WABASH LOAM

Wabash loam consists of black friable rather gritty loam to a depth of about 12 or 14 inches. Below this depth and continuing to about 28 inches is very dark-brown or black heavy loam which is underlain by a subsoil and substratum as heavy as or heavier than the soil above. Wabash loam has no distinct layers but is deep dark-colored loam which with depth becomes gradually less dark and maintains the same or a heavier texture to a depth ranging from 3 to 4 feet. The soil contains no lime and tests from slightly to strongly acid.

In areas mapped as Wabash loam there is considerable variation in texture both of the surface soil and the subsoil. Small spots of fine sandy loam, silt loam, clay loam, and silty clay loam are included in mapping.

Wabash loam occupies the higher parts of the bottoms, in many places the first rise from the meadowlands along the stream channel.

In some places the surface soil is subject to change caused by the sandy stream deposits left by frequent overflows. Overflows do not last long, and water does not stand so long on this as on other back-bottom soils. However, the frequent overflows render cropping of much of the soil impractical. The soil itself has good underdrainage and holds moisture well except in the few areas having porous gravelly substrata.

Most of the Wabash loam is in pasture land together with the adjacent meadowlands along the stream valleys. Grasses do well, and the soil has a high pasture value. Under cropping Wabash loam is not quite so productive as well-drained areas of Wabash silt loam. It is more easily handled under extreme moisture conditions and more of it is naturally better drained in ordinary seasons. However, few areas are of sufficient size for cropping.

CASS SANDY LOAM

To a depth of about 14 inches Cass sandy loam consists of very dark-brown moderately loose sandy loam. Between depths of 14 and 24 inches the soil material is moderately loose and porous dark-brown sandy loam which is a trifle heavier than the layer above and becomes more coarsely crumby when dry. A few black stains or streaks caused by organic material are usually present to a depth of 24 inches. Between depths of 24 and 34 inches is brown or dark yellowish-brown very porous loose sand containing waterworn rounded pebbles. Below a depth of 34 inches is coarser sand and some loose and porous gravel.

The texture of the surface soil varies in small areas from loam to loamy sand, and the depth to the looser coarse sand or gravelly subsoil ranges from 20 to as much as 40 inches in places.

Cass sandy loam is very inextensive. It occupies well-drained and slightly ridged areas of bottom lands close to the stream channels. All the areas are small, only a few being large enough to crop. The larger areas lie along West Fork Cedar River and Beaver Creek in sections 9, 10, 11, 34, 35, and 36 of Beaver Township and sections 35 and 36 of Albion Township and along Shell Rock River in sections 34 and 35 of Dayton Township.

This is not considered a very productive soil. Because of a higher-lying water table the soil is not quite so droughty as the higher-lying O'Neill sandy loam. These two soils are similar. The supply of organic matter is a little higher in most areas of the Cass than in the O'Neill soil. Some of the smaller areas are chosen as sites for the farm buildings or are devoted to truck and garden crops such as potatoes or beans. The cropping and soil-management practices in present use and recommendations for soil improvement are similar to those mentioned for O'Neill sandy loam.

LAMOURE SILTY CLAY LOAM

Only a very small acreage of Lamoure silty clay loam is mapped in the county. The areas are along the south county line in sections 31 and 32 of Washington Township and section 34 of Albion Township. They form parts of the basin of upland drainage ways in which sediments have collected to form a deep black soil containing lime at a depth of 3 feet or less. Except in its lime content in the

subsoil Lamoure silty clay loam is similar to Wabash silty clay loam. Crop practices and soil management are very similar on this soil, Wabash silty clay loam, and Clyde silty clay loam. The small areas mapped are mainly in pasture and afford excellent pasturage.

MEADOW

Those lands lying along the main stream channels of the county which are cut up with dead channels, sandy ridged banks, and strips of mud flats present such variable and spotted soil conditions that they are classed as meadow rather than as a definite soil type. Small spots of practically every soil type, from sand to clay, of the Wabash, Cass, Sarpy, and Lamoure series may be found on these lands.

All the meadow is pastured, with the exception of a few small spots or patches which are in crops. In many places an open timber growth skirts the channels. Most of the meadow areas are well drained. Overflows are rather frequent, but they seldom last long. The pasture value of this land is high, and there is little waste land. A few small swampy areas support a dense brushy growth of alder and willow. In many places boundaries drawn between meadow and the adjoining bottom soils are arbitrary.

MUCK AND PEAT

Only three small areas of muck and peat are mapped in the county. The areas in section 35 Fremont Township occupy seepy hillside such as those commonly occupied by the Clyde soils. In this locality the soil is dark-brownish muck or peat containing about 35 or 40 per cent of organic or volatile matter. The material is loose and fluffy when dry, but in its usually moist soggy condition it is spongy. At a depth of about 12 inches below the surface this material changes to a more blackish muck with a greater admixture of soil. When dry it is still a fluffy light-weight mass, but when moist or wet it is less spongy and more soggy than the layer above. A coarse bunchy grass growth furnishes a fair amount of pasturage.

The other area is in sections 5 and 6 of Ripley Township. This area also is used as pasture. The muck soil here, however, extends only to a depth of about 2 feet and is underlain by stiff sticky black clay. Only a thin 2 or 3 inch surface covering consists of brownish fluffy peat. This area occupies a depression in which drainage is restricted, and it remains more or less soggy the year round owing to the run-off waters received from the uplands.

SOILS AND THEIR INTERPRETATION

The most noticeable soil characteristic common to all except a few of the soils of Butler County is the dark-colored granular surface soil. In the virgin state the land was treeless, except small areas adjacent to the stream valleys. Prairie grasses grew abundantly on the treeless areas and formed a large part of the undergrowth on the small wooded tracts. The dark color of the surface layer is owing to the thorough decay of the grass roots and the incorporation of the resultant finely divided carbonaceous material with the mineral constituents of the soil.

A second soil characteristic common to all the soils of Butler County except the Fargo and Lamoure soils is the absence of lime to a

depth ranging from 4 to 5 feet. Lime may occur immediately below this depth and may continue to a depth of 15 feet below the surface. With lime present in the parent material, the absence of it in the upper soil layers has undoubtedly been brought about by leaching of carbonates downward from the weathered soil layers.

A third characteristic common to all the soils of Butler County, with the exception of the alluvial soils of the first bottoms and some of the terrace soils, is a well-defined and perfect granulation, with the granules ranging from very fine to coarse and having fragile to firm cementation. The granulation extends to average depths of 24 or 30 inches in the well-drained soils and to a slighter depth in the poorly drained soils.

The activity of the soil-forming agencies has varied in extent and degree. The relief and the surface and internal drainage, which regulate the soil-moisture conditions, are responsible, to a large extent, for the stage of soil development at the present time. It is this difference in degree to which weathering has proceeded which gives rise to the main differences between soils of the different series.

The greater part of the soils of the county occur on well-drained uplands and terraces under moisture conditions favoring leaching and aeration. The resultant soil is one in which the incorporation of organic matter has produced a dark granular surface layer ranging in thickness from 8 to 20 inches and averaging about 12 inches, and from which leaching has removed the carbonates. Below this black surface soil is a dark-brown slightly heavier soil of very fine or fine granular structure, which is also leached of carbonates. It is in this layer that granulation is usually most perfect and of the finest cementation. Directly below this layer is a layer of dark yellowish-brown heavier soil material forming large and firm structure masses which shatter into a very imperfect granular soil mass. The fourth layer from the surface is different from the layer above in color, being lighter yellowish brown with faint stainings of gray, rust brown, and yellow. The structure masses formed are a little larger than in the layer above, and they shatter more easily and form a more coarsely crumbly soil mass. The material of the fifth layer is a more highly stained yellowish-brown soil which is more friable than the layer above when dry but moderately compact in place and less plastic when wet. The less-weathered soil, which lies at greater depths, differs little from the material in the fifth layer except that it is more variable in texture and color and at a depth ranging from 4 to 15 feet contains carbonates.

The reaction profile varies, no one layer being consistently acid or even consistent in degree of acidity. Most of the soil is acid in some degree to a depth of 4 feet or within a foot or two of the lime zone where the soil is neutral or alkaline.

In the following detailed profile descriptions of the representative soils of the series, the main differences between the soil series comprising this group are brought out. It will be well to keep in mind that the first three layers of soils of this group are essentially alike in all characteristics except texture. The chief differences occur in the fourth and fifth layers. Thus, in soils of the Carrington series these layers are gritty silty clay loam containing embedded gravel and pebbles; in the Tama series they are silty, pebbleless, more friable silty clay loam or heavy silt loam; in the Dodgeville series the fifth

layer consists of very plastic gritty sandy clay directly underlain by bed limerock; in the Dickinson series the two lower layers are stratified loose porous coarse sand and gravel; in the Waukesha series they are silty clay loam more or less gritty, heavier than the surface soil but rather friable, and in the Millsdale series they are essentially like the lower layers of the Waukesha soils but with bed limerock directly below.

The following profile typical of Carrington silt loam was observed in the NE. ¼ sec. 8, T. 90 N., R. 18 W.: (1) From 0 to 11 inches, a 1 or 2 inch layer of silt loam filled with grass roots and humus, underlain by friable very fine perfectly defined granular silt loam. The granules are fragile and of irregular rather rounded shapes. The incorporation of organic matter has thoroughly penetrated the granules and has given the soil mass a black color when moist and only slightly less black when dry. This is the darkest layer of the soil. (2) From 11 to 18 inches, perfectly defined fine-granular silt loam. The granules are firmer than in the first layer and of more definite shape, being irregularly angular. The soil has a tendency to form large structure masses which are easily shattered into a friable granular mass. The organic matter has not penetrated to the center of the granules as in the above layer. Consequently, when the granules are crushed the material changes from the black color of the surface of the granules to dark brown. (3) From 18 to 26 inches, silty clay loam forming large irregular-shaped moderately firm structure masses which shatter into imperfect coarse granular masses with less definite-shaped and less angular granules. The soil in this layer contains but little organic matter and the breakage surfaces have thin, very dark grayish-brown coatings over dark yellowish-brown interiors. Grass roots do not penetrate below a depth of about 24 inches. The material is friable when dry, but moderately plastic when wet. The dry soil is rather gritty owing to its content of embedded sand and gravel, but the grittiness disappears in the moist soil. (4) From 26 to 40 inches, a silty clay loam layer grittier than the layer above owing to its greater content of sand and pebbles. When moist the material is moderately plastic, but when dry is a little more friable. The irregular-shaped structure masses are larger, but are more fragile than in the layer above. They shatter into a coarse crumbly yellowish-brown soil mass. The crushed or sliced surfaces are of lighter shades of yellowish brown, gray, yellow, and brown. Rust-brown and black concretionary iron stains are very noticeable on sliced soil surfaces. (5) From 40 inches downward, sandy clay or very gritty silty clay loam, in which the color is darker yellowish brown, probably because of a greater iron content. Similar color stainings occur in this layer as in the layer above. When dry the soil is slightly friable and is compact in place. When wet, it is moderately plastic. The layer is structureless, and the texture from place to place in the layer is more variable than in the layer above, being somewhat gravelly in spots.

The reaction profile is slightly or medium acid in the first layer, strongly acid in the second and third layers, and medium acid in the fourth and fifth layers. At a depth of about 5 feet the substratum contains sufficient lime to effervesce with acid. Bowlders occur in small numbers on the surface and in the soil. These, together with the gravel contained in the lower layers, indicate the nature

of the parent material, a comparatively young glacial drift deposit. in which leaching of carbonates has progressed to a depth of about 5 feet.

The profile just described is typical in its principal characteristics of the soils of the Carrington and Tama series of the well-drained uplands, of the Waukesha soils of the well-drained terraces, and of the deeper phases of the Dodgeville soils.

The profile described in the following paragraph is typical of Dickinson sandy loam in Butler County. It was observed in the NW. ¼ sec. 4, T. 92 N., R. 18 W.: (1) From 0 to 13 inches, friable and rather loose sandy loam having a fair degree of granulation when dry. The upper inch of soil is filled with grass roots and raw humus. When moist or wet the soil is of fair consistence. The color is very dark grayish brown when the material is dry and almost black when it is wet. (2) From 13 to 23 inches, sandy loam somewhat looser in structure than the above layer. When wet or moist the soil is very slightly sticky, but when dry it is pulverulent and contains only a few small crumbly aggregates. The color is more brownish than the layer above, but is still very dark grayish brown. The moist crushed or cut soil surface is very dark brown. (3) From 23 to 33 inches, very dark-brown sandy clay loam which is crumbly and loosely friable when dry but moderately plastic when wet. Structure masses about one-half inch in diameter and of irregular, rather rounded shapes are well defined in this layer. (4) From 33 to 54 or more inches, loose porous well-assorted sand containing only a very small number of pebbles or gravel. The material is structureless. It is pale brown or light yellowish brown in color. The reaction profile is medium acid in the first layer, strongly acid in the second layer, and slightly acid in the third and fourth layers.

A description of the profile studied as typical of soils of the O'Neill series in Butler County follows: (1) From 0 to 11 inches, a 2-inch covering of grass roots and humus underlain by friable loam containing moderately fine or medium sand particles. The structure is very imperfectly granular, the granules being very fine, soft, and fragile. The color of the soil material is very dark grayish brown when it is dry and almost black when it is wet. (2) From 11 to 16 inches, heavy more granular loam, in which the granules are a little larger than in the surface layer. The granules are fragile and make up less than one-half of the soil mass, the remainder being of single-grained structure. The color is very dark brown but not so dark when wet as the surface soil. (3) From 16 to 21 inches, light clay loam containing coarser grades of sand than the first two layers. Large irregular-shaped structure masses are formed which readily shatter into a friable soil mass, half granular and half crumbly. The material is easily pulverized into a single-grained mass. When wet the soil is slightly plastic. The color is dark yellowish brown with faint dark stainings on some of the breakage surfaces. These stains are caused by the incorporated organic matter. (4) From 21 to 28 inches, yellowish-brown heavy coarse loam containing considerable white cherty gravel. The soil mass is more fragile than in the layer above and is almost structureless. The few large structure masses present shatter very easily into a crumbly mass which shows no granulation. When wet the material is slightly plastic. (5) From 28 inches downward. loose coarse sand and gravel, some

of which is as large as a hen's egg. White cherty pebbles are prominent in the soil mass. The color is light reddish yellow or brown with staining caused by black iron concretions. The sand and gravel occur in horizontal strata. The reaction profile is slightly acid in the first and second layers, medium or strongly acid in the third and fourth layers, and medium acid in the fifth layer.

A large group of soils in Butler County includes those having dark-colored surface soils, which have weathered under poor soil-moisture conditions and imperfect aeration, thereby retarding the intensity and force with which the soil-forming agencies have acted. The abundant moisture has favored a luxuriant grass vegetation. Owing to the abundant supply of vegetable matter, which has decayed and become incorporated with the soil particles, the soil is more intensely black and extends to a greater depth than the surface soils of the well-drained soils. The dark-colored layer is more distinctly granular and less dustlike than the corresponding layer in the well-drained soils. The heavy upper subsoil layer, developed under poor drainage, is denser, tougher, and more impenetrable. The structure is more poorly defined, the large structure masses being larger, more irregular in shape, and more resistant to breakage than those in the corresponding layer of well-drained soils. The structure masses in this layer have a surface coating of dark gray or dark grayish brown rather than the yellowish brown of the well-drained subsoils.

In Butler County the Floyd and Clyde soils of the uplands and the Bremer and Fargo soils of the terraces belong to this group. The Floyd soils are a little better drained than the Clyde soils, as the granulation is more perfect in the upper subsoil layer, the lower subsoil layer is less tough and impenetrable, and the black surface soils are shallower. The Bremer soil differs from the Fargo principally in that it contains no lime.

Floyd silt loam is representative of this group of soils. A detailed description of the profile of an area of this soil, observed in the NW. ¼ sec. 25, T. 92 N., R. 17 W., follows: (1) From 0 to 6 inches, rather gritty and impure friable heavy silt loam which is very fine granular and of an intensely black color when wet. In grass-covered areas the topmost 2 inches is filled with grass roots, forming a turf. (2) From 6 to 19 inches, fine or medium granular silty clay loam in which the granules are of irregular, somewhat rounded shapes. On drying they become firm but form a friable crumbly soil mass. When wet the soil is plastic. (3) From 19 to 27 inches, heavy silty clay loam more coarsely granular than the layer above. The granulation gives way to a larger structure mass formation. In this layer the black color becomes stained with yellowish brown. The dark-colored coating of the structure masses is thin, and when crushed the material appears very dark grayish brown. When wet the material is plastic. (4) From 27 to 35 inches, heavy silty clay loam forming irregular, large structure masses. When dry the masses are tough and very resistant to breakage, but when wet the soil material is very plastic. The color is yellowish brown mottled with rust-brown and black iron spots, considerable dark gray, and some light gray. (5) From 35 to 52 and more inches, gritty silty clay loam or sandy clay, which when wet is moderately plastic and sticky, but when dry the large structure masses are more fragile and the shattered soil

mass more friable than in the layer above. With depth the soil becomes structureless. The color is similar to the layer above but there are less black iron spots and more dingy-gray and bright rust-brown spots.

The reaction is slightly acid in the first and second layers and neutral or very slightly acid in the third, fourth, and fifth layers. Lime occurs in most areas at a depth of about 5 or 6 feet.

The Clyde and Bremer soils differ from the Floyd soil in their greater development of those characteristics produced by deficient drainage, such as the gray or mottled color of the subsoils.

A third major group of soils in Butler County, occurring on the well-drained uplands, is characterized by light-colored surface soils. The light-colored surface soil is owing to the character of the native vegetation under which the soil has developed. The uncleared areas support a hardwood timber growth, together with a scant grass growth. The roots penetrating the upper soil layers are largely of a woody nature and are more resistant to decay than grass roots, consequently the surface soil below the thin layer of leaf mold and humus is lighter colored than in soils developed under grass vegetation, being a light grayish-brown or light yellowish-brown mellow soil. The second layer is yellowish-brown or brown fine perfectly granular soil which is less mellow than the surface layer. The third layer is the layer of large structure mass formation. It is deep yellowish brown and heavier textured than the layers above. The fourth layer is light yellowish brown more friable material, similar in structure to the layer above but less well defined, and the structure masses are more fragile. The fifth layer is structureless friable mottled yellowish-brown soil. Both the Fayette and Lindley soils conform to this general description. The main differences between these soils are in the third, fourth, and fifth layers. These layers in the Fayette soil are not so heavy in texture or so plastic when wet, and they lack the sand and pebble content of the same layers in the Lindley soil. The Fayette is a more friable soil throughout and is weathered from a siltier or very fine sandy, loose deposit. The Lindley soil is more compact, more variable in texture, and is weathered from glacial drift deposited on the uplands.

A description of a profile of Fayette very fine sandy loam observed in the SW. ¼ sec. 20, T. 90 N., R. 15 W., follows: (1) A 1½-inch layer of fine sandy loam filled with leaf mold and grass roots, underlain to a depth of 7 inches by friable, smoothly mellow, soft, very fine-granular very dark-brown or grayish-brown very fine sandy loam. In plowed areas the surface soil dries out to a grayish-brown color. (2) From 7 to 17 inches, medium-granular silt loam, in which the granules are angular and very firm when the material is dry. Granulation is perfect. When wet the soil is smooth and mellow, and when dry it is friable and crumbly but somewhat compact in place. The surfaces of the granules are light yellowish brown with a grayish cast. When crushed the material loses its grayish color. (3) From 17 to 28 inches, more coarsely granular deep yellowish-brown heavy silt loam or very fine sandy clay loam, in which the granules are not so tough as in the layer above. Large irregular-shaped structure masses form, but they are easily shattered into small structure masses or granules. When wet the material is rather plas-

tic, but when dry it is crumbly and friable. (4) From 28 to 40 inches, more friable smooth gritty very fine sandy loam. Large structure masses form which are irregularly and imperfectly columnar. These large structure masses are more fragile than in the third layer, and they shatter into a more single-grained soil mass. The color is lighter yellowish brown or lemon yellow. (5) From 40 inches downward, very friable and structureless very fine sandy loam which is more sandy than the layer above. The color is lighter, and gray and yellow stains and rust-brown and a few black iron spots or streaks are in evidence.

The soil has a good moisture-holding capacity throughout, is very uniform in texture, and the several soil layers gradually change into one another. The reaction is slightly acid to a depth of about 10 inches and medium or strongly acid below.

The Lindley soils are similar in their principal characteristics to the Fayette soils. The differences between these soils are due to the influence of the parent materials.

In a fourth large group may be placed the Wabash, Cass, and Lamoure first-bottom soils. These soils are derived from alluvial materials which have been recently deposited and are still subject to alterations from overflow deposits in some places. The soils have not developed distinct layers.

The grouping of soils into soils having dark or light colored surface soils and soils weathered under well drained and poorly drained conditions are groupings which relate directly to the features of the soil profile without any relation to the origin or parent material of the soil. The soils of Butler County can be placed in four groups on the basis of the parent materials. The largest group in Butler County is the one including soils weathered from the glacial drift deposits on the upland, the second group comprises soils weathered from loessial deposits mantling the drift, the third group includes soils wholly or partly of residual origin which have weathered in place over limestone, and the fourth group comprises soils weathered from transported materials deposited by streams on the flood plains. Classification of the soil series on this basis results in the following grouping: (1) Soils of the Carrington, Clyde, Dickinson, Floyd, and Lindley series; (2) soils of the Fayette and Tama series; (3) soils of the Dodgeville series; and (4) soils of the O'Neill, Waukesha, Bremer, Fargo, Millsdale, Wabash, Lamoure, and Cass series.

In Table 5 the pH values of two of the soils of Butler County are given.

TABLE 5.—*pH determinations of soils in Butler County, Iowa*

(1½ c. c. soil. 1:2 soil-water ratio)

Sample No.	Soil type	Depth (inches)	pH value	Sample No.	Soil type	Depth (inches)	pH value
337607	Tama silt loam	0 to 2	5.90	337631	Carrington silt loam	0 to 11	5.53
337608	do	2 to 14	6.12	337632	do	11 to 18	5.29
337609	do	14 to 26	5.79	337633	do	18 to 26	5.37
337610	do	26 to 35	5.79	337634	do	26 to 40	5.37
337611	do	35 to 52	6.03	337635	do	40+	6.15
337612	do	52 to 108	7.43				

SUMMARY

Butler County is in the north-central part of Iowa in a well-developed general farming section. It includes an area of 581 square miles.

The transportation facilities of the county provide ready access to grain and livestock markets.

The upland areas are gently rolling. Three rather wide stream valleys cross the county from west to east and provide good drainage for all sections. Narrow strips of land skirting the stream channels and some of the steeper slopes and higher upland crests bordering the valleys are wooded. Elsewhere the prairies are dotted by small wood lots or shelter belts around the farmsteads.

The average frost-free season is 146 days. The mean annual rainfall of 33.43 inches is usually normally well distributed throughout the growing season. The mean summer temperature is 70.5° F. and that of winter, 18.7° F.

Agriculture has always been the main industry of the county. Rainfall and temperature conditions insure against crop failure. Yields of the staple crops, corn, oats, clover and timothy, barley, wheat, rye, and potatoes vary widely under different seasonal conditions and on different soils, but complete crop failures never occur.

Corn and oats are the principal grain crops. Barley, wheat, and rye yield well, and a considerable acreage of these crops is grown. The hay lands are practically all in tame-hay grasses. Clover and timothy mixed, timothy alone, and clover alone occupy the largest acreages. Small but steadily increasing acreages of alfalfa and sweetclover are grown. The most important livestock industry is the fattening of livestock, principally hogs, for market. Dairying is increasing in importance. On practically every farm a steady income is derived from poultry products. Enough colts are raised to supply local demands for work animals.

On the basis of the color of their surface soils the soils of the county are divided into two groups, dark-colored soils and light-colored soils. Each of these groups may be further divided on the basis of natural drainage into well-drained and poorly drained soils.

In the group of dark-colored well-drained soils are the Carrington, Tama, Dodgeville, and Dickinson soils of the uplands and the O'Neill, Waukesha, and Millsdale soils of the terraces. In the group of dark-colored poorly drained soils are the Floyd and Clyde soils of the terraces. In the group of well-drained light-colored soils are the Fayette and Lindley soils of the uplands. On the first-bottom lands in the stream valleys are the Wabash, Lamoure, and Cass soils and mixed soil areas classed as meadow. By far the greater part of the soils of the county are dark colored, well drained, and highly productive. Manure is practically the only fertilizer used. Most of the soils are acid and need liming for such crops as alfalfa and sweetclover.

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[PUBLIC RESOLUTION—No. 9]

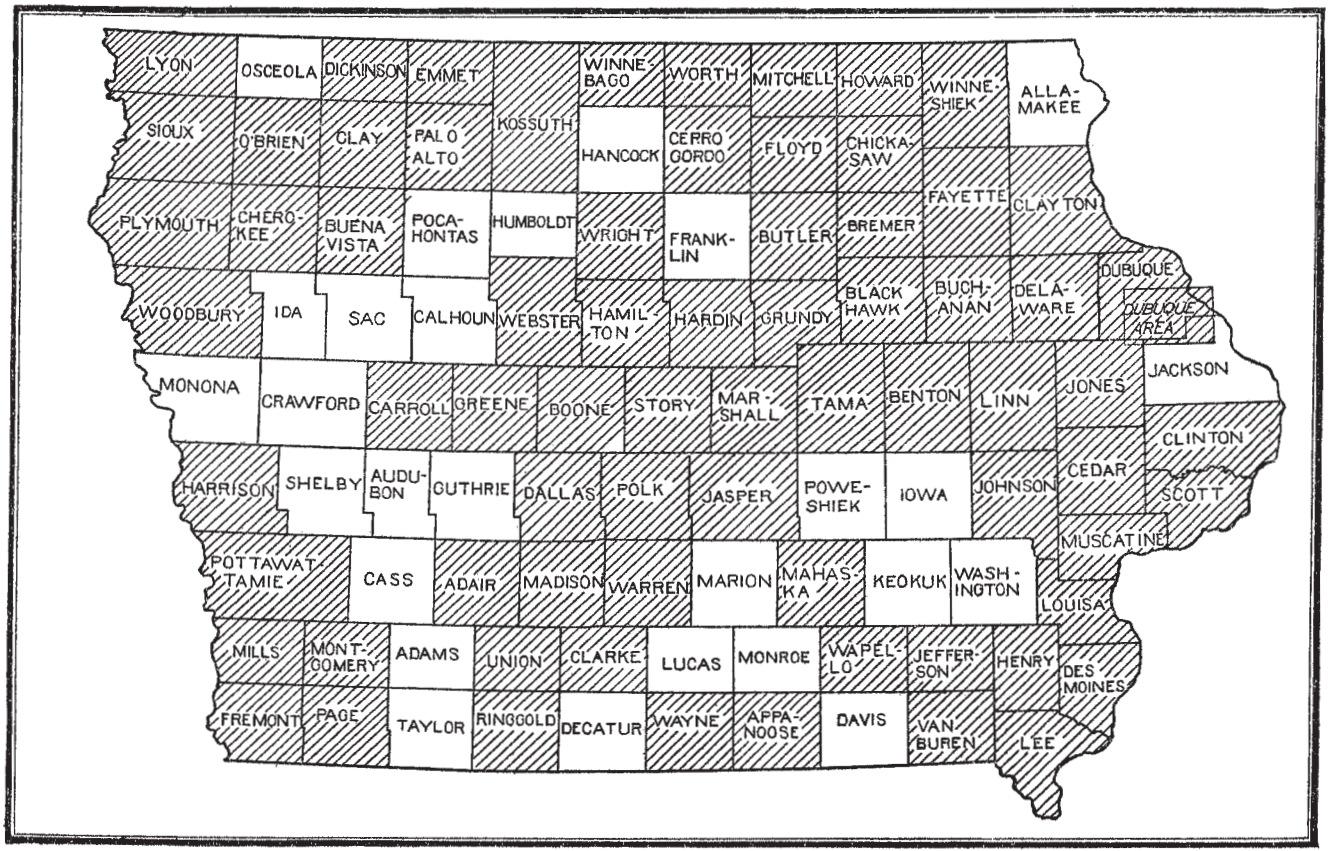
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for 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 area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils, and on July 1, 1927, the Bureau of Soils became a unit of the Bureau of Chemistry and Soils.]



Areas surveyed in Iowa, shown by shading

U. S. GOVERNMENT PRINTING OFFICE: 1931

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