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UNITED STATES DEPARTMENT OF AGRICULTURE

Soil Survey
of
Franklin County, Iowa

By

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and

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United States Department of Agriculture

Bureau of Chemistry and Soils

In cooperation with the
Iowa Agricultural Experiment Station

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BUREAU OF CHEMISTRY AND SOILS

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SOIL SURVEY OF FRANKLIN COUNTY, IOWA

By T. H. BENTON, Iowa Agricultural Experiment Station, in Charge, and F. R. LESH, United States Department of Agriculture

COUNTY SURVEYED

Franklin County is situated a short distance northeast of the center of Iowa (fig. 1). Hampton, the county seat, is about 80 miles northeast of Des Moines. The county comprises an area of 578 square miles, or 369,920 acres.

It is part of a vast, relatively smooth plain over which at different times sheets of glacial drift and loess have been deposited. Slight relief has been produced by streams which flow across the county in a general southeasterly direction. On the basis of surface features, determined in large part by the deposition of glacial debris by the last two ice sheets that invaded this region, the county can be separated into two distinct areas. The boundary between the two areas crosses the county in a general northwest-southeast direction.

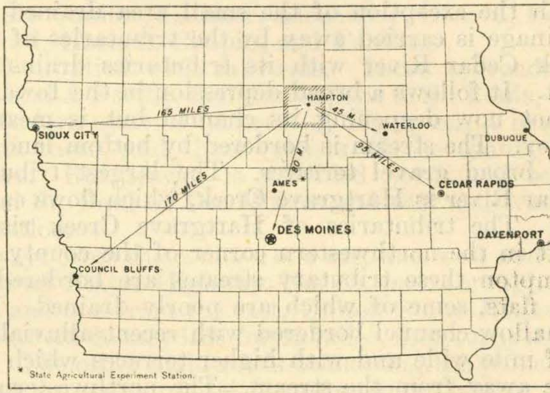

FIGURE 1.—Sketch map showing location of Franklin County, Iowa.

The western part, including about five-eighths of the total area, is covered by the more recent Wisconsin glacial till, and its topography is constructive and characteristically immature.[1] This section displays two types of surface features: the hilly, knobby tracts, and the areas of relatively smooth drift plain. The first of these can be seen along the eastern border of the Wisconsin drift area, which is marked by a belt of hilly country ranging in width from 2 to 7 miles. In Richland and Marion Townships it has an average width between 4 and 5 miles, but it narrows toward the southeast. The hills of this morainic region are not prominent, and the relief becomes smoother toward the west and gradually merges into the drift plain. West of the moraines the surface of the plain is varied by occasional low ridges of drift or knobs of sand and gravel and numerous ponds and marshy places. As a rule drainage channels have been established only near the larger streams. The largest areas of undrained till plain are in the northwestern part of the county in Wisner, Scott, and Morgan Townships.

[1] Iowa Geol. Survey, Ann. Rept. 16 : 455.

The eastern part of the county is covered by Iowan drift, but this drift is thin and in most places does not entirely conceal the older surface features. The Iowan drift in turn is covered by loesslike silty material. The effect of these deposits is to smooth the surface features and to form the gently rolling landscape of the typical Iowan drift plain on which numerous lenticular hills are most prominent.

Alluvial lands are well developed along the larger streams. They consist of first bottoms adjacent to stream channels which are subject to annual overflow and of terraces, or second bottoms, usually bordering the uplands and well above flood waters.

The drainage is influenced to a large extent by the surface features of the two drift sheets. This is shown by the differences in stream development. All the perennial streams except Iowa River, which cuts the southwestern corner, are confined to the Iowan drift. With the exception of the small area drained by Iowa River, the drainage is carried away by the tributaries of Cedar River. West Fork Cedar River with its tributaries drains the entire northern part. It follows a broad depression in the Iowan drift. The stream is not now deepening its channel but is meandering through its valley. The stream is bordered by bottom lands of recent alluvium and broad gravel terraces. The largest tributary of West Fork Cedar River is Hartgrave Creek, which flows eastward from Hampton. The tributaries of Hartgrave Creek rise in the Wisconsin drift in the northwestern corner of the county. North and east of Hampton these tributary streams are bordered by gravel terraces and flats, some of which are poorly drained. Iowa River flows in a shallow channel bordered with recent alluvial deposits about one-half mile wide and with higher terraces which extend more than a mile away from the stream. The northwestern part of the county has not yet developed efficient natural drainage systems, but a large part of this area has been improved by artificial drainage.

The general direction of the streams would indicate that the slope of the country is toward the southeast, and elevations determined by several surveys verify this fact. The greatest altitudes are in the northwestern part. The highest point recorded is on the Chicago Great Western Railroad about 1 mile east of the northwestern corner of the county, which has an altitude of 1,256 feet. Hansell, near the eastern side, is 1,031 feet above sea level.[2] The altitudes of other towns are: Alexander, 1,253; Dows, 1,142; and Ackley, 1,092. The maximum differences in elevation between any two places in the county is 270 feet, and the general gradient is about 10½ feet to a mile. Nearly all of the county lies between 1,000 and 1,250 feet above sea level.

The first settlers found the greater part of the county a grass-covered plain. A few of the steeper valley slopes and the alluvial land along Iowa River were covered by a growth of trees. Scattered patches of trees were also found along West Fork Cedar River and a few of its larger tributaries. The tree growth has been increased by groves of cottonwood, boxelder, maple, and conifers which have been planted around buildings on nearly all farms.

[2] GANNETT, H. A DICTIONARY OF ALTITUDES IN THE UNITED STATES. U. S. Geol. Survey Bull. 274, ed. 4, 1072 pp. 1906.

The first settlers came into the territory now occupied by Franklin County about 1850, and the county was organized in 1855. The name Franklin was given in honor of Benjamin Franklin, and the first county seat, located 2 miles south of the present site of Hampton, was called Benjamin.

The population of the county as reported by the census of 1930 was 16,382, of which 14,903 were of native birth. Of the 1,479 persons of foreign birth, Germans were most numerous, and the remainder were mainly Danes, English, and Norwegians. The rural farm population is 9,791, and the rural nonfarm population is 3,118.

Hampton, the county seat, is situated near the center of the county and in 1930 had a population of 3,473. Ackley, in the extreme southeastern corner, is a town having 1,524 inhabitants. The third town in size is Sheffield with a population of 1,057. Dows, in the southwestern corner, has 926 inhabitants. Other locally important towns and shipping points are Coulter, Latimer, Alexander, Geneva, Popejoy, Burdette, Bradford, Hansell, Chapin, and Faulkner.

The county is well supplied with railroads. Three railroads of the Chicago, Rock Island & Pacific, the Minneapolis & St. Louis, and the Chicago Great Western systems intersect at Hampton; a branch of one of them starts there, and three corners of the county are crossed by other lines. Bus service is provided north and south from Minneapolis and St. Paul to Des Moines and east and west to Fort Dodge and Waterloo.

Three paved highways cross the county; one east and west and one north and south, United States Highway No. 65, pass through the center of the county, and one from the east, United States Highway No. 20, follows the southern county line for 12 miles, then turns south into Hardin County. The other main roads connecting the principal towns are graveled, as are many of the farm-to-market roads. The rest are dirt roads but are graded and maintained in good condition.

The farm products, consisting mainly of livestock and livestock products, find a market in several directions. The cattle and hogs are shipped to several small packing plants at Austin, Minn., and at Waterloo and Mason City, Iowa. A smaller proportion is shipped to the larger markets at Chicago and St. Paul. Poultry and poultry products go to Chicago and eastern markets. Grain elevators are located at Geneva, Chapin, Sheffield, Faulkner, Bradford, Hampton, Hansel, Alexandria, Popejoy, Dows, and Ackley. Creameries are located in Dows, Hampton, Ackley, Hansel, Latimer, and Sheffield. Large nurseries are located at Hampton, as are also a canning factory, a poultry packing plant, and several other small factories. A brick and tile plant is located at Sheffield.

Rural mail routes and telephone lines reach every part of the county. Educational facilities are provided by high schools in the larger towns and by district schools and a number of consolidated schools in the rural districts.

CLIMATE

The climate is continental and is typical of the Corn Belt, having a wide annual range in temperature, with normally cold winters and hot summers. The growing season is of sufficient length to mature all staple crops common to this section. The extreme northern part of the county is at the southern edge of a zone where a variety of corn should be grown maturing earlier than the corn grown in the central and southern parts.

The mean annual precipitation as recorded at Hampton is 33.76 inches, about 60 percent falling during the months of April, May, June, July, and August, which is the most critical part of the growing season. Occasionally spring rains retard planting, but rarely do they delay it enough to prevent the maturing of corn. October and November are normally dry enough to allow the proper maturing and drying of the corn crop.

The mean seasonal temperatures range from 18.1° F. for the winter months, to 69.7° for the summer months. Extremely cold winters are not common, the extreme cold usually being restricted to periods of a week or 10 days, milder winter weather intervening. When heavy snows and accompanying high winds occur, livestock must be well protected, as temperatures fall below −30°.

During the summer months temperatures rise above 100°. Drying winds from the south and southwest cause only short periods of drought usually, but sometimes they materially cut the grain yields. The sandier soils suffer most during these periods, but a total crop failure is unknown except on soils with deep sand or gravel subsoils.

Damage from hailstorms is local, usually occurring in narrow strips 1 to 2 miles wide and 6 or 7 miles long. According to statistics, the northern part of the county has suffered the most from hailstorms. Growing crops are occasionally damaged by windstorms.

The average frost-free season covers a period of 153 days, the average date of the last killing frost being May 4 and the average date of the first, October 4. The latest and the earliest killing frosts recorded were on May 30 and September 12, respectively. The grazing season covers a period of about 225 days.

Table 1, compiled from records of the United States Weather Bureau station at Hampton, gives a summarization of the normal monthly, seasonal, and annual temperature and precipitation, which is fairly representative for the county as a whole.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Hampton, Franklin County, Iowa*

[Elevation, 1,146 feet]

Month	Temperature	Precipitation			Month	Temperature	Precipitation		
	Mean	Mean	Total amount for the driest year (1910)	Total amount for the wettest year (1902)		Mean	Mean	Total amount for the driest year (1910)	Total amount for the wettest year (1902)
	° F.	*Inches*	*Inches*	*Inches*		° F.	*Inches*	*Inches*	*Inches*
December	21.3	1.20	0.41	2.42	June	66.8	4.86	1.83	8.30
January	14.9	1.11	1.85	1.46	July	72.5	4.05	.95	10.95
February	18.1	1.19	.56	.87	August	69.8	3.61	5.40	5.77
Winter	18.1	3.50	2.82	4.75	Summer	69.7	12.52	8.18	25.02
March	31.7	2.02	.36	2.88	September	62.1	3.70	2.36	4.67
April	47.0	3.04	.93	1.07	October	49.3	2.71	.78	1.33
May	58.4	4.70	1.97	7.45	November	33.7	1.57	.31	2.16
Spring	45.7	9.76	3.26	11.40	Fall	48.4	7.98	3.45	8.16
					Year	45.5	33.76	17.71	49.33

AGRICULTURAL HISTORY AND STATISTICS

Agriculture has been the main industry in Franklin County from the time of its first settlement. Prior to the coming of the railroads, farming was of a pioneer type consisting of the growing of small patches of corn and oats as feed for work animals, wheat and buckwheat for flour, flax for homespun articles, potatoes and other vegetables for home consumption, and sorgo for sirup. When railroad facilities were provided new markets were opened for agricultural products, and wheat became the principal cash crop. Wheat farming, however, was not carried on to the exclusion of other crops, as it was in sections farther north. Wheat production gradually declined, and the farms turned to a more diversified type of farming with a well-balanced production of crops and livestock.

Table 2, compiled from reports of the Federal census, gives the acreage of the principal crops in the census years 1879 to 1934, inclusive.

TABLE 2.—*Acreage of the principal crops grown in Franklin County, Iowa, in stated years*

Crop	1879	1889	1899	1909	1919	1929	1934
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Corn harvested for grain	56,136	81,027	106,886	100,594	[1] 112,338	[1] 134,379	[1] 116,661
Oats	17,397	64,928	87,497	77,352	85,329	82,993	77,353
Barley	1,141	1,023	4,292	4,423	1,435	7,622	2,719
Wheat	43,159	1,151	10,785	883	1,124	349	260
All hay	21,647	56,542	40,811	53,910	41,008	30,853	[2] 43,903
Timothy and (or) timothy and clover mixed.	-------	-------	-------	36,279	32,159	21,383	10,192
Clover alone	-------	-------	331	714	368	3,284	670
Alfalfa	-------	-------	-------	29	50	2,908	7,588
Wild or prairie grasses	-------	-------	19,322	15,221	7,900	2,243	[3] 9,327

[1] Includes corn for silage, fodder, and hogged or grazed off.
[2] Includes sorghums for forage.
[3] All other tame and wild grasses.

It will be seen from table 2 that the acreages of corn, oats, and several other crops have increased as the wheat acreage decreased.

Corn has been the principal cultivated crop since the county was settled. Of the total acreage of corn in 1934, 87,458 acres were harvested for grain. The rest, 29,203 acres, was cut for silage or for fodder or was hogged off. Both white and yellow dent varieties of corn are grown. The most popular varieties are Reid Yellow Dent, Osterland Yellow Dent, McArthur Golden King, Ioleaming, Silver King, and Dewey White Dent. Hybrid seed corn developed by the Iowa Agricultural Experiment Station and by commercial companies for this section is being used in increasing amounts annually. Corn is generally planted between May 1 and May 15. Some plantings for silage or fodder are made as late as June 15. Most of the corn planted is checkrowed. Only a very small percentage of the corn grown is shipped. Harvesting of the grain crop begins about October 15. In 1929, 555 farms reported putting up silage. In 1933 the State census reports the average production of corn for this county at about 47 bushels an acre as compared with a State average of 43.6 bushels. Sweet corn is grown for home use and for canning and is marketed at the large canneries at Hampton and Ackley.

The Federal census of 1930 reported 82,993 acres of oats threshed for grain with a production of 3,153,679 bushels, and 809 acres of oats were cut and fed unthreshed in 1929. Practically all oats grown in the county are fed on the farm. Oats are not a profitable cash crop but are a fairly sure crop and are valued by the farmers for their feeding value and for their suitability as a follow-up crop for corn. Mixed home-grown seed is commonly used, and the most successful varieties are Albion (Iowa 103), Richland (Iowa 105), Iogold, Iowar, Iogren, Green Russian, and Kherson. The crop is seeded in April, and the early varieties are harvested between July 10 and July 20. More oats are sold as a cash crop than any other grains. About an equal amount of early and late oats is seeded. Smut is common but is kept under control by the formalin treatment.

Timothy and clover mixed is the main hay crop. The yield ranges from 1 to 2 tons an acre and averages about 1½ tons. Timothy and clover are sown with small grains as a nurse crop, and if the season is favorable they are used for light fall pasture. Several thousands of acres of clover alone are grown, of which the greater part is medium red. The acreage of this crop has been increasing rapidly in late years. In the eastern part of the county, where the greater part of the clover is grown, it is necessary in many places to apply lime in order to insure a good stand.

Wheat, which once held second place among the crops of the county, has decreased in acreage until it is now of little importance. Only small patches, mostly of spring wheat, are now grown. Rye is grown on only a few hundred acres. Barley is grown to some extent, the approximate acreage fluctuating in different years from 1,000 to 8,000 acres. Most of the grain is fed to hogs. This crop is sometimes used to take the place of oats in the crop rotation. Smaller acreages are devoted to a number of other crops including kafir, buckwheat, sorghum, millet, flax, and Sudan grass. Rape is sown either alone or with corn and is used as hog pasture. Some potatoes are grown for home use on nearly very farm. Soybeans are being grown in increased quantities.

Of the total land area, 363,015 acres, or 98.1 percent, were in farms in 1935. Of the land in farms, 258,558 acres were in crops, and 83,230 acres were in pasture, of which 44,625 acres were plowable and were used for pasture temporarily or to meet the need for pasture in a system of livestock production and the rest were poorly drained land and wet land.

Fertilizers are not generally used, but in 1930, 248 farms reported the use of fertilizer at a total cost of $17,236. This fertilizer was used largely on peat land for the production of all crops and on other land for the production of sugar beets and sweet corn. Potash and phosphate, principally of the formula 0–9–27 [3] or 0–14–14, were used on peat. Most farmers use phosphates on sugar beets and sweet corn, but few use complete fertilizers. The soils of the eastern part of the county are generally acid, and during the last few years

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

lime has been used in considerable quantities. Ground limestone is shipped from Alden in Hardin County and from Mason City. Lime is necessary in many places in order to obtain a good yield of red clover or other legumes.

Nearly 64 percent of the farms employ labor, the average cost in 1930 being $336.50. This labor is employed during the entire year on some of the dairy and livestock farms and on other farms for short periods during harvesting of small grains and corn.

The average size of farms has fluctuated somewhat during the agricultural history of the county; it gradually increased until 1900, when the average was 193.5 acres, and by 1935 it had declined to 168.5 acres. The increased use of machinery probably accounts for the increase in the size of farms up to 1900. The decline of wheat production and the introduction of crops requiring closer cultivation caused the subsequent decrease in the average size.

In this county, as in other parts of Iowa, the proportion of farms operated by owners has greatly decreased since pioneer days. By 1880 only 74.9 percent of the farms were operated by owners; this proportion steadily decreased in every decade, and the census of 1935 shows that only 43.5 percent were operated by owners. Nearly all farms operated by tenants are under a share system. The usual arrangement is that one-half of the corn and two-fifths of the oats go to the owner of the land and in addition the tenant pays an average rental of about $5 an acre for pasture and hay land. This rental for hay land and pasture is justified by the fact that land in all tame-hay crops is included. In rather rare instances in which cash is paid for use of land, the rental ranges from $5 to $7 an acre.

Table 3 shows the number and average size of farms, the average amount of improved land per farm, the average value of all property per farm, and the land tenure for the census years 1880 to 1935, inclusive.

TABLE 3.—*Number and average size of farms, average amount of improved land per farm, average value of all property per farm, and land tenure in Franklin County, Iowa, in stated years*

Year	Farms	Average size of farms	Improved land per farm	Average value of all property per farm	Operated by—		
					Owners	Tenants	Managers
	Number	*Acres*	*Acres*	*Dollars*	*Percent*	*Percent*	*Percent*
1880	1,429	157.0	125.3	3,551	74.9	25.1	0
1890	1,697	188.0	161.7	5,969	67.8	32.2	0
1900	1,874	193.5	174.2	10,239	60.4	39.0	.6
1910	1,915	186.3	163.9	18,756	52.6	46.4	1.0
1920	2,040	174.7	150.0	44,884	45.5	53.5	1.0
1930	2,082	173.8	148.4	27,884	44.6	54.8	.6
1935	2,154	168.5	140.8		43.5	55.7	.8

Livestock is the chief source of income on most farms. As has been stated, the greater part of the crops grown are fed on the farm, and the farmer sells livestock and livestock products. Table 4 shows the number and value of the different kinds of livestock, according to Federal census figures for 1920, 1930, and 1935.

TABLE 4.—*Number and value of different kinds of livestock in Franklin County, Iowa, in 1920, 1930, and 1935*

Kind of livestock	1920		1930		[1] 1935
	Number	*Value*	*Number*	*Value*	*Number*
Beef cattle	40,158	$2,061,707	[2] 47,602	[2] $2,602,658	[2] 58,422
Dairy cattle	15,170	846,693			
Swine	85,802	1,791,468	110,609	1,643,682	82,872
Horses	15,537	1,224,301	12,087	1,022,075	10,588
Sheep	15,163	156,134	9,390	85,157	27,324
Poultry	312,246	310,819	[3] 378,657	314,285	360,395

[1] Value not reported. [2] All cattle. [3] Chickens only.

The production of livestock and livestock products has several branches—the production of pork, beef, poultry, poultry products, and dairy products.

An important part of the farm income is derived from dairying. On most farms the production of milk is carried on as a side line, but a few farms are devoted exclusively to this business. The Holstein-Friesian is the most popular dairy breed. Small numbers of Guernseys and Jerseys are kept. According to the census of 1935, 17,741 dairy cows produced 8,414,190 gallons of milk. In 1929 cream sold as butterfat reached a total of 1,967,565 pounds. The butterfat and a comparatively small amount of whole milk were sold to local creameries.

The greater part of the beef cattle marketed are farm-raised native animals purchased locally. A few livestock farmers, however, buy feeders for winter fattening from the stockyards, mainly at Sioux City, St. Paul, and Omaha and a few from Kansas City. Feeders are grade Herefords, Shorthorns, and Aberdeen Angus, mostly the first two. About half the farms in the county report beef or dual-purpose cattle. The Hereford is the most popular breed for beef production, and Shorthorn and Aberdeen Angus rank next.

Poultry is raised on nearly all the farms, and the income from this source is important. The number of chickens reported on farms in 1930 was 378,657. In 1929, the chickens sold alive or dressed numbered 275,855, and 2,153,262 dozen eggs were produced.

The work animals on the farms in 1935 consisted of 10,588 horses and 298 mules. Percherons are the favored breed of horses. The number of colts raised is not sufficient to keep up the supply of work animals. More interest is being taken in raising colts, however, and the number raised has increased noticeably during the last few years.

Table 5 gives the value of selected crops and livestock and livestock products according to Federal census figures for the census years 1899 to 1929, inclusive.

TABLE 5.—*Value of selected crops and livestock and livestock products in Franklin County, Iowa, for the census years 1899 to 1929, inclusive*

Year	Cereals	Hay and forage	All domestic animals	Animals sold and slaughtered	Dairy products	Poultry and eggs
1899				$1,305,236	$189,537	[1] $84,137
1909	$2,586,241	$593,151		1,864,249	354,213	314,663
1919	6,272,833	1,789,198	$6,109,960		659,715	696,691
1929	4,073,966	805,675	5,401,661		982,083	1,082,695

[1] Value of chickens raised in 1899; value of eggs produced in that year not reported.

SOIL-SURVEY METHODS AND DEFINITIONS

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

The soils are examined systematically in many locations. Test pits are dug, borings are made, and exposures, such as those in road or railroad cuts, are studied. Each excavation exposes a series of distinct soil layers or horizons called, collectively, the soil profile. Each horizon of the soil, as well as the parent material beneath the soil, is studied in detail; and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The reaction of the soil [4] and its content of lime and salts are determined by simple tests. The drainage, both internal and external, and other external features, such as the relief or lay of the land, are taken into consideration, and the interrelation of soil and vegetation is studied.

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

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

Within a soil series are one or more soil types, defined according to the texture of the upper part of the soil. Thus the class name of the soil texture, such as sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam, and clay, is added to the series name to give the complete name of the soil type. For example, Webster silty clay loam and Webster loam are soil types within the Webster series. Except for the texture of the surface soil these soil types have approximately the same internal and external characteristics. The soil type is the principal unit of mapping and because of its specific character is usually the soil unit to which agronomic data are definitely related.

A phase of a soil type is a subgroup of soils within the type which differ in some minor soil characteristic that may, neverthe-

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

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less, have an important practical significance. Differences in relief, stoniness, and the degree of accelerated erosion are frequently shown as phases. Thus, for example, within the normal range of relief for a soil type, there may be portions which are adapted to the use of machinery and the growth of cultivated crops and other portions which are not. Even though there may be no important differences in the soil itself or in its capability for the growth of native vegetation throughout the range in relief, there may be important differences in respect to the growth of cultivated plants. In such an instance the more sloping portions of the soil type may be shown on the map as a sloping or hilly phase. Similarly, soils having differences in stoniness may be mapped as phases, even though these differences are not reflected in the character of the soil or in growth of native plants.

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

SOILS AND CROPS [5]

As Franklin County has nearly uniform conditions of temperature and precipitation throughout its area, the distribution of crops cannot be attributed to climatic conditions. The land, with the exception of relatively small patches of sloping land and poorly drained depressions, can be cultivated. Shipping and marketing facilities do not vary greatly in different parts of the county. Because these economic, climatic, and topographic conditions are rather uniform, the nature of the soil is the most important factor determining the distribution of crops. The kinds of crops grown and the yields obtained on any particular farm are due in a very large measure to the internal characteristics of the soil, modified in some places by its external features of relief and drainage.

A large proportion of the soils are productive for the crops commonly grown in this section. The most extensive types of soil do not differ very widely in general agricultural value but vary to some degree in their adaptability to the production of particular crops. A soil, by reason of its composition, surface features, drainage conditions, or other features, may be suited to the production of some particular crop, but its utilization for this purpose may require special treatment.

The dominant soils belong to types regarded as the most productive in the State. They occupy, for the most part, nearly level or gently rolling lands which are well suited for general farming. The soils of the Tama and the Carrington series in the eastern part and those of the Clarion and Webster series in the western part may be said to dominate the agriculture. These soils have in common dark-colored surface layers indicating a large supply of humus, mellow

[5] Franklin County adjoins three Iowa counties that have been previously surveyed. In places the soils as mapped in Franklin County do not have the same names as those mapped in adjoining counties; for example, the Buckner soils, as mapped in Wright and Hardin Counties, are now called the O'Neill soils. By a change in definition the Carrington soils in those counties are now combined with the Clarion soils of Franklin County.

surface soils, and adequate drainage conditions in both surface soil and subsoil. The soils of the Waukesha, Floyd, Fargo, and Bremer series and some of the Wabash soils are scarcely inferior in agricultural value to the soils just mentioned. These soils are also dark, but have a less favorable topographic position. The soils of the Dodgeville, Dickinson, and O'Neill series are dark colored but have thinner topsoils than those previously mentioned. The Clyde and Lamoure soils and peat and muck are in many places rather poorly drained. The light-colored soils are represented by the Fayette and Lindley series.

The types of soils in Franklin County may be used either for the production of cultivated crops or for grazing. The relative proportion devoted to each use depends mainly on the character of the soil and to a less degree on the necessities of individual farming.

The system of livestock farming which prevails widely is centered around the production of corn. In such a system corn can be utilized on the farm, and the productiveness of the land can be maintained by the use of manure and the growing of legumes in rotation. Although corn is grown to a greater or less extent on every soil in the county, the yields are not equally high on all soils. A soil especially suitable for corn must be well drained, supplied with available plant nutrients, high in humus, mellow and easily handled, and capable of holding a supply of moisture in reserve for the use of the crop in dry seasons, and the surface should be level so that farm machinery can be used in planting, cultivating, and harvesting. All the soils of the county, with the exception of the more rolling areas of the Fayette and the Lindley soils, peat and muck, and poorly drained areas and stream bottoms, meet the soil requirements for the production of corn. Corn is, therefore, the dominant crop and is grown as often as possible where soil conditions are favorable, frequently to the extent of seriously depleting the soil fertility. Oats rank second to corn in the list of cultivated crops. This crop fits into the rotation well and provides an important part of the feed of work animals and dairy cattle. Other small grains and hay are grown to supplement corn and oats as feed and to serve as members of a well-balanced crop rotation.

The soils of the county may be placed in two broad groups on the basis of natural drainage conditions—well-drained soils and soils having slow natural drainage. This grouping does not indicate relative productivity but does indicate that in the soils of the second group a condition of excessive moisture prevails temporarily or permanently and demands the attention of the farmer. Some of the best soils for corn are in this group, but other soils, such as peat and muck, are in this group by reason of composition, poor drainage conditions, and a low productivity rating. Well-drained soils may be subdivided on the basis of color, which depends on their content of humus, into dark-colored soils and light-colored soils.

In the following pages the soils are described in detail, and their agricultural importance is discussed; their distribution is shown on the accompanying soil map; and their acreage and proportionate extent are given in table 6.

TABLE 6.—*Acreage and proportionate extent of soils mapped in Franklin County, Iowa*

Soil type	Acres	Percent	Soil type	Acres	Percent
Clarion loam	85,760	23.2	Clyde silty clay loam	18,944	5.1
Clarion loam, rolling phase	26,048	7.0	Clyde silt loam	2,176	.6
Clarion sandy loam	3,584	1.0	Webster silty clay loam	64,960	17.5
Carrington loam	19,200	5.2	Webster loam	8,512	2.3
Carrington silt loam	14,592	3.9	Bremer silty clay loam	5,376	1.4
Carrington sandy loam	1,024	.3	Bremer loam	384	.1
Tama silt loam	48,064	13.0	Benoit silty clay loam	2,496	.7
Dickinson sandy loam	1,920	.5	Benoit loam	2,112	.6
Dickinson loamy fine sand	960	.3	Fargo silty clay loam	2,112	.6
Dickinson loam	2,432	.6	Floyd silt loam	4,416	1.2
Dodgeville silt loam	3,456	.9	Peat	2,240	.6
Waukesha silt loam	2,112	.6	Muck	1,472	.4
Waukesha loam	4,480	1.2	Wabash loam	6,144	1.7
O'Neill loam	13,760	3.7	Wabash silty clay loam	9,152	2.5
O'Neill sandy loam	1,024	.3	Wabash silt loam	1,792	.5
Lindley sandy loam	640	.2	Lamoure silty clay loam	3,712	1.0
Lindley loam	1,600	.4			
Lindley silt loam	768	.2	Total	369,920	
Fayette silt loam	2,496	.7			

WELL-DRAINED SOILS

The group of well-drained soils includes soils that have adequate drainage but are retentive of sufficient moisture for the use of crops in normal seasons. The water-holding capacity is mainly due to the favorable texture and structure of both surface soil and subsoil. The subsoils are not so heavy and impervious as to retard the removal of excessive moisture or so loose and coarse as to allow the rapid escape of soil water that later may be needed by the crops. Tama silt loam, which belongs to this group, has a dark-colored surface layer and has been developed over silty material known to geologists as loess. Fayette silt loam is also developed from loess but because of differences in native vegetation differs from the Tama soil especially in the lighter color of its surface layer. Four other series of soils have developed over glacial drift. The Carrington soils have dark-colored surface soils and fairly heavy subsoils and are leached of their lime to a depth of many feet. The Clarion soils are similar to the Carrington soils in many respects but have an abundance of lime at a depth of less than 3 feet. The Dickinson soils have dark-colored topsoils underlain by sand and are largely leached of their lime. Dodgeville silt loam is dark colored and is underlain at a slight depth by limestone. The Waukesha soils are developed over water-laid materials and occupy well-drained terraces. They have dark-colored surface layers and moderately heavy subsoils. The O'Neill soils occupy similar positions, but their dark-colored soils are underlain by sand or gravel.

DARK-COLORED SOILS

The dark-colored members of this group of well-drained soils do not differ widely in productivity. None of them is entirely unsuited for the systems of farming practiced in this section. The Dickinson and O'Neill soils, which are excessively drained by their sandy and gravelly substrata, and the Dodgeville soil, which is shallow over rock, have a lower average productivity than the other soils of this group. In favorable seasons this difference is not noticeable on the greater part of their areas, but in dry years yields are considerably lower than on soils having subsoils retentive of moisture. Soils of the Tama, Clarion, Carrington, and Waukesha series vary in agricultural value within very narrow limits. All are suited to corn and the other crops that are used in the systems of livestock raising and dairy farming common in this county.

Clarion loam.—Clarion loam, the most extensive soil in the county, occupies a large part of the uplands of the western half. It lies on low knolls, ridges, and gentle slopes of the better drained lands on the Wisconsin drift formation, which terminates at approximately a line drawn from 3 miles west of the center of the north county line southward to a point 3 miles east of the center of the south county line. It is thoroughly drained, both in surface soil and subsoil, differing in this respect from the flat and poorly drained depressed areas of Webster silty clay loam and Webster loam which adjoin it in many places.

The surface soil consists of very dark grayish-brown mellow loam to a depth ranging from 10 to 16 inches, depending on relief. Underlying the dark topsoil is heavy yellowish-brown loam, slightly darkened with the infiltration of organic matter from the topsoil, extending to a depth ranging from 18 to 22 inches. No lime is present in the surface and subsurface soils, and the lime requirement, as determined by the Truog method, ranges from 1 to 3 tons an acre. The subsoil is yellowish-brown silty clay loam which passes at a depth of about 30 inches into grayish-yellow friable gritty silty clay loam containing large streaks, splotches, and concretions of lime, with much free lime in finely divided form. Gravel, boulders, stone, rock fragments, and sand, intermixed with silt and clay, compose the subsoil and are scattered over the surface and through the upper subsoil layer. The coarser material usually comprises only a small part of the soil layers.

Local variations from the typical soil are widely scattered and numerous. Between the closely associated Webster and Clarion soils is a gradation belt where the soils are darker and deeper than typical Clarion loam and the subsoils are less highly oxidized. Small pockets of sand and gravel, which are too small to be shown on the soil map, occur on the sides or tops of gentle knolls. Gravel pits and surface gravel are indicated by the standard symbols. The surface soil overlying undisturbed gravel pockets is generally sandy loam or gravelly sandy loam. There is considerable textural variation in places, especially in the central-southwestern part of the county where the soils of certain areas contain a high percentage of sand and are texturally between a loam and sandy loam. Another variation is the depth to the limy subsoil, which in the normal undisturbed soil is about 30 inches. At the shoulders and tops of the hills where erosion has apparently been more rapid than leaching, the lime is nearer the surface. Accumulations of black loam at the bases of slopes increase the depth to lime.

Clarion loam is one of the best four soils in the county. Internal drainage and external drainage are excellent except on the lower slopes where the soil grades into the poorly drained Webster soils. This soil is excellent for general farming and does not clod or bake when plowed. It can be handled under a wide range of moisture conditions. Because of its better drainage it warms earlier in the spring and can be worked earlier than the Webster soils. It is retentive of moisture, and crops rarely suffer where the organic content of the soil has been kept up, except in extreme and prolonged droughts. Although regarded as less fertile than the Webster soils, as large yields can be obtained on it as on any other soil type in the county by systematic seeding down and plowing under of legumes and the regular use of barnyard manure.

This soil is practically all under cultivation. The principal crops are corn, oats, and hay. Some wheat, rye, barley, soybeans, and sugar beets are grown. Small acreages of sweet corn for commercial canning are around Hampton and Ackley. Occasionally a field is seeded down but not systematically in rotation except on a relatively small number of farms. Red clover will grow in many places without lime, but alfalfa requires liming of the soil to insure a good stand. Corn yields from 35 to 60 bushels an acre under normal seasonal conditions, and yields of 70 to 80 bushels are often reported on well-managed farms. The average yield is between 40 and 45 bushels. Oats yield 30 to 40 bushels an acre in normal years on most farms and 50 to 70 bushels on the better farms. Mixed hay yields 1 to 2 tons, red clover 1½ to 2½ tons, and alfalfa 2½ to 3½ tons an acre. Some sweetclover is cut for hay, but most of it is utilized for pasture and is plowed under the second year. Oats are the most common nurse crop for sweetclover and alfalfa.

Clarion loam, rolling phase.—The rolling phase of Clarion loam occupies the strongly rolling and hilly lands along the larger streams and on the prominent morainic hills widely scattered through the Wisconsin drift region which occupies the western half of the county. It occurs on groups or chains of hills rising well above the surrounding flat to gently rolling prairies. The most extensive development is in a broad, irregular, and more or less broken north-and-south belt lying 3 miles west of Chapin, 1½ miles west of Hampton, and 1½ miles west of Bradford and swinging westward in the southwestern part of the county toward Dows. This soil is closely associated with typical Clarion loam, differing from the latter in having a slightly lighter colored topsoil.

The surface soil of the rolling phase of Clarion loam is dark grayish-brown, or dark-brown loam. The maximum thickness is about 10 inches, but it ranges from 4 to 8 inches over a large part of the area. On the shoulders of many hills and on steeper slopes, the entire topsoil covering has been removed by erosion, exposing the yellowish-brown or pale-yellow subsoil. Underlying the darker surface soil is well-oxidized friable yellowish-brown silty clay loam, uniform in color and containing much silt. This layer is darkened in the upper part by infiltrations of organic matter, which follow root channels and earthworm or insect burrows.

Below 25 inches and extending to 48 inches is yellowish-brown silty clay loam slightly heavier than the upper subsoil and containing some bright reddish-brown and rust-brown iron streaks and concretions but very little coarse grit. The parent material directly under this layer is pale yellowish-brown friable silty clay loam containing much grit and gravel, many small stones, and here and there small boulders.

Numerous dark-brown iron stains and concretions one-fourth of an inch in diameter are present. Soft iron concretions 1 to 2 inches in diameter and short tongues and flecks of lime are present in the upper part of the lower subsoil layer. The concretions increase with depth, and much free lime is present at 4½ to 5 feet. Boulders, rock fragments, and coarse gravel are exposed on the surface in many places as a result of erosion. Many pockets of sand and gravel are found throughout this soil near the tops of the ridges, on knolls, or at the bases of the slopes. Sand, pebbles, and rock fragments are much more abundant at all depths than in typical Clarion loam. The surface soil in many places approaches a sandy loam. Because of their limited occurrence, small areas of sandy loam, mostly in the south-central part of the county, were combined with the rolling phase of Clarion loam. In many places the white limy parent material abruptly underlies the dark-colored virgin topsoils at a depth ranging from 6 to 9 inches. Sharp ridges and high knolls may have had the entire soil layer removed, exposing the whitish-yellow calcareous parent material. Such areas are most numerous in the chain of morainic hills lying from 2 to 5 miles northeast and north of Popejoy. These exposures, because of their small area, have been combined with this soil. Because of their small total acreage, a few small patches of Pierce loam are also combined with this soil. They have a dark-brown loam topsoil containing much sand. This is underlain by sandy loam or loamy sand to a depth ranging from 8 to 20 inches. Below this is a bed of gravel and sand, usually calcareous. These small areas, being low in organic matter and very droughty, are much less productive than the typical soil. Run-off is rapid on this soil because of the relief, although the substratum is very porous.

In normal years, crop yields are less on this soil than on typical Clarion loam. Corn produces 6 to 12 bushels less an acre, and oats produce 7 to 15 bushels less. In years of drought the maximum difference in yield occurs. This soil must be limed for the growing of legumes except where the calcareous deep subsoil is exposed. The normal soil has a 2- to 3-ton lime requirement an acre, according to the Truog test.

Clarion sandy loam.—Clarion sandy loam occurs in rather small bodies ranging from 10 to 80 acres in size. The largest areas are in the southwestern part of the county north of Popejoy and east of Dows. Other sizeable areas are northwest of Coulter and in section 4 of Marion Township.

The surface soil consists of moderately dark grayish-brown sandy loam to a depth of 12 inches. It is underlain by yellowish-brown heavy sandy loam containing considerable clay. At a depth ranging from 20 to 24 inches this changes to sandy clay loam or silty clay loam containing considerable grit, pebbles, and rock fragments and some iron stains. The coarser materials in the subsoil increase with depth.

This soil is variable in texture, ranging from loam to loamy sand, but it is predominately sandy loam. In some areas considerable gravel is scattered over the surface, and small spots of gravelly loam have been included with this type. These variations are not indicated on the soil map, as the changes in texture are irregular and the areas small. Pockets of sand and gravel are numerous throughout the type.

This soil warms early in the spring and is easy to cultivate. Yields are good in wet seasons, but in periods of prolonged drought crops suffer considerable damage because of the porosity of the upper soil layers. The soil is planted mostly to the staple crops, which produce on the average about one-third less than on Clarion loam.

With the systematic incorporation of green manure, which is essential, and the use of good farming methods, this soil will produce yields in normal seasons comparable to those on Clarion loam, rolling phase. Legumes will not do well on this soil unless it is limed.

This soil occupies gently rolling to rolling relief. Erosion has not seriously lowered the value of this land, but the soil is susceptible to gullying, and on slopes of 5 to 10 percent, gullies will develop rapidly if once allowed to start.

Carrington loam.—The topsoil of Carrington loam is dark grayish-brown friable loam about 14 inches thick. It differs from the topsoil of Clarion loam in being, on the average, a shade lighter in color and usually more acid. The subsoil is yellowish-brown silty clay loam, becoming slightly heavier with depth. Many brown iron stains and concretions are present below a depth of 3 feet. Some small gravel, stone fragments, small boulders, and numerous sand and gravel pockets are of local occurrence.

Carrington loam has developed on the Iowan drift which was deposited over the eastern part of the county. The greater part of the Iowan drift in this county, or perhaps all of it, was covered by a mantle of loess. The Carrington soils have developed where the Iowan drift was either never covered by loess or the thin loess covering has been removed by natural erosion.

In the northeastern part, north of West Fork Cedar River, areas of Carrington loam occupy interstream divides. In the loessial region the type is developed along stream valleys where the thin loess covering has been removed by erosion. Along the boundary between the Iowan and Wisconsin drifts, which is also the approximate boundary between the Tama and the Clarion soils, large areas of Carrington loam have been developed. The boundaries between the Carrington and the Clarion soils here depend on the age of the parent drift as indicated by the extent of leaching and in places are drawn arbitrarily. The largest area of Carrington loam is in this transitional belt in the southeastern part of the county northwest of Ackley.

The differences between Carrington loam and Clarion loam are due to the relative ages of the two parent drifts. The older Iowan drift has been leached to a depth of more than 5 feet, and the Carrington soils developed from it are lacking in the large amounts of lime which characterize the Clarion soils. The surface soil of Carrington loam usually shows a lime requirement of 3 to 4 tons an acre. The soil material becomes less acid with depth.

Several variations from the typical soil were too small to be separated from it on the soil map. Eight miles north of Hansell are several small areas where limestone is within 28 or 30 inches of the surface. Here the lower subsoil layer directly over the limestone is developed from residual material, highly mottled red and brown silty clay or clay. Included with this type also are small areas having a sandy subsoil, similar to the Dickinson subsoils. In the extreme southeastern corner of the county along Beaver Creek small areas included with Carrington loam lie on slopes adjacent to the stream bottoms. They are mostly forested and too steep for cultivation.

Carrington loam and Clarion loam are adapted to the same crops, but Carrington loam, especially the more sandy and rolling parts, produces slightly less per acre. Practically all of this soil is in cultivation, and all staple crops of the region are grown. Lime must be applied for the growing of legumes, particularly alfalfa.

Carrington silt loam.—Carrington silt loam is widely scattered over the eastern half of the county, particularly along the edge of the loess-drift boundary and on slopes toward the streams and drainageways which intersect the loess-covered uplands. A large isolated area is in the extreme northeastern corner, covering the greater part of four sections.

The surface soil of Carrington silt loam is dark grayish-brown silt loam to a depth of 14 inches, passing into dark-brown or brown heavy but friable loam containing a high percentage of silt. At a depth ranging from 18 to 24 inches this grades into yellowish-brown gritty silty clay loam. Sand, gravel, stone fragments, and a few small boulders are in the lower subsoil layer. The lower soil layers are derived entirely from glacial drift, but the surface soil has an admixture of loessial material. The thickness of the silty loessial mantle over the drift differs in different parts of the county; it averages about 15 inches but in many places is 24 inches.

Included with this soil are areas of loam or sandy loam, usually occurring on the tops of knolls or gentle ridges, too small to be mapped separately. There is considerable variation in soil texture over much of the area. The soil contains various proportions of silt and sand, but it is predominantly smooth friable silt loam. Variations in texture are especially common in the extreme northeastern corner of the county.

Almost all of this soil is in cultivation. The crops grown and the proportion of land devoted to each crop are about the same as those on Carrington loam. Yields average slightly higher. Most of the slopes are long and gentle, permitting good drainage. The surface soil is strongly acid and the lime requirement according to the Truog test is 3 to 4 tons an acre. Liming is absolutely essential to insure a good growth of legumes.

Carrington sandy loam.—Carrington sandy loam occupies a few small areas in the northeastern corner of the county, north of West Fork Cedar River. The surface is undulating to rolling.

The surface soil of Carrington sandy loam is dark-brown sandy loam to a depth of 10 inches. This is underlain by yellowish-brown sandy loam containing considerable clay. It is sticky when wet but loose and friable when dry. Beginning at a depth ranging from 20 to 30 inches the lower subsoil layer consists of yellowish-brown silty clay loam or sandy clay loam, containing some gravel and rock fragments. Several small areas lying south of School No. 2 in West Fork Township, 6½ miles east of Sheffield, are fine sandy loam and have considerable silt in the topsoil. Small pockets of sand, 3 or more feet in depth, occur in some places in the soil.

The greater part of this soil is cultivated, the principal crops being corn, small grains, and hay. It is similar in crop-producing power to Clarion sandy loam. It is well drained, because of its sandy character, and does not retain sufficient moisture for crops during dry seasons.

Tama silt loam.—Tama silt loam occupies a large part of the eastern half of the county.

The surface soil is dark grayish-brown friable silt loam to a depth ranging from 10 to 15 inches. This passes into yellowish-brown friable silty clay loam heavily stained with organic-matter coloring. This transitional, or upper subsoil layer, is from 4 to 6 inches thick and passes at a depth of about 18 or 20 inches into yellowish-brown silty clay loam, uniform in color, somewhat friable, and free from grit. Below a depth ranging from 30 to 60 inches, or at an average depth of 42 inches, this grit-free subsoil is underlain by yellowish-brown gritty silty clay loam containing gravel, small rock fragments, and a few small boulders.

The parent material of Tama silt loam is a loessial material 30 to 70 inches thick overlying Iowan glacial drift. This loessial blanket extends almost to the boundary line between the Iowan and the Wisconsin drifts but nowhere covers the Wisconsin glacial drift, as the Wisconsin glacier invaded north-central Iowa after the Iowan glaciation and its overlying loess had been deposited. The relief of Tama silt loam is for the most part undulating to gently rolling. The land is thoroughly drained in both surface soil and subsoil. Where Tama silt loam areas approach streams and the slopes are sharp, the loessial covering is thin, ranging from a few inches to 2 feet, the underlying drift being exposed in places. The surface soil in these areas is shallow, ranging from 4 to 8 inches in thickness, and is slightly lighter in color than the typical topsoil.

The distinction between Carrington silt loam, which is developed from glacial drift on a thin loessial silty deposit over the drift, and Tama silt loam is based arbitrarily on the thickness of the loessial mantle. Where the loess covering is more than 24 inches thick the soil developed over it has been mapped as Tama silt loam.

Practically all the area of Tama silt loam is under cultivation, except that used for farm buildings, lots, and roads. The soil is highly productive and is easily tilled because of its friable texture and structure and the absence of stones, grit, or boulders. The moisture-holding capacity of this soil is excellent, and total crop failures have never occurred.

Corn is the most extensive and important crop on this soil. The average yield over a period of years is between 40 and 45 bushels an acre. In favorable years the better farmers obtain from 60 to 75 bushels an acre. Yields of 25 to 35 bushels are obtained on farms that have been heavily cropped or where erosion is active, and no adequate effort has been made to protect the soil or to maintain its productiveness. The lowest yields are due to occasional local hailstorms and hot dry winds, but these are of rare occurrence. The next most important crop is oats, averaging about 40 bushels an acre. If hot winds occur just when the oats are maturing, the yield is greatly reduced. In favorable seasons 45- to 65-bushel yields are not uncommon. The total hay crops occupy almost as much of the farm acreage as do oats. Timothy and clover lead in hay acreage, although clover alone is increasing. Lime must be applied at the rate of 2 to 2½ tons an acre to insure best results with clover or alfalfa. Most of the alfalfa is grown in small fields ranging from 2 to 10 acres in size. Small grains, principally oats, are used as nurse crops for alfalfa and clover.

Sweet corn is grown on a small acreage, the extent of which is largely regulated by the demands of corn-canning plants at Hampton and Ackley. Soybeans are increasing in popularity for hay and seed. Minor crops are barley, rye, wheat, and millet. The size of orchards ranges from a dozen trees to those occupying 2 acres on the individual farm. Plums, cherries, pears, and apples are the principal tree fruits, apples comprising about 80 percent of the total. Truck crops and small fruits are grown for home use and to supply local markets.

The principal need of this soil is more organic matter to build up and hold fertility at a normal point, as the lack of good crop rotation and systematic seeding down of fields has lowered the level of the available plant nutrients more than is generally realized. The turning under of clover and green-manure crops should be practiced more extensively. Barnyard manure is used as a top dressing for clover and timothy and on cornland but is not available in adequate quantities to maintain fertility. Only a small amount of commercial fertilizer is used, most of which is applied to beets and sweet corn. The use of phosphates and lime has proved profitable on this soil.

On two areas, one 2½ miles north of Geneva, the other 1½ miles southwest of Chapin, the soil profile is somewhat different from that of typical Tama silt loam. Here the surface soil, which is only very slightly acid compared to the normally strongly acid topsoil of typical Tama silt loam, is dark grayish-brown silt loam to a depth of 10 or 12 inches, underlain to a depth of about 18 inches by yellowish-brown friable but heavy silt loam or silty clay loam which is darkened by organic-matter infiltration extending through this layer in threadlike and fingerlike projections. Little or no lime is present to this depth. The subsoil is pale yellowish-brown silt loam or silty clay loam containing numerous lime nodules one-sixteenth to one-fourth of an inch in diameter and some fine lime flour in the lower part. At a depth ranging from 40 to 50 inches the lower subsoil layer is pale-yellow silt loam highly impregnated with white lime carbonate and small lime nodules, the lime carbonate comprising from 15 to 20 percent of the soil material. This layer is underlain at a depth ranging from 60 to 70 inches by pale-yellow or grayish-yellow silt loam, uniform in color but containing a very high percentage of very fine lime carbonate. This variation of Tama silt loam occupies prominent lenticular morainic hills extending in a northwest-southeast direction, which have been termed paha ridges by geologists.

In similar topographic positions this soil and typical Tama silt loam produce similar yields of corn and small grains. The high lime content of this soil increases the possibilities of success with alfalfa and clover.

Dickinson sandy loam.—Dickinson sandy loam is moderately dark grayish-brown or dark-brown sandy loam to a depth of 10 inches, where it gradually becomes lighter in color, and at a depth ranging from 12 to 15 inches changes to yellowish-brown fine sandy loam or loamy sand. Below a depth of 22 or 24 inches the subsoil is light-yellow sand, uniform in color and texture and, in contrast to most glacial subsoils in this soil region, contains no pebbles, rock fragments, or boulders. At a depth ranging from 6 to 8 feet the sand is underlain by sandy clay loam. In places sandy loam having a sandy clay subsoil at a depth ranging from 30 to 40 inches is included with Dickinson sandy loam. Small patches of gravel, with a surface layer of gravelly sandy loam, are in some of these areas.

The largest developments of this soil are on a series of intermittent ridges, which rise prominently above the surrounding plain, in the northeastern corner of the county north of West Fork Cedar River. In many places in these areas the uniform yellow sandy subsoils are from 7 to 10 feet thick. A number of small areas are scattered throughout the western half. The soil is developed over sandy glacial drift or glacial outwash material and is closely associated with Clarion loam and Carrington loam. The boundaries between it and these two soils are somewhat arbitrary, as the change in texture is gradual.

The loose sandy character of the soil at all depths gives good to excessive drainage. In dry seasons it is affected adversely by drought. During periods of high winds, which usually occur in the spring, crops may be damaged by wind-blown sand, cutting and covering the small tender plants. Wind damage is particularly heavy on the loamy sand areas.

Corn, oats, and some timothy and clover are grown. Average yields are materially less than on Carrington and Clarion loams. This soil is particularly adapted to melons and to truck crops. In normal or wet seasons fair crops of corn and small grains are grown.

The topsoil to a depth of 20 or 24 inches is very acid, but the acidity decreases with depth. The surface soil has a 3- to 4-ton lime requirement an acre. The subsoil at a depth ranging from 4 to 5 feet was found to be neutral to calcareous in several tests.

The greatest need of this soil type is organic matter to increase productiveness and moisture-holding capacity.

Dickinson loamy fine sand.—The surface soil of Dickinson loamy fine sand, to an average depth of 12 inches, consists of dark grayish-brown loose loamy fine sand. Below this, to a depth of about 27 inches, the sand is of similar texture, but the color is brown or moderately dark grayish brown. In some areas of this soil the material from the surface downward consists of well-assorted sand which is almost free from glacial pebbles. In other areas pebbles and a few boulders are embedded in the soil at all depths. The soil material is low in lime, and the surface layer in many places is strongly acid. Below a depth of 5 or 6 feet, the sandy layers of this soil may be underlain by heavy sandy clay till in which large quantities of gravel and small boulders are embedded.

The principal areas are in the northeastern part of the county, usually on low rounded hills and on slopes adjacent to stream valleys. The soil is developed for the most part from sandy glacial drift, but in some of the areas the sand content of the soil has probably been augmented by sand blown from the stream beds. In nearly all areas the surface sand has been shifted to some extent by the wind.

Dickinson loamy fine sand is a little less retentive of moisture and, therefore, is less productive than Dickinson sandy loam. Because of its droughtiness and lack of organic matter, the soil presents more problems than do most of the other soils of the county. On uncultivated areas the grass cover is less dense than on most other soils, and drifting and washing of the surface soil may take place. It is difficult to obtain a stand of pasture grasses. Alfalfa and clover are not readily established unless lime and manure are applied. Most of this soil, together with other heavier soils, is cropped to the staple grain and hay crops, and a small acreage is used for pasture. Redtop is the pasture grass best suited to this soil.

Dickinson loam.—Dickinson loam is widely scattered over the county in relatively small bodies on knolls, ridges, and moundlike areas mostly in Carrington loam and Clarion loam areas. A few small areas along Maynes Creek in the central-eastern part are on uplands near the stream bottoms.

The surface soil of Dickinson loam is dark grayish-brown friable loam, similar to that of Carrington loam. The subsurface layer below 12 or 14 inches is brown silty clay loam or sandy clay loam darkened by organic infiltrations. This layer reaches a depth of 18 or 20 inches, and below it lies a yellowish-brown sandy clay loam or yellowish-brown uniform fine sand. The lower subsoil layer, below a depth ranging from 26 to 34 inches, is pale-yellow fine sand. Some colloidal clay is incorporated in the upper part of the fine sand portion of the subsoil. A clay subsoil is reached within 3 feet only along the edge of the area or in transitional areas where the soil joins Carrington loam.

This soil is cropped and farmed in conjunction with the surrounding soils, which it resembles on the surface. In seasons of abundant rainfall corn yields are only slightly less than those on adjoining Clarion and Carrington loams. Yields are cut materially when drought is of long duration. Oats, barley, and other small grains, especially the earlier varieties, give good yields under normal conditions.

Organic matter is needed on most of these areas to increase and maintain fertility. The topsoil is acid, having a 1½- to 3-ton lime requirement, but the lower part of the subsoil, below 30 inches, is less acid and in some places is neutral.

Dodgeville silt loam.—Dodgeville silt loam lies principally on slopes along streams where the soil cover is not more than 3 feet thick over limestone. The soil material is largely of glacial origin, but a thin weathered layer lies directly on the underlying rock. Dodgeville silt loam occurs principally along Maynes and Otter Creeks, along West Fork Cedar River, and along some short tributaries of Bailey Creek south of Sheffield.

The surface soil is dark grayish-brown friable loam to a depth ranging from 8 to 15 inches. This is underlain by yellowish-brown friable silty clay loam or clay loam containing considerable sand, fine gravel, and small rock fragments. The upper soil material is largely Iowan drift. A yellowish-brown residual silty clay layer from 4 to 6 inches thick covers the limestone bedrock, which usually occurs within 30 inches below the surface.

Included with this type is a shallow silt loam soil developed from loessial material. It is similar to Tama silt loam and in a few places is like Carrington silt loam but has limestone rock from 2½ to 4 feet below the surface. The topsoil is dark grayish-brown friable silt loam underlain by a yellowish-brown silty clay loam subsoil commonly of loessial material but in places resting upon yellowish-brown gritty clay loam, 12 to 24 inches thick, of Iowan drift material. The entire soil profile lies over limestone or, in places, over a clayey shale at a depth ranging from 3 to 4 feet. This variation of Dodgeville silt loam is 1 mile south of Sheffield, 1½ miles northeast of Chapin, and on slopes below the areas of deeper Tama silt loam on the uplands which extend to the outer edge of the valley floor.

Some areas, particularly along Maynes Creek, occupy steep slopes on which the limestone outcrops and which are not suitable for cultivation. Probably 50 percent of this steep land is in crops, and the remainder is mostly in pasture. Trees and brush have recently encroached on a few of the steeper areas along stream banks.

About two-thirds of Dodgeville silt loam is in cultivation, and most of the rest is in pasture. The typical soil and the variations developed on loessial material are comparable to Carrington loam and to Tama silt loam in productiveness. On the shallower areas where the limestone comes within 1½ or 2 feet of the surface, crops suffer in dry seasons.

Waukesha silt loam.—Waukesha silt loam lies on terraces almost entirely in the eastern half of the county along Maynes Creek, West Fork Cedar River, and other streams. In most places it occupies narrow strips at the bases of upland slopes and from 10 to 30 feet above the bottom lands. The natural drainage is good.

The surface soil is dark grayish-brown friable silt loam to a depth of 12 or 14 inches. This is underlain by brown or light-brown silty clay loam. Dark streaks, due to organic-matter infiltration, are noticeable in the upper part of this layer. At a depth ranging from 18 to 22 inches is yellowish-brown silty clay loam containing a small amount of coarse and fine sand and a few pebbles. The subsoil is uniform in color and is noncalcareous.

Variations occur in a few places. Some areas of loam or very fine sandy loam too small to be shown separately were mapped with this type, and a few small depressions in which the surface soil is light silty clay loam were included. These heavier textured areas have a faint gray mottling in the yellowish-brown subsoil layer. In places a sand or gravel subsoil lies from 4 to 7 feet below the surface. The soil is well drained because of the perviousness of the subsoil, but it is retentive of moisture and is not affected by ordinary droughts. Total crop failures seldom, if ever, occur on this soil.

Crop yields and general farming methods are the same as on Tama silt loam of the uplands, and the land has about the same value. Corn and oats are the principal crops. Clover, timothy, and barley are also grown.

Waukesha silt loam is naturally fertile, of excellent physical structure, and easily farmed. The surface soil is moderately to extremely acid, and lime is essential for the growing of alfalfa and legumes.

Waukesha loam.—Waukesha loam is widely developed in disconnected small irregular-shaped areas along all the larger streams and many of their tributaries over the entire county. It occupies flat benches from 10 to 40 feet above the first-bottom or overflow land.

The topsoil is dark grayish-brown friable loam to a depth of 12 inches and contains a high percentage of fine and medium sand. This is underlain by yellowish-brown silty clay loam containing a small proportion of sand and gravel. The subsoil is uniform in color but varies in the small amount of sand, pebbles, and rock fragments present.

Surface texture varies somewhat in places, because of differences in sand content. Areas of fine sandy loam or sandy loam and loose sand, too small to be shown separately on the soil map, are included with this type. A gravelly clay loam or sandy clay loam underlies this soil along the small streams in the western part of the county. Sand and gravel form the base of the Iowan drift but are from 4 to 6 feet below the surface and do not produce a droughty condition except in droughts of long duration.

The surface soil and subsoil vary greatly in the degree of acidity. The surface soil in the Iowan drift region has a 3- to 6-ton lime requirement, but in the western part covered by the Wisconsin drift the range is from 1½ to 2 tons. The subsoil is much less acid or may be nearly neutral in the western part of the county.

Waukesha loam is well drained, friable, and easy to handle. It can be worked within a few hours after a rain with no danger of clodding. This soil is not quite so good agriculturally as Waukesha silt loam and produces slightly lower average crop yields.

Practically all this soil is in cultivation to the common crops. Corn is the dominant crop. The plowing under of legumes, in a systematic rotation of crops, increases yields from 10 to 40 percent. Applications of barnyard manure and limestone for growing legumes are necessary, especially on the sandier areas of this soil.

O'Neill loam.—O'Neill loam is the most extensive soil developed on terraces in the county and occurs along all the principal streams and their larger tributaries. The largest areas are along West Fork Cedar River, Hartgrave Creek, Maynes Creek, and Beaver Creek in the eastern half, and along the north side of Iowa River in the southwestern part, extending northward along the western county line to Dows, where the river channel again enters the county forming an irregular semicircle 2 miles across from north to south. It occupies flat terraces from 5 to 40 feet above the first-bottom lands.

O'Neill loam has a dark grayish-brown friable loam topsoil to a depth of 10 inches. The upper subsoil layer, which is 6 or 8 inches thick, is brown or yellowish-brown silty clay loam or sandy clay loam modified and darkened by organic-matter infiltrations brought down from the topsoil. The lower subsoil layer is yellowish-brown or yellow sandy loam or sandy clay loam, which overlies beds of stratified yellow sand or gravel from 24 to 36 inches below the surface.

This soil type varies considerably in texture. The topsoil ranges from heavy loam to almost sandy loam; the subsoil, from sandy loam to silty clay loam, containing various amounts of sand and clay. A few small areas of loam, identical with O'Neill loam, except for a calcareous substratum, have been combined with O'Neill loam because of their limited extent. These are along the smaller streams in Richland and Marion Townships in the central-northern part of the county.

A silty variation of O'Neill loam is developed on level benches from 30 to 40 feet above the flood plains along Hartgrave and Maynes Creeks and in small areas along the major streams. The best developed areas are 2 miles south of Hansell in the central-eastern part of the county. The topsoil to a depth of 12 or 14 inches is dark grayish-brown or dark-brown friable silt loam containing some very fine sand. The upper subsoil layer is yellowish-brown silty clay loam or sandy clay loam, the sand increasing with depth. At a depth ranging from 24 to 30 inches, this is underlain by yellow medium to coarse sand containing some coarse gravel in places. Although the lower layers are very open and porous in structure this soil will withstand drought much better than the sandier O'Neill soils and in normal seasons will produce almost as well as Waukesha loam. In dry seasons the sandy subsoil causes "firing" and reduces production materially.

Because of the openness of the substratum, the drainage is good to excessive. In places where gravel beds lie near the surface, crops are seriously affected by drought. Crops do fairly well on this soil in seasons of heavy rainfall. On the lower benches, where the water table is highest, crops produce the highest yields.

Almost all this land is under cultivation, only a small percentage being used for pasture. Corn yields from 24 to 40 bushels an acre in normal seasons, and oats 30 to 35 bushels. Hay produces 1 to 1½ tons an acre. In seasons of drought, heavy damage results unless systematic crop rotation has been practiced and the organic-matter content has been maintained. Additional organic matter is the greatest need of this soil. Legumes should be grown in rotation and plowed under. Lime should be applied at the rate of 2 or 2½ tons an acre on most of the land to insure the best results with legumes. Clover and timothy do well, but clover alone must be limed to produce good results over most of this soil. Clover is subject to winter-killing where no lime or manure is used.

O'Neill sandy loam.—O'Neill sandy loam occupies small areas on terraces, principally along West Fork Cedar River, Iowa River, and Hartgrave Creek. A few small areas are along their short tributary streams.

O'Neill sandy loam has a dark-brown sandy loam topsoil, 8 or 10 inches thick. This is underlain by looser brown or yellowish-brown sandy loam or loamy sand, which continues to a depth of 14 or 16 inches. The subsoil is yellowish-brown or yellow loamy sand or sand. At a depth ranging from 24 to 30 inches the soil rests on layers of stratified gravel or coarse yellow sand.

The surface soil in places is loamy sand. A few small scattered areas, two on the south side of Iowa River in the extreme southwestern corner of the county and one 3 miles southeast of Dows, are fine sandy loam.

The soil is excessively drained, because of the loose open character of the surface soil and subsoil, and crops are subject to severe damage by drought. Corn yields range from 20 to 30 bushels an acre in normal seasons. Small grains are better adapted than corn, as they mature earlier and have a better chance to escape injury in dry seasons. They yield about the same as on O'Neill loam except when dry periods occur shortly before the grain is ripe.

LIGHT-COLORED SOILS

The light-colored soils differ so widely in their appearance and agricultural relationships from the prevailing black Prairie soils of the county that they form a distinct group. Their essential feature is the light-brown or grayish-brown surface soil lacking in the store of organic matter that characterizes the other soils. These soils occupy gently to sharply rolling slopes along streams where trees, rather than grass, dominated the native vegetation, and it is largely to this fact that they owe their unique characteristics. Organic matter could not be accumulated in the soil under forests, and the soil did not develop a dark color. Because of the relief, natural run-off and erosion have been more active than on the Prairie soils.

Two series of soils have developed in these positions, and their differences are due largely to the character of the parent materials. The Lindley soils are developed over glacial drift, and Fayette silt loam is developed over loess. On account of the less favorable relief, or lay of the land, these soils are not so generally cultivated as are the black Prairie soils, but the smooth parts are used to some extent for the usual crops of the section. They do not give such high crop yields as do the black soils, but they are fairly productive. The more rolling and broken areas are used only for pasture.

Lindley sandy loam.—Lindley sandy loam is an upland soil developed on rolling land and under forest vegetation. The largest areas are 5 miles northeast of Hansell along West Fork Cedar River near its exit from the county and along Maynes Creek northeast and northwest of Geneva. Smaller areas are scattered along the banks of the principal streams throughout the county.

The surface soil is grayish-brown friable sandy loam to a depth of 8 or 10 inches. It is underlain by yellowish-brown sandy clay loam or silty clay loam. Below a depth of 15 to 18 inches the lower subsoil layer is brighter yellowish-brown silty clay loam containing considerable sand and some small gravel. In some small areas the subsoil is sticky clayey sand. The texture of the surface soil is somewhat variable, ranging from fine sandy loam to loamy sand. In several areas south of Maynes Creek, about 2½ miles northeast of Geneva, the surface soil is fine sandy loam containing a high proportion of silt. The subsoil is similar to that under the typical sandy loam, with slightly more clay.

Lindley sandy loam is mostly under cultivation, but a part of several areas is still covered with scattered native hardwood trees and hazel brush. The original tree growth was mostly of oak, elm, and hickory.

Corn and small grains are the principal crops. The usual acre yield of corn in normal seasons ranges from 20 to 30 bushels. Oats produce from 18 to 35 bushels, and timothy and clover 1 to 1½ tons of hay an acre. Small grains and hay crops are best suited to this soil.

This soil, though well drained because of the open nature of the surface soil, is erosive. Gullies have started in various places. The planting of trees, such as black locust, in gullies will tend to check the cutting, and eventually the gully bank can be stabilized with the aid of bluegrass. The surface soil is slightly to moderately

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acid, having a 1- to 3-ton lime requirement an acre, but the subsoil is only slightly acid or neutral. Red clover will sometimes grow well on this soil without liming, but lime is needed for best results. Timothy and clover do well.

Organic matter is the greatest need of this soil. The plowing under of green-manure crops greatly increases crop yields. Surface shifting of the soil by strong winds in the spring will be largely prevented by the incorporation of adequate amounts of organic matter.

Lindley loam.—Lindley loam is a formerly forested upland soil occupying small areas. The largest area is north of Bradford in Reeve Township. Smaller areas are along Buffalo, Beaverdam, and Maynes Creeks and along West Fork Cedar River.

The surface soil, to a depth of 2 or 3 inches in uncultivated areas, has a dark grayish-brown color due to organic matter. In cultivated areas the topsoil is uniform grayish-brown friable loam. At a depth ranging from 10 to 12 inches the surface layer changes into grayish-brown or yellowish-brown friable silty clay loam which is sticky when wet. The subsoil below 15 or 18 inches is yellowish-brown clay loam containing considerable sand and some gravel and rock fragments. Iron stains and rust-brown iron nodules occur at a depth of 24 inches and become more numerous with depth. The lower subsoil layer, below a depth ranging from 30 to 36 inches, is yellowish-brown silty clay mottled with gray. It contains much grit and coarse material.

In places the surface soil contains a high percentage of silt, and small areas have some fine gravel scattered over the surface.

The land occupies both the more rolling uplands and the moderate or sharp stream slopes. More than 70 percent is in cultivation, and the rest is in trees or pasture. The soil is fairly retentive of moisture, but on slopes it drains rapidly, and crops on it are affected adversely by prolonged drought. The soils erode on the slopes when gullies are once started, but the greater part of the surface soil is protected by vegetation and is not eroded.

All the common farm crops of the section are grown on this soil, but corn, oats, and timothy and clover are the principal crops. Yields range from moderate to poor. Some watermelons, vegetables, and truck crops are grown and do well. The soil is acid, requiring from 1 to 3 tons of lime to neutralize the acidity. Lime is essential for obtaining the best stands of legumes. The content of organic matter is low and should be increased by plowing under green-manure crops. Timothy and clover do well without lime or fertilizer. Little commercial fertilizer is used on this soil. Phosphates, together with nitrogen in the form of green manure, will often increase yields from 20 to 40 percent.

Lindley silt loam.—Lindley silt loam occupies uplands with a generally gently rolling surface and includes rough or broken strips along steep stream banks. It lies in small isolated areas widely scattered along the principal streams in the eastern half of the county. The largest areas lie 1 and 2¼ miles north of Hampton. Others are 2 and 3½ miles northwest of Sheffield, 3 miles southwest of Chapin, and 2 miles northwest of Ackley.

The surface soil is grayish-brown uniformly fine textured floury silt loam to a depth of 10 inches. Underlying this is yellowish-brown silty clay loam containing much fine sand which becomes brighter and grades into tenacious yellowish-brown silty clay at a depth of 18 or 20 inches. The lower subsoil layer, below a depth of 30 or more inches, is light yellowish-brown gritty clay, heavy and tenacious, containing many iron stains and a larger proportion of sand, gravel, and rock fragments.

The usual textural variations occur, including small areas of loam and fine sandy loam, in spots too small to be shown separately on the soil map.

This soil is developed under a forest cover. The steeper slopes are covered with thin stands of trees, principally oaks, and with scattered hazel brush. Probably 50 percent of the timber has been cut, and most of the cleared land is in cultivation. A small part of the total area is in bluegrass pasture. Drainage is adequate to excessive on the steeper slopes.

The common field crops are grown. The better part of this soil produces from 10 to 15 bushels less corn an acre than the better dark-colored upland soils. Tree and small fruits do especially well. Clover will do well ordinarily without liming. The topsoil is only slightly acid and has a lime requirement of only one-half ton an acre.

This soil is handled and farmed in the same manner as the surrounding darker colored soils. The topsoil is mellow and is easily plowed and cultivated. On a few flat divides the heavy subsoil causes the drainage to be restricted. The soil erodes severely on the sharper slopes because of the slow percolation and the heavy subsoil.

Organic matter is the chief requirement for the improvement of this soil. Clover should be grown systematically in the rotation and plowed under. The steeper slopes, because of their erosivity, should be kept in permanent pasture.

Fayette silt loam.—Fayette silt loam has developed from loessial material on rolling to hilly upland under forest cover. It occupies high ridges and hills adjacent to the larger streams or near the heads of their smaller tributaries. It is restricted to the northeastern quarter of the county. The largest continuous area lies 4 miles northeast of Hansell along West Fork Cedar River.

The surface soil to a depth of 15 inches is grayish-brown friable silt loam containing a small percentage of very fine sand. Underlying this and continuing to a depth ranging from 24 to 28 inches is yellowish-brown friable silty clay loam. Below this the lower subsoil layer is paler yellow silty clay loam or very fine sandy loam, containing much very fine sand. Faint gray mottlings and a few small iron concretions are present in the lower part of this layer. In places below a depth of 3½ or 4 feet this soil is underlain by very fine sandy loam.

Because of their small total area, several bodies of Fayette very fine sandy loam have been included with this soil. These sandy areas lie 3½ miles east of Hampton, 2½ miles north of Hansell, 2 miles northeast of Chapin, and 2 miles southwest of Chapin. The surface texture of the typical silt loam is variable but everywhere contains a small percentage of very fine sand. In the siltier textured areas many small spots are very fine sandy loam.

Fayette silt loam is extremely erosive, and gullies have cut deeply into the slopes in many places where the land has been poorly managed. The loose porous nature of the surface soil and subsoil permits rapid percolation and good drainage, but the soil is easily moved, and erosion when once started proceeds rapidly.

Most of this soil is farmed. About 15 percent is in pasture and trees. Corn is the principal crop. Yields of all crops are from 5 to 15 bushels less an acre on this soil than on Tama silt loam, with which it is most closely associated. Fine stands of clover can be had over most of this type. The soil is very slightly acid to neutral at the surface, neutral in the upper subsoil layer, and in places slightly calcareous below a depth ranging from 24 to 36 inches. Some fruit trees, mainly apples, are grown and yield well. The orchard land is in the large area 4 miles northeast of Hansell.

This soil is low in organic matter, as is evident from the color of the topsoil. Green-manure crops should be plowed under in systematic rotation. Corn should never be grown more than 1 year on this type of soil. Where a 3-year rotation is used with clover—as corn, small grain, and clover—the soil can be built up and maintained at a high productivity equaling that of the adjacent dark upland soils. Clover grows well without liming and should be used more. Rye and wheat should do well on this soil. Truck crops, tree fruits, and bush fruits are also well adapted.

SOILS HAVING SLOW NATURAL DRAINAGE

The group of soils having slow natural drainage includes soils which, as a result of a flat surface or on account of low topographic position and lack of natural drainage outlets, are not completely drained during a part of the year and soils in which the water table is permanently near the surface.

When this section was first occupied by farmers the land comprising these soils was poorly drained, and a large part of it was covered by standing water during a part of the year. Artificial drainage by means of ditches and tiling now removes the surface water so efficiently that crops can be grown on most of this land without damage except on the comparatively flat low areas in unusually wet seasons. Some of the stream bottoms are for the most part still undrained, but a large proportion of these soils may be converted into valuable farming land by proper drainage. The common characteristics of these soils, distinguishing them from other soils of the county, are those which develop when soils have been subject for a long time to conditions of excessive moisture. The surface layers are black, as conditions have favored the accumulation of large quantities of organic matter. The luxuriant grass vegetation before these lands were cultivated gave the soils a higher content of black organic matter than that of the better drained soils, and the preservation of this material has resulted in a deep black layer. In places the large quantities of partly decayed vegetation on the surface and in the upper part of the surface layer have produced a mucky or peaty character.

As a rule the texture of the soils of this group is heavy, ranging from heavy loam to silty clay loam. Under conditions of optimum moisture even the heavier soils have a crumbly granular structure and are easily tilled. The surface soils are underlain by gray or mottled gray and yellow or gray-brown subsoils, somewhat heavier in texture as a rule than the surface soils. The details of the profiles of these soils vary considerably, depending on the composition of the parent materials from which they were derived and the depth to which good drainage and oxidation have penetrated. The Webster soils have developed over glacial material in poorly drained areas. Both surface soils and subsoils are of fairly heavy texture. The soils of the Fargo series have a similar profile, but they occur on water-laid material on poorly drained terraces or in depressions. The Clyde soils are similar to the Webster soils in origin, but their present drainage is not so good and their lime content is lower than those of the Webster soils. The Floyd soils are developed from glacial drift, but the drainage conditions are somewhat better than those in the Clyde soils. The Bremer soils occur on poorly drained terraces. Their surface soils are black and are underlain by mottled clay. The lime content is low. The Lamoure and the Wabash soils occur on the recent alluvial deposits along streams and differ mainly in lime content: the Wabash soils contain no lime, whereas the Lamoure soils in many places have lime in their surface soils and in all places in their subsoils. Muck and peat represent different stages of the decomposition of organic matter: muck consists of well-decomposed finely divided organic matter containing some mineral matter, and peat is composed of raw fibrous partly decomposed organic matter.

The soils of this group with the exception of peat and muck and a few of the more poorly drained areas of other soils are among the most productive soils for corn in the county. Heavy rains in the spring may hinder planting at the proper time and in some years decrease yields, but the average yield is higher than that on the soils of the rolling uplands. These soils are used to a considerable extent for small grains, and average yields are high, especially on the better drained types such as Webster loam. In moist areas where the soils contain much organic matter the growth of small grains is too rank and damage may result from lodging.

Clyde silty clay loam.—Clyde silty clay loam occurs in depressions throughout the Carrington and Tama soil areas, which are mainly in the eastern half of the county. It occurs in fingerlike lobes which extend into all parts of the upland.

The surface soil is black heavy silty clay loam to a depth ranging from 12 to 18 inches. It contains various quantities of fine sand. Considerable sand is found near the edges of the areas of Clyde silty clay loam occurring within areas of the sandy Carrington soils. The surface layer is underlain by dark grayish-brown or almost black clay loam which is heavier than the surface layer. Below a depth ranging from 18 to 24 inches is grayish-brown silty clay mottled with gray and brown. Below a depth of 30 inches, the mottlings increase with depth, and many rust-brown iron stains may be seen. Glacial gravel and a few granite boulders are present in the lower subsoil layers. When the land was first settled, glacial boulders, mostly of granite, ranging from 1 to 4 feet in diameter, thickly covered the surface of the Clyde soils. Most of these have been removed, but in a few areas the original boulder covering is undisturbed.

Within areas of Clyde silty clay loam are small areas of muck ranging from 1 to 5 inches in depth. These are usually in patches ranging from 30 to more than 60 feet in diameter, too small to be mapped, near the center of very poorly drained areas. In other small areas salts are sufficiently concentrated to cause injury to crops. Applications of horse manure are effective in minimizing this type of damage.

Clyde silty clay loam is subject to seepage from the surrounding soils of the upland which lie on the tough impervious gumbotil of the Kansan glaciation. Seepage waters moving over the floor of the gumbotil drain into lower Clyde areas in many places, making them permanently wet. The undisturbed natural vegetation is sloughgrass and other water-loving plants.

Because of the poor natural drainage, only a small part of this land is in cultivation, 70 percent or more being in pasture. Part of this soil now in cultivation has been improved by tile drainage and surface ditching. In order to insure good drainage, tile should be laid along the sides and around the heads of the sloughlike areas. The better drained areas are cropped mainly to corn. Small grains have a tendency to lodge, as they make too rank stalk growth. Corn yields from 40 to more than 60 bushels an acre on well-drained areas. Hay produces 1½ to 2½ tons. The soil is very slightly acid or neutral in the surface soil and slightly calcareous or neutral in the lower part of the subsoil. The soil is heavy and rather difficult to handle but works up into a mellow seedbed under favorable moisture conditions. If plowed or worked when too wet, it bakes and clods.

Clyde silt loam.—Clyde silt loam, like Clyde silty clay loam, is restricted to rather small areas, largely in the eastern half of the county, and occupies depressions extending fingerlike into the higher lying soils. It is in the upper reaches which have better natural drainage than those occupied by Clyde silty clay loam.

The surface soil is very dark grayish-brown or almost black heavy silt loam underlain at a depth of about 8 inches by very dark grayish-brown silty clay loam. Both of these layers appear black when wet. Below a depth ranging from 15 to 18 inches, the soil is gray clay loam faintly mottled with yellowish-brown iron stains. The lower subsoil layer, below a depth ranging from 24 to 28 inches, is dull yellowish-brown or grayish-brown clay loam or silty clay highly mottled with orange-brown iron stains. In places, fine sand and boulders are present throughout the soil, but they are more abundant below a depth of 3 feet.

Clyde silt loam is rather variable in different parts of the county, depending on the character of the higher land from which its parent materials have been derived. Where the surrounding soil is Tama silt loam, little or no sand is found at any depth, the entire soil layer being silty and almost entirely free from grit. In a few narrow strips and small areas where the soil material has washed from the higher sandy loam areas, a considerable quantity of sand is incorporated in the surface soil. Numerous small areas of sandier texture occur in section 6, West Fork Township, others are widely scattered in the extreme northeastern part of the county, north of West Fork

Cedar River. Crop yields on these sandier areas are a little higher than on the typical silt loam. Areas of Clyde silty clay loam, too small to be mapped separately, occur within areas of Clyde silt loam.

Only about 25 percent of the total area of Clyde silt loam is planted to crops, most of the areas being in pasture. A small part of the cultivated land has been drained with tile. The soil is as productive as the better drained upland types when properly tiled. Corn is the chief crop. Timothy and clover give high yields, averaging 2 tons an acre. Oats grow fairly well but have a tendency to lodge because of the high organic-matter content of the soil. The surface soils are slightly to moderately acid. Neither lime nor commercial fertilizer is used to any extent. The greatest need of this soil is adequate drainage for efficient handling. Tile should be laid at close intervals and not too deeply to insure prompt removal of the water.

Webster silty clay loam.—Webster silty clay loam occupies flats and depressions in nearly every section of the gently rolling to rolling Wisconsin drift areas of the western half of the county. It is closely associated with Clarion loam, which occupies knolls and ridges rising above the flat Webster silty clay loam areas.

The surface soil is black silty clay loam which is extremely sticky when wet. At a depth ranging from 14 to 18 inches, the black surface soil grades into dark-gray clay loam, which is very plastic when wet. At a depth of 26 or 28 inches the subsoil is gray or light-gray silty clay loam becoming siltier and more friable with depth and containing an increasing amount of free lime and lime pebbles, with some small gravel and sand and a few boulders. In most places there are streaks and splotches of lime and small lime nodules below a depth of 20 inches.

The thickness of the surface soil is variable. In places the dark organic-matter coloring extends to a depth ranging from 24 to 30 inches. Large areas having thicker surface soils are noticeably more poorly drained. Shallow layers of muck, ranging from 1 to 3 inches thick, occur in many places in depressed ponded areas.

Small areas of salt accumulation, locally known as "alkali spots", are in and around depressed areas, as is evidenced by the white coating, noticeable in dry summers, caused by the rise of alkaline water to the surface and the subsequent evaporation of water, leaving the thin salt encrustation. The salts affect corn very noticeably. The corn makes a good growth for a short time in these salty spots but turns yellow when it reaches a height of 1 to 3 feet, depending upon the concentration of salt present. Ears, if formed at all, are nubbins.

Webster silty clay loam was the last soil type of the uplands, excepting peat and muck, to come under cultivation. Open ditches and 48-inch concrete tile furnish the main drainage channels. Five- to ten-inch laterals are used, the size of the tile depending on the distance the drainage waters must be carried to the main outlets. On many farms the tile has been installed for 20 years or more and is no longer efficient in wet seasons, but most of the tiling has been done since 1916. Previously, much of this soil was under water during wet periods in spring and fall. The land is easily drained, as the gritty and limy subsoils allow rapid percolation of water into the tile.

The soil is high in natural fertility and can withstand continuous cropping better than any other soil in Iowa. Until the last few years, the only crops grown on this soil were corn and oats. Hay and some legumes are now grown in the rotation. Small acreages, usually the lowest lying and most poorly drained, are used for pasture. Bluegrass thrives on this soil. Lime is not needed, as the topsoil is neutral or very slightly calcareous in the lower depressed areas. The subsoil is everywhere highly calcareous. Alfalfa yields from 3 to 4 tons an acre on this soil, from three cuttings, which can be made in normal seasons. Corn yields 40 to 80 bushels, depending on seasonal conditions—maximum yields being produced in dry years—and on the efficiency of tile drainage. The average yield is about 45 bushels an acre. Where rotations include red clover, sweetclover, or alfalfa, corn in favorable seasons will yield from 70 to as high as 100 bushels following the hay crop. Small grains are apt to lodge because of the tendency to rank growth, but short stiff-strawed varieties do well.

Webster loam.—Webster loam is scattered widely throughout areas of Webster silty clay loam over the western half of the county. It occupies slightly higher lying areas ranging usually from 10 to 30 acres. It adjoins Clarion loam in many places. The surface is flat or gently undulating.

This soil differs from Webster silty clay loam mainly in texture and in the thickness of the surface layer. The surface soil to a depth of 8 or 10 inches is heavy loam which is sticky when wet. The subsoil is similar to that of Webster silty clay loam but differs from the latter in places in having a slightly yellow tinge and less lime. The natural drainage is better on this soil than on the silty clay loam, and in wet seasons bettter yields are obtained. There is very little difference in productiveness in normal seasons.

Corn averages about 50 bushels an acre in favorable seasons, and oats yield from 50 to 80 bushels. Because this soil has better drainage and a lower organic content than the silty clay loam, small grains do not lodge so readily and produce much higher yields.

Variations within the type consist mostly of pockets of silty clay loam in small circular depressions which have no outlet. Heavy rings of salts form around these depressed areas on the loam soils. Drainage of these pockets and applications of horse manure or phosphate usually will effect normal crop production. In places within the type small gravelly loam areas occur, with a high concentration of sand and scattered gravel in the first 2 or 3 inches of surface soil; and in a few other places a gravel deposit several feet thick occurs at a depth ranging from 15 to 25 inches beneath the surface.

Bremer silty clay loam.—Bremer silty clay loam occupies many areas, mostly of small size, on terraces along the larger streams. It is most extensive along West Fork Cedar River and a few of its short tributaries. The larger areas are 4 miles northeast and 6 miles north of Hansell. A few smaller areas are along Hartgrave Creek and along Iowa River. Areas of irregular shape occur along Maynes Creek, the largest lying 4 miles northeast of Geneva.

This soil is developed on flat terrace benches, most of which are from 5 to 20 feet above the present limit of flooding by the stream.

Some of the lower lying areas may be flooded for a short time in periods of high water, and a few small areas occupying low swales are ponded for short periods by run-off waters after heavy rains.

The topsoil is black silty clay loam, similar to that of Webster silty clay loam. The upper subsoil layer, extending from a depth of 16 inches to a depth of 24 inches, is dark-gray or dark grayish-brown clay loam or silty clay. The lower subsoil layer consists of gray silty clay, which in the better drained areas is mottled with yellow at a depth of 30 inches.

The drainage is poor, and ditching or tiling is necessary if the areas are to be cropped successfully. Less than 60 percent of the total area is sufficiently drained to insure good crop yields in all seasons.

On the soil map several areas of Bremer silt loam are included in the areas of Bremer silty clay loam. The principal difference between the silt loam and the silty clay loam is the lighter texture of the surface soil, which is a heavy but friable silt loam in the included areas. The subsoil is yellower because of better oxidation and drainage. The silt loam, because of better natural drainage, can be cropped to better advantage under adverse conditions. The largest areas of silt loam included in this type lie 2½ miles northeast of Chapin, and a few small areas lie along Spring, Hartgrave, and Maynes Creeks and along Iowa River. In a few places, small bodies of wet swampland, which are ponded almost the entire year, are included with Bremer silty clay loam.

Where well drained, Bremer silty clay loam produces good yields. Corn is grown continuously on many areas and produces from 40 to 45 bushels an acre. Wild sloughgrass covers the undrained areas, which are used for hay or pasture. Small grains are not grown extensively because of their marked tendency to lodge. The soil is neutral or very slightly acid.

Bremer loam.—The topsoil of Bremer loam to a depth of about 9 inches is very dark grayish-brown or black finely granular friable loam. Below this and continuing to a depth of 18 inches is grayish-brown structureless heavy plastic silty clay loam or clay loam. This layer is underlain by gray heavy clay loam or silty clay, mottled with yellowish brown and a few iron stains. To a depth of 4 or 5 feet the soil contains no lime and usually tests from slightly to strongly acid.

This soil occurs on flat terraces that were formerly poorly drained. Most of the areas are now drained by ditches or tile.

Bremer loam occurs in comparatively small areas, 60 acres or less. These areas are most numerous on the more extensive terraces of Iowa River and West Fork Cedar River. Most of these occur within or adjoining slightly lower lying areas of Bremer silty clay loam.

With the exception of small poorly drained areas that are used for pasture, Bremer loam is cultivated. On account of its more favorable texture and better soil drainage, this soil is somewhat more productive than is Bremer silty clay loam. Corn is the principal crop, and in seasons of moderate rainfall it yields 60 bushels or more an acre.

Benoit silty clay loam.—Benoit silty clay loam, a poorly drained soil, lies on terraces principally along West Fork Cedar River north and east of Sheffield and along Hartgrave Creek southeast of Hansell. A few small isolated areas are on the high terrace bench along Iowa River.

The surface soil to a depth of 8 inches is black silty clay loam or silty clay underlain by gray or dark-gray clay, which passes at 24 inches into grayish-brown silty clay mottled with gray and a little yellowish brown. This layer lies on coarse stratified sand and gravel. It differs from Bremer silty clay loam in having a highly calcareous gravel or sand substratum within a depth of 40 inches from the surface.

Most of this land is cultivated. Corn, oats, and hay are the principal crops, and yields are comparable to those on the better drained Bremer silty clay loam. Crops suffer in seasons of extreme drought on spots of this soil where the gravel is within a depth ranging from 18 to 24 inches.

Benoit loam.—Benoit loam is closely associated with Benoit silty clay loam, lying at slightly higher elevations on ridges or flats adjacent to the latter type. The most extensive areas are one-fourth mile north and one-half mile east of Sheffield. Other areas are along West Fork Cedar River, along Hartgrave and Spring Creeks, and along Iowa River in the extreme southwestern corner of the county.

This soil differs from Benoit silty clay loam only in having a loamy surface soil and a better drained subsoil, as is evidenced by the extensive yellowish-brown mottlings. The gravel and sand substratum lies from 30 to 36 inches below the surface.

On a few narrow ridges within the areas of Benoit loam, the surface soil is sandy loam and is inclined to be droughty. In a few small spots the soil covering is shallow, the gravel and sand substratum being at a depth ranging from 20 to 24 inches. Crops suffer on such spots in dry seasons.

The common field crops are grown on Benoit loam, producing about the same yields as those on O'Neill loam.

Fargo silty clay loam.—Fargo silty clay loam is a poorly drained soil occupying small depressed or basinlike areas, ranging from 10 to 40 acres, on terraces along Iowa River; Otter, Buffalo, Spring, Hartgrave, and Maynes Creeks; and West Fork Cedar River.

The topsoil is black silty clay loam to a depth of 15 inches and is underlain by dark-gray silty clay loam or silty clay, becoming lighter gray at a depth ranging from 24 to 30 inches. The lower subsoil layer is highly calcareous. The soil profile corresponds to the profile of Webster silty clay loam, differing mainly in having less lime in the lower part of the subsoil.

A few small areas of Fargo loam, principally along Iowa River and closely associated with Fargo silty clay loam, are included with this type. The profiles are practically identical except for the difference in the surface texture. Fargo loam has a black heavy loam topsoil and is very sticky when wet.

Fargo silty clay loam needs artificial drainage for successful cultivation. About one-half is farmed, and the rest is in pasture. Corn is the principal crop.

Floyd silt loam.—Floyd silt loam occurs at the heads of draws of poorly drained Clyde soils surrounded by the higher lying Carrington or Tama soils on the uplands. It occupies nearly flat land which slopes gently toward the Clyde basins or draws, is naturally better drained than Clyde silt loam, but is not so well drained as Carrington or Tama silt loam.

The topsoil of Floyd silt loam is moderately dark or very dark grayish-brown smooth silt loam to a depth of 10 inches, being heavier in texture in the darker areas. This passes into dark grayish-brown silty clay loam appearing almost a solid color because of the infiltration of organic matter. At a depth of 17 inches below the surface is brown silty clay loam discolored somewhat with streaks and fine threadlike organic-matter infiltrations. At a depth ranging from 22 to 30 inches below the surface the subsoil is yellowish-brown silty clay loam having a gray cast and a few faint gray mottlings. Some very fine sand is visible in this layer. The lower subsoil layer, from a depth of 30 to a depth of 40 inches, is dull yellowish-brown silty clay loam with some gray and yellow mottlings and a few red iron stains. Some fine-textured grit and some gravel occur, and at a depth ranging from 36 to 40 inches, a few small boulders are embedded. The subsoil is much less mottled than that of Clyde silt loam.

Floyd silt loam is a good soil for corn, but some tile drainage is necessary for the best crop production. The natural drainage is fair, as can be seen by the yellowish-brown oxidized upper subsoil layer, but is somewhat restricted in the lower subsoil layer, which overlies a heavy clayey drift sheet. Floyd silt loam resembles the better drained phases of Muscatine silt loam developed in southeast, central, and east-central Iowa, differing principally in having fine grit, some gravel, and embedded small boulders in the lower subsoil layer, whereas the Muscatine is free from grit or stones, being loesslike.

All of Floyd silt loam is cultivated, and most of it is tiled. Corn and small grains are the principal crops. Corn yields 45 bushels an acre in a normal season, and oats yield from 35 to 40 bushels. Sweetclover and alfalfa require lime and tile drainage. Yields of 2½ to 3½ tons an acre have been produced on this soil. Where the land is drained, red clover will thrive without liming.

No commercial fertilizer and only a small amount of manure are used. The soil is not susceptible to erosion, as the land is nearly flat.

Where tiled, this soil is easily worked and is highly productive. Systematic crop rotation and seeding down and plowing under of legumes are needed to build up and maintain productivity.

Peat.—Small areas of peat are widely scattered in the lowest swales and former shallow ponds or small lakes throughout the Wisconsin drift region in the western half of the county. It is closely associated with Webster silty clay loam, which in most places is around the edges of the bogs surrounding the peat. Large areas ranging from 40 to more than 100 acres occur 2 and 4 miles northeast of Popejoy, 3 miles east of Dows, and 1½ miles west of Coulter.

Peat is an accumulation of partly decomposed remains of sedges and other aquatic plants which have developed in shallow lakes, marshes, or ponded areas. The decay and accumulation of the plant leaves and fibrous roots form a loose porous semidecomposed vegetable mat, preserved from rapid oxidation or deterioration by complete or partial immersion most of the year. In the raw stage peat has no agricultural value.

To a depth ranging from 8 to 15 inches, the surface layer of peat is decomposed vegetable matter, forming a loose spongy mass. It is reddish brown when dry and dark brown when wet. Underlying the surface layer is a more fibrous mass, of lighter red color, in which the plant remains are less decayed. The original form of the decayed leaves and stems of the aquatic plants are recognizable in places. The thickness of the vegetable mat ranges from 6 inches to 8 feet in the largest bogs. The subsoil underlying the peat is gray calcareous sandy clay having a top layer from 2 to 8 inches thick of black tenacious clay loam. Small white shells are scattered over the surface of the shallower beds in places.

The degree of decomposition of the topmost layer of peat areas varies widely, but in most of the areas the topmost 6 or 8 inches of the vegetable material is rather finely disintegrated through 10 to 15 years of cultivation and cropping. The thickness of the layer of vegetable matter is also variable, being governed largely but not everywhere by the size of the area. Large areas, usually occurring in narrow strips, are in places only 6 or 8 inches deep, and are better suited for agricultural use than are the deeper areas. These shallow areas are not shown separately on the soil map. Except in four or five of the largest areas, the depth of peat does not exceed 30 inches. The accumulation is deepest in the center of the areas, where it may have a depth of 3 or 4 feet, and thins to 6 to 10 inches around the edges. A few areas have been burned and are reduced to worthless areas of ash. At the time of the survey one bog had been burning for over a year.

Land formerly covered by peat is useless for farming for some time after the peat is burned.

Most of the areas have been drained by the use of open drainage ditches or tile. About half of the land is used principally for corn with some small grains, and the rest is used for hay and pasture. Millet and timothy do well on these areas and are best for the newly cultivated land. A mixture of timothy and alsike clover is used for hay and pasture. Small grains are apt to lodge before the grain can ripen. Some potatoes and sugar beets are grown and produce well. A 0–8–32 fertilizer is used for potatoes and special crops. Some peat treated with phosphate alone will produce high yields of corn, but both phosphate and potash are required on some areas for best results. The fertilizer requirement can be easily determined by experimenting on the individual area with applications of phosphate or potash. Where fertilizer is not used the yields of corn and small grains are variable, depending largely on the depth of the vegetable material to underlying sand or clay. Because of the unbalanced plant-nutrient content and the lack of mineral elements, peat is not naturally adapted to corn and small grains. Where the land is not fertilized corn grows well for a few weeks, but the leaves turn yellow when the plant is from 12 to 18 inches high, the growth becomes stunted, and only nubbins are produced. The degree of injury is highest where the amount of salts are most concentrated. Corn produces from 40 to 50 bushels an acre where properly fertilized and where drainage is good. Deep plowing is recommended to hasten decomposition of peat.

Muck.—As a rule, muck occupies much smaller areas than peat and is widely scattered, mostly through Webster silty clay loam areas in shallow lakes and formerly ponded areas. The bodies range in size from 5 to 20 acres, and the total area is smaller than that of peat. Shallow muck areas also exist within areas of Clyde silty clay loam but, because of their small size, are not shown on the map.

It is probable that muck was formerly peat, from which it differs chiefly in being decomposed to a greater degree in the upper 6 to 12 inches. It represents a more advanced stage of oxidation and decay of the plant remains forming the original vegetable mat. Muck differs from peat in color, being dark grayish brown or black at the surface, fluffy when dry, and firm but mellow when wet. It is usually shallower than peat, ranging from a few inches to 3 feet in thickness. The vegetable mat underlying the surface is darker reddish brown and is more compacted usually than that under the peat areas, although it is of similar structure. Quantities of sand, silt, and clay have been mixed with the surface layer most extensively around the edges of the areas. Small white shells are scattered through the material at all depths and are found on the surface nearly everywhere. The material is usually strongly alkaline.

In most places muck beds range from 10 to 20 inches in thickness, but in a few places they range from 24 to more than 30 inches thick. The shallower muck, from 6 to 10 inches thick, borders deeper peat and muck areas or is in small pot holes and swales having no outlet. Some of it is within Clarion areas, but most of it occurs in close association with the Webster soils.

Most of the muck is drained and under cultivation. It is used largely for corn, hay, and pasture. Where well decomposed, it will produce fair to good crops of corn, potatoes, onions, and beets, and truck crops do well. Where fertilizer is not used, it is best adapted for hay and pasture.

In places the distinction between muck and peat is close, as the comparative stage of decomposition is the chief difference. Muck is called "black peat" by many farmers, who recognize a difference in agricultural value between it and "red peat", which is the less decomposed raw material.

Wabash loam.—Wabash loam occurs over the entire county in narrow strips, along all the larger streams, and all is subject to overflow.

The surface soil is dark grayish-brown or almost black friable loam to a depth ranging from 10 to 14 inches. It contains much fine sand in the eastern part of the county and a higher percentage of clay in the western part. The subsoil above a depth ranging from 23 to 30 inches is grayish-brown clay loam or silty clay mottled faintly with brown in the lower part. Below this depth the lower subsoil layer has increased yellowish-brown mottlings and many rust-brown soft iron concretions.

As with most bottom-land soils, many variations occur throughout the soil. Surface textural variations are common. Sandy loam occurs in small pockets or narrow strips and on ridges near the streams. Depressed areas of silty clay loam, usually at the outer edge of the flood plain, too small to be indicated on the soil map, are included with Wabash loam. A few small areas north and west of Ackley along Beaver Creek and some along Hartgrave Creek have a sandy subsoil but are included with this type because of their small total acreage.

Practically all of Wabash loam is used for pasture. About 10 percent is in cultivation in small irregular fields. Bluegrass grows luxuriantly over most of this soil and affords excellent pasture over a long period. The soil is inherently fertile and is highly productive when the crops are not harmed by flood waters. Yields ranging from 40 to 60 bushels of corn an acre are common in favorable seasons. The small acreage used for crops is practically all planted to corn annually. The land is best suited for pasture. Thin stands of trees are scattered over the soil, principally in strips from 100 to 200 feet wide along the banks of the streams, but some extend out one-eighth of a mile.

Wabash silty clay loam.—Wabash silty clay loam lies principally along Spring and Otter Creeks and West Fork Cedar River, in the northeastern part of the county, and along Iowa River, in the extreme southwestern part. A few small scattered areas are along Beaver and Maynes Creeks and a few small tributaries. The soil is developed in sloughs, in basinlike areas at the outer edge of the flood plains, and on flats and depressions one-fourth of a mile or more wide, starting almost at the edge of the stream.

The surface soil of Wabash silty clay loam is very dark grayish-brown or black heavy sticky clay loam to a depth of 10 inches, underlain by heavy clay loam or silty clay which extends to a depth of 18 or 20 inches. The subsoil below the layers colored by dark organic matter is grayish-brown or gray silty clay, becoming lighter in color with depth and mottled with brown and orange-brown iron stains below a depth of 28 to 30 inches. The upper soil layers to a depth ranging from 24 to 30 inches are free from grit or gravel, but some sand and fine gravel are below this depth.

The drainage on the bottom lands occupied by this soil is naturally very poor, and small areas of peat and muck have developed in swales and formerly ponded areas. This cumulose soil is from 2 to 6 inches thick. A considerable area remains in a swampy condition in the depressions and sloughs. In places small swamps, or marshes, a few hundred feet wide, are under water practically the entire year. They support growths of cattails and sedges. All the land is subject to overflow during periods of excessive rainfall. Some of the land has been drained by surface ditches. Although this drainage system is inadequate, it helps carry off much water that would stand on the ground after heavy rains.

A very small proportion of this land is in cultivation. Corn is the only cultivated crop. It yields from 20 to 40 bushels an acre, depending on seasonal conditions. Most of the land supports a heavy growth of coarse grasses and is used as pasture. A little wild hay is cut. The soil requires careful handling when cultivated to prevent clodding and baking.

Scattered growths of trees are usually on knolls and on higher ground where the silty clay loam joins the better drained Wabash loam.

Wabash silt loam.—Wabash silt loam lies on first bottoms subject to periodic overflow along all the larger streams in the eastern half of the county and along Iowa River in the southwestern corner. The areas it occupies are relatively small and discontinuous, being interspersed here and there through Wabash loam areas which occupy the greater portion of the bottom lands.

The topsoil is dark grayish-brown or almost black heavy silt loam containing considerable fine sand. The subsoil to a depth of 18 inches is dark-brown silty clay loam, uniform of color and becoming heavier in texture with depth. Below this is dark grayish-brown heavy silty clay loam or silty clay, mottled faintly with iron stains. The lower subsoil layer, below a depth ranging from 24 to 30 inches, is gray heavy silty clay mottled with yellow, brown, and rust-brown iron stains, which increase with depth.

The texture of the surface soil is variable, as in most bottom-land soils, particularly along the larger streams where the greatest reworking takes place. Nearest the banks the topsoil contains the highest proportion of sand, and some narrow strips of loam in these areas were included with this soil. Small depressed and poorly drained areas and narrow strips of silty clay loam are scattered throughout this soil type.

Considerable tree growth, consisting largely of elm, poplar, oak, cottonwood, maple, and willow, is scattered over the soil. The soil is high in natural fertility, but only a small part is farmed. The surface is flat, and the drainage, which is only fair naturally, is slow after heavy rains. Corn on the better drained areas yields from 30 to 50 bushels, depending on seasonal conditions. Oats and small grains do fairly well but are inclined to lodge. Timothy and clover produce excellent crops, from 1 to 2 tons an acre. Bluegrass covers a large part of this soil, which is utilized largely for pasture.

Lamoure silty clay loam.—Lamoure silty clay loam is similar to Wabash silty clay loam except that the subsoil and in places the surface soil of the Lamoure soil is highly calcareous. The surface soil is black heavy silty clay loam underlain at a depth of 8 or 10 inches by very dark grayish-brown or almost black silty clay which extends to a depth ranging from 18 to 24 inches. This is underlain by grayish-brown plastic clay, mottled with gray and yellowish brown and with orange-colored iron stains at a depth ranging from 24 to 30 inches, the mottling and iron concretions increasing with depth. Lime concretions and free lime are plentiful below a depth ranging from 1½ to 3 feet.

Lamoure silty clay loam occurs principally in the western half of the county in the bottom lands along the upper reaches of the principal streams rising in the Wisconsin-drift area and their short tributaries. The intermittent shallow streams have cut channels from 3 to 5 feet deep into the swalelike immature narrow bottoms which meander through the Clarion and flat Webster soils. The gradient is so low in these small tributaries that ditches have been cut through in places to carry the waters away and minimize flooding. Along the larger streams Lamoure silty clay loam lies in sloughlike depressions, old channels, and flats, receiving the drainage from the surrounding lands after heavy rains. A strip more than 2 miles long and almost one-fourth mile wide lies along the north side of West Fork Cedar River 2 miles southeast of Sheffield.

This soil is periodically flooded, and water stands in small depressions throughout the flat low-lying troughlike bottoms for days after the floods have receded. The soil is high in natural fertility, and weeds make a rank growth—4 to 6 feet high—in summer. Excellent pasture is supplied on this soil, and some wild hay is cut in sloughs in which water stands for some time after hard rains. Not over 5 percent of the soil is cultivated, practically all of it being covered with coarse pasture and sloughgrasses.

LAND USES AND AGRICULTURAL METHODS

According to the Iowa Yearbook [6] Franklin County had in 1934, 237,225 acres of land in crops out of a total of 362,258 in farms. Of this 31.7 percent was in corn, 21.7 percent in oats, 9.69 percent in tame hay, 4.7 percent idle cropland, the remainder being in rye, barley, sweet corn, truck crops, and minor crops. Pastures occupied 23.12 percent of the total land in farms, and buildings, feed lots, and highways, 5.52 percent.

Farming centers largely around the production of corn, which is grown on practically all soil types. The feeding of cattle and hogs is the principal livestock industry, and dairying plays a minor but important part. Most of the grain produced is fed on the farm, a relatively small percentage being sold locally.

Land to be planted to corn is practically all fall plowed. Where sweetclover is used as a green-manure crop in small-grain seedings, plowing is usually done in spring, but late fall plowing, after the first hard killing frost, is effective and is preferred by some farmers. Fall plowing is advantageous on flat to gently undulating lands, especially those with heavy-textured topsoils and subsoils such as Webster, Clyde, Bremer, Fargo, and Benoit silty clay loams. With sweetclover, care should be taken in using the double-gang plow to see that both plows cut and completely turn and cover the green tops and roots, leaving no uncut roots or uncovered vegetation between furrows. Hilly land is usually plowed in spring to prevent washing and soil loss through erosion. Winter cover is needed on slope or hill land to prevent damage by late fall and early spring rains.

Fields are double disked and harrowed in the spring, and corn is usually planted from May 5 to May 20, the date of planting depending on seasonal conditions. Corn is all planted in checkrows, except for swale acreages grown for silage or hogging down. The first cultivation is with a harrow, soon after planting. Horse- and tractor-powered cultivators are used, usually averaging about three cultivations, the number of rains and weed growth largely determining the number of cultivations. The last cultivation is usually from July 15 to July 25, depending on seasonal conditions. Harvesting begins the latter part of October and lasts until about December 1. Corn picking is being done increasingly by machines, as it is becoming difficult to obtain labor to pick by hand. Corn is stored in

[6] All statistics quoted in this section are from the Iowa Yearbooks for 1933 and 1934.

covered cribs, but in seasons of heavy production many open cribs built of wire or slat fencing are used.

Locally developed strains of open-pollinated yellow corn are largely grown, although hybrid seed is becomining increasingly popular. According to some farmers, good hybrid seed, because of increased yields, will usually pay for the extra cost. Hybrid seed corn ranges in price from $5 to $12 a bushel.

Of the small grains, oats are the most extensively grown. In 1933 the average yield from 90,476 acres was 29.7 bushels an acre for the county. Oats usually follow corn in rotation in the cropping system. A disk is used to cut the stalks after the field is dragged, and the oats are sown broadcast at the rate of from 2½ to 3 bushels an acre. The grain is cut in July with a binder, shocked in the field, and let stand until cured. It is practically all threshed from the shock, little being fed in bundles. Considerable oats are sold as a cash crop. Barley is second in importance of the small grains, 5,128 acres being grown in 1933 with an average yield of 22.4 bushels an acre. Barley is practically all fed to hogs and calves. Wheat, once an important crop, is now very little grown and totaled only 294 acres in 1933. Wheat when grown is drilled. Soybeans are being more extensively grown, being planted with corn for hogging down or drilled for hay and seed.

Tame hay was grown on 24,836 acres in 1933, comprising approximately 10 percent of the cultivated land. Mixed clover and timothy was planted on 11,659 acres, alfalfa on 6,143 acres, red clover on 2,933 acres, timothy alone on 2,111 acres, and other tame hay on 1,990 acres. Wild hay was cut from 2,155 acres, largely from the poorly drained Clyde silty clay loam and Wabash and Lamoure silty clay loams. Liming for legumes is absolutely necessary to produce a good stand on some soils and in certain fields. On all except the Webster, Fargo, Benoit, and Lamoure soils liming is usually essential and highly beneficial. The results are particularly noticeable when a legume crop follows liming. Before attempts are made to grow legumes, careful tests should be made of the topsoils in each field, and lime should be applied in the quantity needed. All legumes should be inoculated, as the expense is small. In growing legumes, particularly alfalfa, well-drained fields only should be chosen.

The use of phosphates and other fertilizers can best be studied in tables 7 to 11, inclusive, which give the results of fertilizer treatments on three of the principal soil types—Clarion loam, Tama silt loam, and Webster silty clay loam, which together constitute more than half the land area of the county. As has been shown experimentally, phosphate fertilizers as a rule produce a marked effect on clovers and other legumes and on corn, oats, and all small grains. The quality of the grain is improved, and the yield is increased. Many times phosphorus will improve the quality of the grain to the extent of bringing in a considerably larger cash return. Both superphosphate and rock phosphate have been used with success and profit. Where fertilizer is to be tried, it is recommended that small strips through the field be treated first, and the results carefully noted, in order to determine the economic use and return. Where the use of complete fertilizer is contemplated, it is highly important to make these tests. When grain and hay are normally priced, phosphorus can be profitably used. In this climate, poor stands of clover or legumes are frequently winter-killed. Applications of manure, lime, lime and phosphate, or phosphate alone, depending on the soil type, will minimize winter-killing and increase yields, besides giving a beneficial residual effect for a year or two following the application.

The pasture acreage in 1933 was 71,144 acres, or 19.72 percent of the total acreage in farms. Pastures are mainly of bluegrass on the better drained soils and of coarse water-tolerant native grasses on Clyde silt loam, on Clyde silty clay loam, and on Wabash and Lamoure silty clay loams in the first bottoms. On the neutral to calcareous extensively developed and widely scattered Webster soils in the western half of the county pastures are mainly of timothy and red clover, with considerable sweetclover and some alfalfa in places. Small-grain stubble and cornfields after corn is picked, together with tame and native pastures, carry the livestock into the winter with little feeding. Livestock is turned on the pastures early in the spring, and good grazing is afforded through the summer and fall in normal seasons. The Clyde and other poorly drained soils normally afford excellent pasturage, even through dry seasons.

Crop rotation is practiced on every farm but is inadequate on many farms. Corn-corn-oats or corn-oats is the most common rotation, with an occasional seeding of some hay crop, mainly clover and timothy. Sweetclover and alfalfa are being more extensively used than heretofore. None of the soils in the county can be continuously cropped without being seeded to grass or legumes and not suffer harmful results. Webster silty clay loam can probably stand more such abuse than any other soil type. The results in table 9 show, however, the beneficial and marked response of this soil to good treatment. The black heavy-textured soils can stand continuous cropping with the least harmful results; whereas the light-colored to moderately dark colored soils, show depreciation quickly where continuous cropping is practiced. Sweetclover, red clover, and alsike clover make excellent green-manure crops. The second crop of a legume should be plowed under in order to aid in maintaining the fertility. On the light-colored soils and on the dark soils that have been eroded, the entire legume crop should be plowed under, if possible. On farms which have been run down and on which crop yields are comparatively low a 3-year rotation should be practiced, with red clover or sweetclover seeded in the small grain, and the full crop should be plowed under the first rotation, and the second crop, each succeeding rotation. Clover used in a 4-year rotation and plowed under will maintain the productivity of good land, but where the land is run down and yields are not satisfactory, the 3-year rotation should be used. Alfalfa used in the rotation stays for 4 or 5 years. In areas where wilt affects the alfalfa, wilt-resistant seed should be used to insure maximum results. Soybeans in rotation should be grown preferably on level areas, as sloping fields erode severely because the upper 2 or 3 inches of the topsoil is loosened, forming an almost dustlike mulch which blows and washes readily after the crop is removed. Heavy losses in fertility are often suffered in this way, the entire surface soil sometimes being removed, leaving the infertile clay subsoil exposed.

Considerable timber is still found on the slopes along the larger creeks in the eastern half of the county, although much of it has been removed in places. The clearing of timber should be done only after a careful study of the possibilities and adaptation of the land for cultivation or pasture. Too much timber has been cut from land which was not suitable for cultivation, resulting in economic loss to the landowners. If the cleared land is adapted to pasture and removal of the stumps is not planned, the stumps should be cut high to prevent sprout growth as much as possible. The present-day value of timber and the high cost of clearing land for cultivation should discourage indiscriminate cutting and clearing of forested slopes; instead, superfluous undergrowth and brush should be cut out, improving the timber stand. Good care of native timberland and selective cutting probably will bring greater returns than will cultivated crops on this land.

Results obtained by the Iowa Agricultural Experiment Station on experimental plots on soils similar to those in Franklin County are shown in tables 7 to 11, inclusive. Experimental plots used are one-tenth of an acre in size and are permanently laid out on soil types representing large areas of soils found extensively in a number of neighboring counties. The plots are established on farms where a definite rotation is practiced and where the soil is typical. The farmer cooperator handles the fields along with the regular crop, planting and cultivating the plots and the remainder of the field at the same time. A fieldman from the experiment station makes the applications of fertilizers and lime and harvests the crops, accurately recording conditions and results.

As can be seen from the tables, these experiments include tests of different fertilizers under both livestock and grain-farming systems. The older fields were laid out under both systems, but the newer fields are under the livestock system only. The older fields have 13 plots with 3 check plots, and the newer fields have 9 plots with 2 check plots.

Under the grain-farming system, crop residues were plowed after being cut with a disk or cutter. The second crop of clover was plowed under where the first crop was cut for hay. On some plots, the first crop of clover was cut, allowed to remain on the land, and plowed under with the second crop. Tests were made of the soil for acidity, and sufficient ground limestone was applied to neutralize it. Tests of the lime requirement for the plots were made once in the rotation, and additional lime was applied every fourth year if needed. Manure was applied under the livestock system at the rate of 8 tons an acre once in a 4-year rotation.

Rock phosphate and superphosphate were used in both the grain and the livestock systems. Rock phosphate was applied at the rate of 1 ton an acre once in a 4-year rotation prior to 1925, when the application was changed to 1,000 pounds an acre; and since 1932, 500 pounds an acre has been used. Superphosphate (16 percent) was applied at the rate of 200 pounds an acre at first; in 1923 a reduction to 150 pounds annually, 3 years out of 4, was made, the application being omitted on the legume crop; and since 1929, 120 pounds of 20-percent superphosphate has been used per acre.

Complete commercial fertilizer 2–8–2 was used in the earlier experiments, at the rate of 300 pounds an acre annually and disked in. From 1923 to 1929, a 2–12–2 mixture at the rate of 200 pounds an acre, which has the phosphorus equivalent of 150 pounds of 16 percent superphosphate, was applied. In 1929 this was changed to a 2–12–6 mixture. Potash was applied as muriate of potash at the rate of 50 pounds annually, 3 years out of 4, in the 4-year rotation.

Tables 7 to 9 show the results of these field fertilizer experiments conducted by the Iowa Agricultural Experiment Station on three of the most extensively developed soil types in the county. Table 7 shows the results obtained on Clarion loam in Wright County, which joins Franklin County on the west, and is representative of the expected response of Clarion loam in Franklin County to similar soil treatments.

TABLE 7.—*Acre yields in field experiment on the Clarion field, on Clarion loam, in Wright County, Iowa*

Plot no.	Treatment	Oats, 1922	Clover, 1923 [1]	Corn, 1924 [2]	Oats, 1925	Sweetclover, 1926	Corn, 1927	Oats and barley, 1928 [3]	Corn, 1929	Winter wheat, 1930	Sweetclover, 1931	Corn, 1932	Oats, 1933	Corn, 1934 [4]
		Bu.	*Tons*	*Bu.*	*Bu.*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Bu.*	*Bu.*	*Bu.*
1	Check	22.9	----	----	46.1	0.61	52.4	27.4	60.7	14.0	0.60	56.1	23.8	26.2
2	Manure	27.0	----	----	53.5	.79	67.3	38.7	66.9	23.0	.82	55.6	28.3	26.0
3	Manure+limestone	26.0	----	----	55.4	1.24	67.1	34.7	69.5	24.2	.92	62.2	32.9	27.4
4	Manure+limestone+rock phosphate	28.5	----	----	61.3	1.34	66.2	46.8	70.6	30.4	1.28	62.3	37.4	17.3
5	Check	26.3	----	----	43.6	.81	52.8	33.1	59.1	17.3	.93	54.4	28.3	24.9
6	Manure+limestone+superphosphate	23.4	----	----	62.3	1.31	60.9	50.8	73.7	27.7	1.10	57.8	37.4	15.9
7	Manure+limestone+superphosphate +muriate of potash	34.4	----	----	74.8	1.39	63.8	45.2	71.1	31.5	1.06	56.0	36.3	16.7
8	Manure+limestone+complete commercial fertilizer	31.8	----	----	63.5	1.26	66.0	47.6	72.3	27.7	1.21	56.4	37.4	17.0
9	Check	25.6	----	----	43.7	.75	52.7	33.9	57.5	16.5	.87	56.0	27.2	28.9

[1] Field pastured; no results.
[2] Poor season for corn, which was damaged by early frost. Field hogged down; no results.
[3] Average weight per bushel, 45 pounds.
[4] Corn damaged by drought and hail.

The results in table 7 show the consistent and ready response of Clarion loam to manure, lime, and both rock phosphate and superphosphate and indicate that these are the most economical and valuable fertilizers on this soil. Manure, used alone, increased the acre yields of corn about 4 to 15 bushels except in 1932 and 1934. In 1934 a severe drought greatly reduced the corn yields, and detrimental effects followed application of fertilizer and manure.

Marked increases were shown on oats, barley and oats mixed, and wheat, with manure alone and with manure and lime. Most significant, however, are the increases due to phosphates, both rock phosphate and superhosphate. Only in 1922 and 1925 were the oat yields increased with complete commercial fertilizer and with addition of potash to manure, limestone, and superphosphate. Yields of sweetclover were increased about 30 percent by the use of manure and about 50 to 100 percent by manure and lime. Both rock phosphate and superphosphate gave increased yields where applied with manure and lime. Lime had a greater stimulating effect than the phosphates, potash, or complete commercial fertilizer. Mixtures containing potash or complete commercial fertilizer proved to be of less value than the phosphates when used in combination with manure and limestone, although, in 1926, the mixture containing potash gave a negligible increase in the yield of sweetclover.

Table 8 gives the average results of limestone and fertilizer treatments on yields of corn, small grains, and hay crops, under both grain and livestock systems of farming in 11 fields on Clarion loam. These fields are widely scattered over the Wisconsin-drift area in north-central Iowa, in Clay, Wright, Dallas, Hamilton, Greene, Boone, Dickinson, and Winnebago Counties, where Clarion loam is the predominating soil.

TABLE 8.—*Average acre yields of crops and increases due to fertilizer treatment on Iowa experiment fields on Clarion loam*

Treatment	Corn [1]		Oats [2]		Hay; [3] clover, timothy and clover, or timothy		Sweetclover [4]		Barley [5]		Alfalfa [6]		Winter wheat [7]	
	Average yield	Increase for treatment	Average yield	Increase for treatment	Average yield	Increase for treatment	Average yield	Increase for treatment	Average yield	Increase for treatment	Average yield	Increase for treatment	Average yield	Increase for treatment
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Bu.*	*Bu.*
Check [8]	46.0	----	45.0	----	1.33	-----	1.12	-----	33.1	----	2.05	-----	19.2	----
Manure	50.5	4.5	50.5	5.5	1.25	-----	1.28	0.16	35.3	2.2	2.18	0.13	24.5	5.3
Manure + limestone	52.5	6.5	53.5	8.5	1.50	0.17	1.52	.40	39.4	6.3	2.43	.38	26.9	7.7
Manure + limestone + rock phosphate	54.2	8.2	55.0	10.0	1.75	.42	1.68	.56	41.3	8.2	2.64	.59	30.7	11.5
Manure + limestone + superphosphate	53.3	7.3	56.9	11.9	1.86	.53	1.72	.60	45.0	11.9	2.93	.88	30.8	11.6
Manure + limestone + superphosphate + muriate of potash	54.9	8.9	60.4	15.4	1.75	.42	1.91	.79	48.7	15.6	3.87	1.82	33.0	13.8
Manure + limestone + complete commercial fertilizer	53.4	7.4	59.7	14.7	1.93	.60	1.92	.80	43.1	10.0	2.96	.91	29.1	9.9
Crop residues	46.0	0	51.4	6.4	2.05	.72	1.52	.40	30.2	----	2.21	.16	----	----
Crop residues + limestone	47.2	1.2	52.3	7.3	2.10	.77	1.68	.56	32.3	----	2.42	.37	----	----
Crop residues + limestone + rock phosphate	49.2	3.2	55.2	10.2	2.56	1.25	1.50	.38	33.6	.5	2.63	.58	----	----
Crop residues + limestone + superphosphate	49.1	3.1	61.2	16.2	2.41	1.08	1.44	.32	36.6	3.5	2.68	.63	----	----
Crop residues + limestone + complete commercial fertilizer	49.1	3.1	62.9	17.9	2.59	1.26	1.29	.17	35.3	2.2	2.60	.55	----	----

[1] Corn yields averaged from 62 crops on 11 fields, except the manure + limestone + superphosphate + muriate of potash plot, which is averaged from 47 crops on 9 fields, and the crop-residue plots, which are averaged from 15 crops on 2 fields.

[2] Oat yields averaged from 36 crops on 11 fields, except the manure + limestone + superphosphate + muriate of potash plot, which is averaged from 29 crops on 8 fields, and the crop-residue plots, which are averaged from 7 crops on 3 fields.

[3] Hay yields averaged from 14 crops on 8 fields, except the manure + limestone + superphosphate + muriate of potash plot, which is averaged from 11 crops on 6 fields, and the crop-residue plots, which are averaged from 3 crops on 2 fields.

[4] Sweetclover yields averaged from 8 crops on 6 fields, except the manure + limestone + superphosphate + muriate of potash plot, which is averaged from 7 crops on 5 fields, and the crop-residue plots, in which only 1 crop on 1 field is involved.

[5] Barley yields averaged from 8 crops on 4 fields, except the manure + limestone + superphosphate + muriate of potash plot, which is averaged from 5 crops on 2 fields, and the crop-residue plots, which are averaged from 3 crops on 2 fields.

[6] Alfalfa yields averaged from 7 crops on 2 fields, except the manure + limestone + superphosphate + muriate of potash plot, which is averaged from 1 crop on 1 field, and the crop-residue plots, which are averaged from 6 crops on 1 field. (Total of 14 cuttings.)

[7] Winter wheat yields represent only 2 crops on 2 fields.

[8] The yields given for the checks are the average of the yields on all check plots on all fields.

The results of these experiments were substantially the same as those shown in table 7, though muriate of potash, when used in connection with manure, lime, and superphosphate, gave good increases in yields of most crops and a marked increase in the yield of alfalfa. Manure, lime, and phosphate were again shown to be the most valuable fertilizers. Phosphate has the additional advantage of greatly increasing the quality of grain as well as the yield.

Webster silty clay loam is second in extent and importance of the soils of Franklin County. Thorough drainage is the first prerequisite for successful farming of this soil. Where properly drained it is naturally very productive.

Table 9 gives the result of field fertilizer tests on this soil in Buena Vista County, Iowa. It is thought that the results are applicable in Franklin County.

TABLE 10.—*Acre yields in field experiment on Grundy Center field, on Tama silt on Iowa experiment fields on Webster silty clay loam*

Treatment	Corn [1]		Oats [2]		Barley [3]		Clover hay [4]	
	Average yield	Increase for treatment	Average yield	Increase for treatment	Average yield	Increase for treatment	Average yield	Increase for treatment
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*
Check [5]	54.1		49.9		42.3		0.90	
Manure	50.7		50.7	0.8	47.8	5.5	1.01	0.11
Manure+superphosphate+muriate of potash	54.7	0.6	53.6	3.7	56.9	14.6	1.29	.39
Manure+rock phosphate	53.1		54.1	4.2	61.8	19.5	1.26	.36
Manure+superphosphate	58.1	4.0	52.8	2.9	57.6	15.3	1.42	.52
Manure+complete commercial fertilizer	56.7	2.6	54.9	5.0	60.7	18.4	1.43	.53
Crop residues	59.0	4.9	60.5	10.6	44.5	2.2	1.08	.18
Crop residues + superphosphate + muriate of potash	59.3	5.2	56.1	6.2	64.4	22.1	1.25	.35
Crop residues+rock phosphate	57.5	3.4	58.3	8.4	52.8	10.5	1.20	.30
Crop residues+superphosphate	56.8	2.7	55.2	5.3	58.2	15.9	1.23	.33
Crop residues+complete commercial fertilizer	55.1	1.0	63.6	13.7	58.1	15.8	1.13	.23

[1] Crop yields averaged from 8 crops on 2 fields, except the crop-residue plots, which are averaged from 5 crops on 1 field.

Oat yields averaged from 5 crops on 2 fields, except the crop-residue plots, which are averaged from 3 crops on 1 field.

[3] Barley yields averaged from 1 crop on 1 field.

[4] Clover hay yields averaged from 1 crop on 1 field.

[5] The yields given for the checks are the average of the yields on all check plots on all fields.

The soil, probably because of its high content of organic matter and lime and its natural high level of productivity, showed comparatively little response to fertilization. The plowing under of crop residues gave the most outstanding increases in yields of corn and oats, and manure had comparatively little effect though it did increase the yields of barley and clover hay. Phosphates gave fairly good increases of yields in most cases. Muriate of potash gave a notable increase in yield only in the case of barley on plots where potash and superphosphate were applied and crop residues were plowed under.

Table 10 gives the results of experiments demonstrating the effects of fertilizers on Tama silt loam on Grundy Center field in

Grundy County, which touches Franklin County at the southeast corner.

TABLE 10.—*Acre yields in field experiment on Grundy Center field, on Tama silt loam, in Grundy County, Iowa*

Plot no.	Treatment	Corn		Oats, 1928	Clover, 1929	Corn		Oats, 1932	Corn, 1933	Oats, 1934[3]	Corn, 1935
		1926	1927[1]			1930	1931[2]				
		Bu.	*Bu.*	*Bu.*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
1	Check	64.9	57.3	43.1	1.71	72.4	68.2	47.9	60.5	------	57.6
2	Manure	67.9	54.5	48.8	1.91	74.6	72.1	49.9	70.0	------	71.1
3	Manure+limestone	64.7	52.4	51.0	2.14	72.5	66.7	50.2	67.1	------	72.0
4	Manure + limestone + rock phosphate	65.7	54.9	52.2	2.35	76.1	64.4	47.4	66.0	------	68.2
5	Check	59.3	38.4	46.5	1.91	67.0	55.5	41.4	50.0	------	65.7
6	Manure+limestone+superphosphate	67.9	54.8	53.3	2.94	76.0	61.6	49.1	65.3	------	68.2
7	Manure+limestone+superphosphate+muriate of potash	68.2	49.4	52.2	2.73	71.5	59.6	45.8	65.8	------	71.7
8	Manure + limestone + complete commercial fertilizer	67.8	48.0	64.7	2.77	71.7	59.4	44.8	66.3	------	70.1
9	Check	67.4	47.2	53.3	1.99	68.4	64.0	45.9	58.2	------	65.9

[1] Very uneven stand on all plots, which accounts for varying yields.
[2] Extreme weather conditions.
[3] Oats poor because of drought; field pastured.

From the data presented in table 10, the value of manure is evident in growing all crops on Tama silt loam. It produced large increases in yields of corn in 1933 and 1935. Limestone with manure showed pronounced results on clover and some increase with oats but negative results for the most part with corn. Over the 10-year period shown in the table, potash and complete fertilizer showed little or no advantage over superphosphate except with oats in 1928. Yields given in this table are comparable to yields on the better farms on Tama silt loam in Franklin County.

Table 11 shows the average acre yields of crops and the increases due to fertilizer treatments on 10 experiment fields on Tama silt loam in Grundy, Black Hawk, Jasper, Madison, Adair, Cedar, and Marshall Counties.

The average of results obtained on these 10 fields shows the ready response of this soil to manure. Lime with manure or crop residues also gave excellent results, especially where the land was used for legumes. Superphosphate with manure and lime gave better results than rock phosphate similarly used, but where rock phosphate and superphosphate were used with crop residues, the former showed the greatest increases in yields of corn and oats. The increased yields with the phosphates are only partly indicative of the value of these applications, as there is a considerable increase in the no. 1 corn harvested, which brings a greater cash return. The data on the effect of the muriate of potash and complete commercial fertilizer are rather inconclusive. On certain crops both induced slightly higher yields when added with the other fertilizers, but careful field tests should be made to determine their economic value on a particular farm. Because of the increased cost of complete commercial fertilizer over phosphate, large increases in crop yields are necessary to give an economic return.

TABLE 11.—*Average acre yields of crops and increases due to fertilizer treatment on Iowa experiment fields on Tama silt loam*

Treatment	Corn [1]		Oats [2]		Hay;[3] clover, timothy and clover, or timothy		Barley [4]		Soybeans [5]	
	Average yield	Increase for treatment	Average yield	Increase for treatment	Average yield	Increase for treatment	Average yield	Increase for treatment	Yield	Increase for treatment
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Check [6]	57.4	-------	50.2	-------	1.60	-------	32.6	-------	29.9	-------
Manure	62.1	4.7	54.4	4.2	1.75	0.15	32.4	-------	31.7	1.8
Manure+limestone	64.9	7.5	58.1	7.9	1.89	.29	29.9	-------	33.8	3.9
Manure+limestone+rock phosphate	64.5	7.1	61.5	11.3	2.03	.43	31.6	-------	36.4	6.5
Manure + limestone + superphosphate	65.7	8.3	61.6	11.4	2.15	.55	31.6	-------	38.2	8.3
Manure + limestone + superphosphate + muriate of potash	63.9	6.5	67.1	16.9	2.17	.57	30.1	-------	39.0	9.1
Manure + limestone + complete commercial fertilizer	64.7	7.3	64.3	14.1	2.04	.44	28.8.	-------	39.2	9.3
Crop residues	51.7	-------	43.5	-------	1.21	-------	-------	-------	-------	-------
Crop residues+limestone	59.9	2.5	50.4	.2	1.61	.01	-------	-------	-------	-------
Crop residues + limestone + rock phosphate	62.8	5.4	51.3	1.1	1.75	.15	-------	-------	-------	-------
Crop residues + limestone + superphosphate	62.0	4.6	51.1	.9	1.88	.28	-------	-------	-------	-------
Crop residues + limestone + complete fertilizer	61.9	4.5	53.8	3.6	1.94	.34	-------	-------	-------	-------

[1] Corn yields averaged from 47 crops on 10 fields, except the crop-residue plots, which are averaged from 8 crops on 1 field, and the manure+limestone+superphosphate+muriate of potash plot, which is averaged from 39 crops on 9 fields.
[2] Oat yields averaged from 21 crops on 9 fields, except the crop-residue plots, which are averaged from 5 crops on 1 field, and the manure+limestone+superphosphate+muriate of potash plot, which is averaged from 16 crops on 8 fields.
[3] Hay yields averaged from 13 crops on 8 fields, except the crop-residue plots, which are averaged from 3 crops on 1 field, and the manure+limestone+superphosphate+muriate of potash plot, which is averaged from 10 crops on 7 fields.
[4] Barley yields averaged from 2 crops on 2 fields.
[5] Soybean yields are from 1 crop on 1 field.
[6] The yields given for the checks are the average of the yields on all the check plots on all fields.

The outstanding increases in yields on Tama silt loam are those from applications of manure, lime, and phosphates.

On Carrington loam, which occurs principally in the northeastern part of the county, applications of limestone and manure are highly beneficial and increase crop yields about in the same proportion as when used on Tama silt loam. Carrington loam is strongly acid, and lime should always be added where legumes are to be grown. Phosphatic fertilizers also produce beneficial effects on both grain and hay crops.

For the sandy loam and silt loam types of the dark Prairie soils and for the lighter colored soils, such as the Fayette and the Lindley, heavy applications of barnyard and green manures are especially needed. Lime with either kind of manure gives good results on most of the soils and is highly recommended. Both superphosphate and rock phosphate give excellent results nearly everywhere. Muriate of potash and complete commercial fertilizer give good results on grain crops in many places but because of the cost should be tried experimentally first, on individual fields.

Where crop yields have decreased and the soils on the farm need to be built up, a 3-year rotation consisting of corn, small grain, and clover is most satisfactory. This has been tried in different parts of the State with excellent results. On farms where the soils are in good tilth and fertility, especially on the darker Prairie soils, a 4-year rotation of corn, corn, small grain, and clover is adequate to maintain productivity.

Many pastures need improvement, especially on the more rolling lands. They should be reseeded with mixtures of timothy, clover, and alsike in early spring, after being disked in one direction with disks set straight to avoid injuring the sod. Phosphates are usually the most needed fertilizer for corn and small grains on peat lands. Both potash and superphosphate should be tried experimentally before widespread applications are made. Potash sometimes gives good results.[7]

ALKALI SPOTS

So-called "alkali" spots are scattered throughout the areas of Webster silty clay loam and Webster loam, usually in association with peat and muck beds. These spots are unproductive because of an accumulation of excessive amounts of salts. The affected areas are small, varying in size from one-tenth of an acre to 2 acres, but they considerably reduce the value of the fields in which they occur.

When the ground is bare the salts form a white deposit on the surface; in cultivated fields the stunted size and yellow color of corn and other crops mark their location. The salty accumulations form not in the lowest places but around the edges of poorly drained areas and on positions corresponding to former shore lines of ponds. Some of the highest concentrations are on loamy ridges, paralleling sloughs or encircling pot holes or small areas of silty clay loam, muck, or peat.

The permanent reclamation of these areas depends on the removal of the salts from the soil. If adequate drainage can be provided, precipitation will gradually wash out the salts. If no drainage outlets can be established, any measures for relief will be only temporary. Movement of salt from land after drainage can be increased by heavy applications of farm manure, preferably horse manure. Manure improves the physical condition of the soil and facilitates the washing out of the salts. The decay of the organic matter releases organic acids which react with the salts and hasten their removal.

MORPHOLOGY AND GENESIS OF SOILS

Most of the soils of Franklin County, Iowa, belong to that subgroup of the Pedalfers to which Marbut[8] has given the name Prairie soils. The Prairie soils may be briefly defined as dark-colored soils in which lime carbonate has not accumulated in the solum at maturity. The factors of environment, including temperature, precipitation, and

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[7] Much additional information on the foregoing soil experiments is given in Iowa Agricultural Experiment Station Bulletins 236, 241, 269, 276, 291, Special Report 3, and Soil Survey Reports 20, 31, 38, 48, 70, 76. These may be obtained by writing to the Iowa State College, Ames, Iowa.

[8] MARBUT, C. F. SOILS OF THE UNITED STATES. U. S. Dept. Agr., Atlas of American Agriculture, pt. 3, Advance Sheets no. 8, 98 pp., illus. 1935.

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relief, led to the leaching out of a large part of the bases in the soil material yet were favorable for a luxuriant growth of grasses, and the development of the soils has proceeded under this kind of vegetal cover. Grass roots penetrated deeply into the soil and decayed, and their partly decomposed materials became an integral part of the upper horizon. The accumulation of organic matter varies, of course, with local conditions of moisture, aeration, and rapidity of erosion. The thickness of the horizon of organic-matter accumulation ranges from 4 to 25 inches, the depth depending largely on the relief, or lay of the land. Under good drainage, such as prevails in the more rolling areas, organic matter accumulates more slowly than in the poorly drained areas, partly because the grass vegetation is not so abundant and partly because a certain part of the dark-colored organic layer is removed by erosion and oxidation. A slight difference in color can be detected between the soils of the rolling upland in the eastern part of the county and those on similar topography in the western part. This may be attributed to the influence of the parent materials. A higher lime content in the soil in the western part has promoted a heavier grass vegetation, and as the organic colloids are saturated with calcium and rendered immobile more of the organic matter is preserved in the soil.

The oldest geologic formation that influences the soils of Franklin County is the Lime Creek of the Upper Devonian, consisting of calcareous shales and limestones. These rocks are exposed on slopes along the streams in the northeastern part. They are not in many places the parent soil materials from which the overlying soils are developed, but they constitute the rocky substratum of the Dodgeville soils. Small areas of the Dodgeville soils in the vicinity of Hampton overlie what is probably the Kinderhook series of the Mississippian system.

With the exception of these small areas, all the soils of the county have developed directly or indirectly from three kinds of unconsolidated Pleistocene deposits; namely, Iowan drift, Peorian loess, and Wisconsin drift.

The eastern part of the county, comprising about three-eighths of the total area, is covered by a relatively thin sheet of Iowan-drift deposit. This material is unassorted glacial till which has been leached of its carbonates to an average depth of more than 5 feet. The Carrington and Lindley soils indicated on the soil map mark exposures of the heavy-textured portion of this deposit, which is not covered by loess. The areas of Dickinson soils are developed over the more sandy deposits of the Iowan drift.

Carrington loam is the representative type of the Carrington series. The surface horizon is dark grayish-brown loam about 12 inches thick. The color is uniform throughout the soil mass. The structure is finely granular, the granules being irregular but of nearly rounded form. The next lower horizon consists of dark-brown loam with well-defined granulation. The color changes downward to brown. The dark color of the upper part and of the tongues extending downward from it is due to a coating of organic matter over the granulation. Below a depth of 18 inches the material is brown or yellowish brown, and the granulation is less well defined. The texture may be similar to that of the horizons above or slightly heavier. The parent material, a variegated drift, is reached in most places at a depth of about 32 inches. This material is gritty clay loam and is usually friable.

The surface horizon of this soil is slightly to medium acid, and the lower part of the solum may be strongly acid. The parent material below a depth of 3 feet is often neutral and below a depth of 6 feet may contain sufficient lime to cause effervescence with acid. A few boulders of various sizes are scattered over the surface and throughout the soil. The hydromorphic associates (associated poorly drained soils) of this soil are the soils of the Clyde and the Floyd series.

Loess of Peorian age covers a large part of the Iowan drift. It consists of a uniform gray or yellow silt, unstratified, permeable, and friable. Leaching has proceeded in most places to a depth of many feet. The soils of the Tama and the Fayette series have developed normally over this material. In a few comparatively small areas leaching has not reached a depth of 3 feet, and the lime of the parent material is near the surface. The soil developed here resembles the Marshall soils of the Missouri loess region of western Iowa. This has not been separated because of its comparatively small area.

Following is a representative description of a profile of Tama silt loam as it occurs in Franklin County, taken from a pit in sec. 34, T. 91 N., R. 19 W.:

1. 0 to 3 inches, very dark grayish-brown silt loam with a dense mat of interlaced grass roots. The surface soil, when wet, is almost black but, when dry, appears dark brown or dark grayish brown, being slightly lighter in color than the surface soil of Clarion loam in the Iowan drift.
2. 3 to 14 inches, dark grayish-brown friable silt loam, granular, breaking into small aggregates one-eighth inch or less in diameter, finer aggregates predominating. Some fine loose silt is also present.
3. 14 to 21 inches, a transitional layer, very friable dark-brown heavy silt loam, highly colored with organic infiltrations from above. On superficial examination the color seems uniform and the soil nearly as dark as the topsoil, but close examination shows darker discoloration along root holes and along worm and insect burrows. When crushed between the fingers the soil is light brown. Soil granules are distinct, having a maximum diameter of one-fourth of an inch.
4. 21 to 44 inches, yellow or yellowish-brown silty clay loam, highly oxidized and uniform in color, compact, but fairly easily crumbled. Very few and faint organic discolorations are found along root penetrations and along worm, insect, and animal burrows.
5. 44 to 51 inches, yellowish-brown silty clay loam or silty clay, not so bright in color as the overlying layer, containing considerable very fine sand and fine sand. This is the Iowan drift which has been covered by a loess mantle.
6. 51 to 71 inches, yellowish-brown silty clay mottled with faint gray. It contains many orange and rust-brown iron concretions, much fine and coarse sand and small gravel, many rock fragments, and a few boulders. There are concentrations of iron concretions in many places at a depth of about 55 or 60 inches in pockets or thin layers from 3 to 12 inches thick and 4 to 5 feet long. The coarse materials in the drift increase in amount with depth.

Over the western five-eighths of the county the surface is covered by Wisconsin drift. This material, originally very calcareous, has been leached to a depth of about 30 inches. Soils of the Clarion series have been extensively developed over this material on the rolling uplands. Clarion loam, which may be regarded as a normally developed soil, is representative of the series and has three distinct horizons. The surface horizon is very dark grayish-brown loam with an average thickness of about 14 inches. The upper part is slightly sandier, as a rule, and more crumbly than the lower part. The lower part is distinctly granular in many places. This horizon contains no free lime and in many places is strongly acid. The next lower layer, which reaches a usual depth of about 25 inches, is transitional between the dark-colored surface soil and the unleached layer below. The material is yellowish brown with tongues and streaks of dark organic matter. Between depths of 25 and 35 inches below the surface is brown loam with few infiltrations of the dark organic matter. The parent material begins at a usual depth of 35 inches and consists of glacial drift in which are embedded more or less decomposed rock fragments of various kinds. White streaks and splotches of lime are abundant, and the material is highly calcareous. This lime is a part of the parent material and was not accumulated by the soil-forming processes.

As the surface of this region, covered by the Wisconsin ice sheet, is a constructional drift plain traversed by morainic ridges and hills, numerous flats and valleys have no natural drainage outlets.

Following is a description of a representative profile of Clarion loam taken from a pit dug in sec. 36, T. 93 N., R. 22 W.:

1. 0 to 3 inches, dark grayish-brown friable loam permeated with fine grass roots which occupy about 75 percent of the layer. Particles of coarse sand adhere to the soil that clings to the grass roots in small, irregular lumps when shaken.
2. 3 to 15 inches, dark grayish-brown friable loam—black when wet. It contains considerable fine sand, some coarse sand, and some small gravel. The structure is granular, the soil mass breaking into imperfect angular aggregates from one-sixteenth to one-eighth of an inch in diameter, the small aggregates predominating.
3. 15 to 20 inches, a transitional layer, brown or yellowish-brown loam stained and streaked with organic-matter infiltrations, giving it a dark-brown or brown appearance. The soil particles, when crushed between the fingers, show a basic yellowish-brown color. The brown color in this layer is not uniform but is streaked with organic-matter infiltrations, being darker along cracks formed in dry seasons and along animal burrows, insect and worm holes, and plant roots. This layer has no definite structure and is not calcareous. It contains a large proportion of silt and approaches a silty clay loam in texture. Very little grit is present.
4. 20 to 30 inches, dull yellowish-brown silty clay loam, uniform in color except for a few darker streaks of organic-matter infiltrations entering through worm and insect holes and along root channels. Much fine sand is present. The layer is coarsely granular. Dark worm casts were found in this layer in places.
5. 30 to 47 inches, olive- or dull yellowish-brown silty clay loam, highly calcareous. The lime occurs mostly in finely divided particles with many moderately soft nodules ranging from the size of fine gravel to 2 or more inches in diameter, 95 percent of the nodules being small. This is the unweathered parent material of the Wisconsin glaciation. Sand, gravel, and a few granite boulders, increasing in quantity with depth, are interspersed throughout this layer and underlying layers.
6. 47 to 56 inches, bright yellowish-brown silty clay loam containing many orange-brown iron stains or mottlings and small nodules of lime. This layer also contains much finely divided lime. Grit and coarse material are abundant in this structureless layer.

7. 56 to 66 inches, the zone of maximum lime concentration, yellowish-brown silty clay loam, much mottled with bright-orange iron stains. Hard and soft lime nodules and splotches one-fourth inch to 5 inches in diameter are abundant. This layer contains a very high percentage of silt, appearing to be silt loam when dry.
8. 66 to 72 inches, pale yellowish-brown uniform very fine sandy clay loam, containing much grit and a few small granite boulders. This layer is highly calcareous, the lime being finely disseminated for the most part, though there are a few nodules. Iron stains are common but not so pronounced as in the layer above. This material has no definite structure.

The hydromorphic associates of the Clarion soils, which occupy adjoining lower and flatter areas, have been classed with the Webster series. The surface soils of the Webster series range from mellow friable black loam to silty clay loam. These are underlain at a depth ranging from 15 to 20 inches by gray or mottled gray and brown silty clay loam or silty clay. The underlying parent material is grayish-brown or light-gray calcareous clay.

A description of a representative profile of Webster silty clay loam as observed in sec. 31, T 91 N., R. 21 W., follows:

1. 0 to 3 inches, very dark grayish-brown or black heavy silty clay loam, containing some fine sand. Granulation is indistinct, but there is faint lamination. Fine grass roots fill this layer.
2. 3 to 8 inches, black heavy silty clay loam. It has little definite structure and is very sticky when wet.
3. 8 to 18 inches, very dark grayish-brown or black silty clay, breaking into small, irregular aggregates, one-sixteenth to one-fourth inch in diameter when dry. The dark organic-matter color is uniform throughout this layer. The granules, when crushed, are only slightly lighter in color, dark grayish-brown.
4. 18 to 26 inches, very dark gray, almost black, silty clay, colored rather uniformly by organic-matter infiltration. An indefinite columnar or block cleavage is apparent in this layer when the soil is dry. The mass breaks up into small irregular aggregates one-sixteenth to one-eighth of an inch in diameter, the finer aggregates composing 80 percent of the whole.
5. 26 to 34 inches, dark-gray or gray silty clay, containing more silt than the overlying layer. Darker gray occurs in the form of large faint mottlings or splotches, caused by organic-matter infiltration. Small soft lime concretions occur throughout this layer, as do orange and black iron stains. The layer is structureless and crumbly when dry. Some fine sand and in a few places small particles of gravel are present in this layer, but commonly it is almost grit free.
6. 34 to 60 inches, gray silty clay material, appearing almost white when dry, which is the unweathered glacial till of the Wisconsin drift. Soft lime concretions and splotches, one-fourth to more than 2 inches in diameter, occur, with large quantities of finely divided lime, in some places constituting from 15 to 20 percent of the soil mass. Rust-brown iron stains are also abundant throughout the soil mass. Fine to coarse sand, various amounts of gravel, small rock fragments, and boulders ranging from 6 to more than 18 inches in diameter are embedded in this unweathered material.

All layers in this profile are slightly to highly calcareous. In many places, however, the soils to a depth ranging from 15 to 20 inches will not effervesce with acid. It is possible that the draining of the land and leaching out of the carbonates have reduced their concentration materially in places.

The Fargo soils have profiles similar to those of the Webster series but occupy terraces in depressions and poorly drained valleys where the glacial drift has been more or less reworked by water.

Areas of well-drained light-colored soils lie over all three of the principal geological formations and are coextensive with areas on which timber was growing when the county was first settled. These light-colored soils of the Gray-Brown Podzolic group, all occupying uplands, are in the Lindley and Fayette series, the former being developed in all three geological regions in the county, the latter, in the loess-covered portion. The soils of the Lindley and Fayette series are erosive, because of their physical characteristics and rolling relief.

The alluvial deposits of the county are largely second-bottom or terrace soils lying on flat benches well above overflow. The flood plains or first bottoms are relatively narrow. The streams have cut shallow channels, for the most part, and the waters move normally with a gentle flow. The Wabash and Lamoure soils are in the first bottoms, the former predominating.

SUMMARY

Franklin County lies a short distance northeast of the center of Iowa. Hampton, the county seat, is about 80 miles northeast of Des Moines. The county comprises an area of 578 square miles, or 369,-920 acres.

The county consists of two topographically distinct parts. The eastern three-eighths was covered by the Iowan glacial drift, which in turn was partly covered by a silty material. The surface features are smooth and the country is for the most part gently rolling with numerous lenticular hills. The western five-eighths of the county was covered by a comparatively recent deposit of drift of the Wisconsin glaciation. The surface is characterized by ridges and knobby hills with numerous ponds and marshy places.

With the exception of a small area in the southwestern part which is drained directly by Iowa River, the drainage is carried by West Fork Cedar River and its tributaries. The general direction of the drainage is toward the southeast. The altitude of the county ranges from about 1,031 to 1,256 feet above sea level.

The first white settlers came into this section about 1850, and the county was organized in 1855. The population in 1930 was 16,382, of which 14,903 were of native birth. The rural farm population is 9,791. Hampton, the largest town, in 1930 had a population of 3,473. Ackley, Sheffield, and Dows are the next largest towns.

Transportation facilities are good. Three railroads intersect at the county seat, a branch line of one of them starts there, and three corners of the county are crossed by other railroads. Three paved highways cross the county, and nearly all of the principal roads are graveled. Farm products, consisting mainly of livestock and livestock products, are shipped to several small packing plants in Iowa and Minnesota and in greater quantities to Chicago and St. Paul.

The climate is typical of the Corn Belt, being characterized by hot summers and cold winters. The growing season is of sufficient length to mature the general crops usually grown.

Agriculture is the principal occupation. The cropping system is centered around corn, which occupies more than 40 percent of the cultivated land. A large part of the corn is fed on the farms in the

production of meat animals and dairy products. Oats and hay are produced to supplement corn and to provide roughage for livestock.

The soils have been placed in two broad groups on the basis of natural drainage conditions: (1) well-drained soils, and (2) soils having slow natural drainage. This grouping does not indicate relative productivity, as productive soils are in both groups. Soils of slow natural drainage have, permanently or occasionally, conditions of excessive moisture that may require the attention of the farmer.

The soils of the first group include well-drained dark-colored soils of high natural fertility. The extensive soils of the Clarion, Carrington, and Tama series of the rolling upland make up a large part of the tillable land. Waukesha loam on the terraces is also a productive soil. The O'Neill soils of the terraces have sandy or gravelly subsoils and are somewhat less productive than those mentioned. The light-colored soils of the Lindley and Fayette series, which also belong with this group of well-drained soils, have the disadvantages of a rolling topography and a lack of organic matter.

The most extensive and valuable of the soils having slow natural drainage are the silty clay loam and loam of the Webster series. These soils occupy flat areas and were originally poorly drained, but they now rank among the very best soils for corn. The Benoit and Floyd soils have a somewhat lower value than the Webster soils. The Wabash and Lamoure soils of the first bottoms are naturally fertile, but occasional floods and poor drainage conditions lower average yields.

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