Series 1933, No. 30 Issued July 1939

Soil Survey

Ida County Iowa

By
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Iowa Agricultural Experiment Station, in Charge
and
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UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY AND SOILS
In cooperation with the
Iowa Agricultural Experiment Station

by the SUPERINTENDENT OF DOCUMENTS, WASHINGTON, D. C. Price 30 cents

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By T. H. BENTON, Iowa Agricultural Experiment Station, in Charge, and W. J. GEIB, Bureau of Chemistry and Soils, United States Department of Agriculture

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

COUNTY SURVEYED

Ida County is in the northwestern part of Iowa, one county removed from the Missouri River and the State of Nebraska, and in the fourth tier of counties south of the Iowa-Minnesota State line (fig.1). The northwestern corner of the county is approximately 32 miles east of Sioux City, Iowa. The county contains 12 full townships. The total area is 430 square miles, or 275,200 acres.

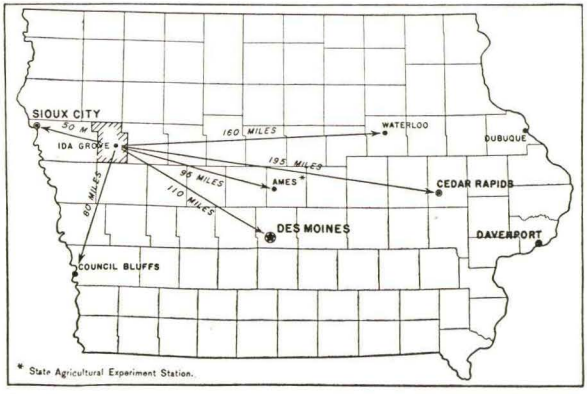

FIGURE 1.—Sketch map showing location of Ida County, Iowa.

Physiographically, Ida County is a loess-covered rolling plain traversed by a number of streams that flow in a general southwesterly direction. The relief produced by these streams and their small tributaries, which ramify and drain the entire county, is characterized by smoothly rounded hills and gentle slopes over most of the upland, although some areas a few miles from the main streams along the headwaters of small drainageways are strongly rolling, with steep slopes and sharp intervening ridges. The largest of the strongly rolling areas is north of Ida Grove and north and south of Battle Creek. The uplands in the northeastern and north-central parts of the county are, in general, much smoother and more nearly level than in other parts, and the land in the extreme northwestern part is the most sharply rolling. In the south-central and western parts the prevailing relief ranges from strongly rolling to hilly, with some broken slopes along the larger streams. No large areas are so rough or steep as to prevent cultivation, but in places the slope is sufficient to render the land unsuited to cultivation. Drainageways have penetrated all parts of the upland plain, and in the more rolling sections have cut deeply below the level of the original plain. There are no areas of upland without adequate drainage.

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The county has a general southwesterly slope. The elevation [1] above sea level ranges from 1,225 feet at Ida Grove to 1,443 feet at Holstein in the north-central part. Elevations above sea level for other important towns are: Arthur, 1,287 feet; Battle Creek, 1,347 feet; and Galva, 1,290 feet. Arthur and Ida Grove are on the alluvial plain.

Drainage ranges from good to excessive, except in a few flat areas, comprising less than a total of 200 acres, occupying low swales of only a few acres each, mostly in the uplands north of Holstein. The surface of the land in this part of the county is more nearly level than in any other part, and natural drainage is somewhat deficient, but tile drains have been installed in some of the poorly drained swales. A few depressed areas with inadequate drainage are along some of the larger streams, and in these areas some tile drainage has been installed. Areas with poor natural drainage, in which no tile has been installed, are used for pasture.

Most of the county is drained by Maple River, which enters the northeastern corner, flows southward to the center, there turns southwestward, and leaves near the southwestern corner. An area covering about a township and a half in the extreme northwestern part is drained by Little Sioux River, and the extreme southeastern part drains into Soldier River and into Boyer River, which flows through Sac and Crawford Counties. All these streams empty into Missouri River. Water is carried away rapidly, as all the streams have considerable fall and an appreciably rapid flow.

Terraces are well developed along Little Sioux River and Maple River. They range from 10 to 50 feet above stream level. Those along Little Sioux River are the higher; those along Maple River do not exceed 25 feet above normal overflow. First-bottom lands are extensively developed along the larger streams. In most places the streams have cut deep channels into the silt and clay soil materials, and floodwaters are carried away so rapidly that much of the bottom land rarely overflows. The bottom lands range from one-fourth to more than one-half mile in width, and most of them slope gently or almost imperceptibly toward the streams.

Luxuriant prairie grasses covered most of the land in the early days, and prairie fires were very destructive. Originally only a small part of the county was forested. Thin stands of trees grew along the bottom lands bordering or near the stream channels. In addition, some of the steeper slopes along streams in the extreme southwestern part once supported a forest, most of which has been removed. The native trees are largely maple, walnut, elm, oaks, ash, cottonwood, and basswood. It is reported that 703 acres of natural forest were in the county in 1875 and 56 acres were planted to trees. Elk, deer, wild turkeys, prairie chickens, quail, and beavers were plentiful when the county was first settled, and wildcats, panthers, and lynx were plentiful before the sixties. Trapping once was an important activity.

The first settlement in Ida County was made in 1854, when two men built a cabin in what is now Ida Grove and produced a crop of sod corn. The county was organized in 1858, at which time the

[1] GANNETT, HENRY. A DICTIONARY OF ALTITUDES IN THE UNITED STATES. U. S. Geol. Survey Bull. 274, ed. 4, 1,072 pp. 1906.

population totaled 40 people. The county was surveyed into sections between 1853 and 1855. The early settlers were mainly from the Eastern States, but later large numbers of foreign-born people, especially Germans, settled in the county. In the southwestern part Swedish settlers predominated; in the east-central part, the Irish; and in Battle and Maple Townships, the Danes. Most of the present population is American born, predominantly of German extraction, with some of English, Scandinavian, and Irish descent. Settlement was slow at first, and only 226 inhabitants were in the county by 1870. The number increased to 794 in 1875, and by 1880 the census reported the total population as 4,382.

The population in 1930 was 11,933, all classed as rural. The average density of population was 27.8 persons a square mile. Ida Grove, the county seat, had 2,206 inhabitants in 1930. Holstein, in the north-central part of the county, is second in size, having 1,300 inhabitants. The populations of other towns, as given in the 1930 census, were: Battle Creek, 804; Galva, 530; and Arthur, 249.

The public-road system is almost complete. United States Highway No. 20 extends east and west across the northern part of the county and is paved. State highways cross the south-central part from east to west, near the central part from north to south, and the extreme northwestern part. These main highways are well graveled, and a number of the county trunk roads have been surfaced with gravel. Most of the other roads follow the section lines, are of dirt construction, and are well graded and maintained.

Lines of the Chicago & North Western Railway cross the county from east to west, one through the south-central part and the other through the northern part, and the Illinois Central Railroad crosses the extreme northwestern part. No part is more than 8 miles from a shipping point.

The county is well supplied with schools. Rural schools are located at 2-mile intervals, except in sections served by a consolidated school district. Excellent high schools are maintained in the larger towns. In addition to the churches in the towns, there are a few country churches scattered over the county. Telephone lines traverse the entire county, making telephone service available to many farms. Electric power lines furnish light and power to all towns and many farmsteads.

Sioux City is the principal livestock market. Poultry and eggs are shipped to New York and Boston, and dairy products to Boston, New York, and Sioux City. A large creamery, the principal product of which is butter, is located at Ida Grove.

CLIMATE

The climate of Ida County is favorable for the production of all staple crops grown in this section. The seasonal fluctuations in precipitation and temperature may raise or lower crop yields in relation to the average, but such differences are not great. Total failures of crops from drought are unknown. The summers are warm, with occasional short periods of excessive heat. Precipitation is well distributed throughout the growing season, and more than one-half of the total annual precipitation falls during the period from May to

August, inclusive. Short periods of drought and hot winds may occur during this period, but crops are rarely damaged to a great extent. Early rains seldom delay planting except on the heavier bottom lands. Abnormal seasons, in which maturity of the corn crop is sufficiently delayed to result in soft corn, are rare. Severe blizzards may occur at any time during the winter, but some winters are free from storms and are comparatively mild.

The average date of the last killing frost is May 14, and of the first is October 3, giving an average of 142 days without frost. The latest recorded killing frost was on May 28, and the earliest on September 15. The grazing season extends over a period of 180 days. The prevailing winds in summer are from the southwest, and in winter from the northwest.

No climatic records have been kept in Ida County. Table 1, compiled from the records of the United States Weather Bureau station at Washta, Cherokee County, gives the normal monthly, seasonal, and annual temperature and precipitation. Cherokee County adjoins Ida County on the north, and weather conditions are very similar in both counties.

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

[Elevation 1,157 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1910)	Total amount for the wettest year (1909)	Snow, average depth
	° *F.*	° *F.*	° *F.*	*Inches*	*Inches*	*Inches*	*Inches*
December	22.0	58	−40	0.79	0.10	1.05	4.7
January	16.1	58	−47	.62	.55	1.10	5.3
February	19.6	66	−36	.84	.25	1.40	6.7
Winter	19.2	66	−47	2.25	.90	3.55	16.7
March	31.9	86	−21	1.14	[1]	.65	4.4
April	46.6	96	10	2.69	.55	2.33	1.4
May	58.7	95	13	4.11	2.68	7.66	[1]
Spring	45.7	96	−21	7.94	3.23	10.64	5.8
June	67.2	101	21	4.79	2.39	6.32	0
July	71.7	106	40	3.76	2.27	6.89	0
August	70.1	100	32	3.20	4.36	1.92	0
Summer	69.7	106	21	11.75	9.02	15.13	0
September	62.2	99	20	3.58	4.09	2.44	[1]
October	49.0	92	2	1.91	.90	3.39	.9
November	34.0	80	−9	1.30	.15	5.18	2.2
Fall	48.4	99	−9	6.79	5.14	11.01	3.1
Year	45.8	106	−47	28.73	18.29	40.33	25.6

[1] Trace.

AGRICULTURAL HISTORY AND STATISTICS

Agriculture has been the chief occupation of the people in Ida County since its first settlement. Corn, wheat, and oats were produced only in quantities to supply the home needs in the early years, as lack of transportation facilities prevented the marketing of surplus crops. Cattle were raised on the open range, and the luxuriant prairie grasses provided abundant feed. Settlement was backward in this section, and in 1867 only 95 acres of corn and 45 acres of wheat were grown in the county. Progress was slow until the advent of the railroads in 1877, when settlers came in rapidly as homestead laws made the acquisition of land attractive.[2] By 1880 there were 626 farms in the county.

The type of farming has changed but little since 1890. The growing of grain and hay and the feeding of cattle have been the chief agricultural enterprises, and dairying has developed into an important branch of agriculture within the last decade.

Table 2 shows the acreage of the principal crops grown in 1879, 1889, 1899, 1909, 1919, 1929, and 1934, as reported by the United States census.

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

Crop	1879	1889	1899	1909	1919	1929	1934
Corn:	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
For grain	24,205	88,262	97,681	94,955	81,848	98,739	68,770
For other purposes					[1] 1,880	12,380	22,484
Oats	3,381	22,675	37,666	44,859	56,654	54,016	42,192
Wheat	17,844	9,112	30,703	2,522	4,631	209	201
Barley	1,051	34,221	4,587	14,119	1,988	9,331	8,828
Sweetclover pasture						4,372	
Clover seed						1,148	
Hay	2,590	27,805	26,705	35,029	27,641	21,733	[2] 34,201
Timothy and clover (alone or mixed)				30,900	19,664	9,704	4,594
Clover alone			500	881	3,106	4,386	1,550
Alfalfa			30	84	2,267	6,753	10,617
Grains cut green			322	55	388	80	8,533
Other tame hay			19,420	115	164	167	[2] 8,907
Wild hay			6,433	2,994	2,052	643	([3])
	Trees	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*
Apples		3,042	27,419	24,634	12,862	4,759	4,608
Plums		5,273	12,781	10,045	2,220	1,476	1,526
Cherries		938	4,552	4,462	1,270	802	1,673
	Vines	*Vines*	*Vines*	*Vines*	*Vines*	*Vines*	*Vines*
Grapes			3,216	7,139	5,266	2,840	2,196

[1] Forage only.
[2] Includes wild grasses and sorghums for silage and fodder.
[3] Included in other tame hay.

Corn has been the principal crop since the first settlement. Wheat ranked second to corn until the late eighties, but now corn and oats comprise more than 90 percent of all grains grown, and corn alone approximately 60 percent. The United States census reports 98,739 acres of corn grown in 1929, which yielded 4,232,952 bushels of grain. Drought lowered the acreage to 68,770 acres and the production to 1,210,815 bushels in 1934. Most of the corn is fed to cattle and hogs. The principal varieties are strains of Reid Yellow Dent,

[2] HULL, JOHN A. T. IOWA HISTORICAL AND COMPARATIVE CENSUS, 1836–1880. 744 pp. 1883.

Golden King, Leaming, and Silver King. Hybrid corn has been rapidly increasing in popularity in recent years.[3] Some calico and strains of squaw corn (red) are grown for hogging down or early feeding.

The United States census reports 4,613 acres devoted to popcorn in 1929. Most of this acreage is in the east-central part of the county. The growing of popcorn started in 1892, and in 1935 popcorn was grown on 4,527 acres.[4] White Rice is the predominating variety grown, and other varieties are South America, Yellow Pearl, and White 8-Row Spanish. The average yield over a period of years is about 1,500 pounds an acre. Prices range from $5 to $8 or more a hundred pounds, depending on the market demand. Large warehouses for storing the popcorn are located at Arthur, Ida Grove, and Odebolt. The latter town is in Sac County 3 miles east of the Ida-Sac County line.

Oats follow corn as an important crop and are used principally for feed. According to the United States census, 54,016 acres were threshed in 1929, with a yield of 2,154,777 bushels. Owing to the drought, only 379,229 bushels were harvested from the 42,192 acres sown in 1934. Iowar, Green Russian, Iowa 105, Swedish Select, and Early Champion are the principal varieties grown. Practically all of the barley is fed to hogs and calves. In 1929, 9,331 acres produced 322,004 bushels; in 1934, 8,828 acres produced only 79,385 bushels. Velvet, Oderbrucker, Wisconsin Pedigree (38), and Trebi are the most popular varieties. Wheat, an important cash crop prior to 1900, now is grown on only a few hundred acres annually.

Hay is the third most important crop. In 1929, 37,418 tons of hay were produced from 21,733 acres; in 1934 only 30,846 tons were obtained from 34,201 acres. Clover, timothy, alfalfa, and clover and timothy mixed are the principal hay crops. Alfalfa was grown on 6,753 acres in 1929, with an average acre yield of 2.1 tons. Yields of 4 tons an acre from several cuttings are common, and maximum yields of 5 or 6 tons have been harvested. Alfalfa is seeded at the rate of about 15 pounds an acre. In dry seasons some seed is produced.

Sweetclover is grown largely for pasture, some is cut for hay, and some seed is harvested. Sweetclover is sown at the rate of 10 or 12 pounds an acre. Soybeans are grown mostly with corn for hogging down, and small acreages are harvested for hay or seed. Small acreages are in millet, rape, and rye, grown for feed. Flax, once an important crop, is now planted on a very small acreage. Sudan grass is grown in small acreages for pasture and hay, and three crops of hay can be cut each season. Red clover is grown, mostly for pasture and hay, in the eastern and northeastern parts of the county on the undulating to gently rolling areas of Marshall silt loam, where the soil seems to be more acid in the surface soil than in the more rolling areas.

The total area of pasture land was 57,315 acres, according to the 1935 Iowa Yearbook, of which 33,988 acres were classed as plowable pasture. Alfalfa, sweetclover, and red clover are used for pasture,

[3] Information furnished by the county agricultural agent.

[4] IOWA STATE DEPARTMENT OF AGRICULTURE. IOWA YEAR BOOK OF AGRICULTURE (36), 1935. 440 pp., illus. 1936.

but clover and timothy mixed comprise the principal pasture growth on the uplands, and Kentucky bluegrass comprises most of the permanent pasture on the bottom lands. In addition a few acres are devoted to bluestem, meadow fescue, and other native prairie grasses for pasture.

Potatoes are grown principally for consumption in the home, although small quantities are grown commercially, chiefly around the towns. Irish Cobbler, Early Ohio, and local strains of Russets are favored varieties.

The fruit trees are principally apple and plum and are grown mainly in small orchards on the individual farms. Oldenburg (Duchess), Rhode Island Greening, and Whitney are the principal varieties. The number of apple trees decreased from 24,634 in 1909 to 4,608 in 1934. A few pear, cherry, and peach trees are grown over the county. Strawberries, currants, raspberries, blackberries, and grapes are the principal small fruits.

Most farms are well supplied with work animals. Several carloads of horses of the light-draft type are shipped in each year from the West to supply farm needs. Only a few colts are raised each season, not enough to replenish the work horses. The principal breed is Belgian, with a smaller number of Percheron. The number of mules is comparatively small.

Table 3 gives the number of livestock on farms in the county in 1920, 1930, and 1935, as reported by the Federal census.

TABLE 3.—*Number of livestock on farms in Ida County, Iowa, in stated years*

Livestock	1920	1930	1935	Livestock	1920	1930	1935
Horses	11,257	9,384	7,913	Swine	97,280	111,417	63,360
Mules	741	819	733	Sheep	6,208	4,641	14,006
Cattle:				Chickens	183,982	229,590	205,138
Beef cattle	32,470	[1] 36,141	[1] 38,894				
Dairy cattle	10,143						
Cows milked		7,691	8,222				

[1] All cattle.

As may be seen from table 3, the numbers of horses and mules have decreased. The increased use of tractors is largely responsible for the marked decrease of work animals on the farms. Many of the sheep are western feeders, and the number shipped into the county varies with the seasonal price. Therefore, when sheep bring a good price on the market, a larger number are shipped in and fed.

The raising and feeding of beef cattle is the chief livestock activity and the principal source of income. The 1930 census reports 36,141 head of cattle in the county, valued at $2,100,941. Many feeders are shipped in, fed for a short period, and sold on the market. Shorthorn, Hereford, and Aberdeen Angus are the principal breeds, named in order of their popularity. Most of the feeders are shipped or trucked in from Sioux City, and some from Omaha. Most of the finished animals are marketed in Chicago, but some are trucked to Sioux City and Omaha. Most of the raisers of beef cattle sell from 15 to 20 head annually, and a number ship several carloads.

Hog raising is second in importance. There were 111,417 swine reported in the county in 1930, with a value of $1,592,132. The prin-

cipal breeds of hogs are Poland China, Duroc-Jersey, Hampshire, and Chester White. The Poland China and Duroc-Jersey are the most popular. A few Tamworth and Spotted Poland China are raised. Very few stock hogs are shipped in, but most of them are raised on the farms within the county.

Dairy products sold in 1929 added $387,710 to the farm income. The establishment of a large creamery at Ida Grove in 1929 has greatly encouraged dairying. The production of milk was 3,521,214 gallons in 1929 and 2,664,824 gallons in 1934. Milking Shorthorn, Holstein-Friesian, and Guernsey are the favored breeds for milking, the first named being the most popular. Milk routes cover this county and extend into adjoining counties, and cream-buying stations are located in all towns. Most of the milk is marketed at the creamery at Ida Grove. Silos are used on most dairy farms.

Sheep raising and feeding is restricted largely to the northern part of the county. From 4,000 to 6,000 head of sheep and lambs are fed and sold annually. Western native lambs are shipped in early in the fall, fed until the middle of the winter, and marketed when they weigh from 90 to 100 pounds, mostly in Chicago. In 1929 the value of the 13,853 pounds of wool clipped was $4,433; in 1934, 46,233 pounds were clipped. Wool is marketed largely through cooperative shipping associations.

Poultry is raised on nearly every farm and is an important source of income. The value of the 363,878 chickens and other poultry raised in 1929 was $302,508. Chickens alone sold for $136,243. The 1,230,317 dozen eggs produced in 1929 were valued at $319,832, of which $294,741 represented the value of the 870,387 dozen sold. In 1934, 292,277 chickens were raised and 870,277 dozen eggs were produced. On an average farm, from 150 to 200 chickens are raised each year. Most of the flocks are of mixed breeding, but the trend is toward purebred flocks. Rhode Island Red, Buff Orpington, White Leghorn, Barred, White, and Buff Plymouth Rock, and Wyandotte are most common. Poultry products are sold to local buyers, principally at Holstein, Ida Grove, and Battle Creek. A large poultry-dressing plant is located at Holstein. Most of the live and dressed poultry are shipped to Chicago and New York. Eggs are marketed in Philadelphia, Boston, and New York.

In the performance of farm work, tractors are in common use. The 1930 census reports 551 tractors on the farms in the county.

Very little commercial fertilizer is used, and only 30 farms reported its use in 1929. Because of the extensive feeding of cattle on the farms, considerable manure is produced, which is applied principally on cornland, but the supply is not adequate to maintain the productivity of the land, and green manures are used as a supplement. Some superphosphate and a very small quantity of complete commercial fertilizer are used. From 10 to 12 carloads of limestone are distributed in normal years over the county generally, except in the western part. The northeastern section receives the most.

A considerable amount of feed is purchased on most farms. In 1929, 1,003 farms, or 70.4 percent of all the farms in the county, purchased feedstuffs amounting to $812,682, or $810.25 a farm.

Table 4 shows the number and tenure of farms in the county, as reported by the United States census in 1910, 1920, 1930, and 1935.

TABLE 4.—*Number and tenure of farms in Ida County, Iowa, in stated years*

Year	Total	Operated by—		
		Owners	Tenants	Managers
	Number	*Percent*	*Percent*	*Percent*
1910	1,474	50.5	48.6	0.9
1920	1,398	42.6	56.1	1.3
1930	1,425	36.6	62.9	.5
1935	1,453	33.9	65.4	.7

The steady increase of farm tenancy is shown in table 4. Deflation of land prices after the high speculative prices during 1919 and 1920 contributed to the increase of tenancy, as many farm owners lost their equities because of encumbrances.

Land rentals are mostly on the share basis, with the owner receiving one-half of the corn and two-fifths of the oats and the tenant furnishing work animals, seed, all farm equipment, and labor. Cash rent ranging from $4 to $8 an acre is paid for pasture and hay land under the share-rental system. A few farms are rented for cash, and the price depends on the condition of the farm and the soil type or types included.

Farmsteads in general are well supplied with outbuildings including a barn, a corncrib, a hog house, a poultry house, and cattle sheds. Buildings were badly depreciated during the depression, but they have been improved on many farms since 1935, and many buildings have been painted and repaired recently.

Power lines are distributed over a considerable part of the county, making electric power available on many farms. Telephone service is extended to nearly every section. Most farms are well equipped with modern machinery.

Farm labor was employed in 1929 on 968 farms, or 67.9 percent of all farms in the county. The total cash expenditure was $467,720, or $483.18 a farm. Farm labor has been very difficult to obtain in recent years, according to reports of farmers and the county agent. Most of it comes from local towns and is employed in the spring and at harvest time. A decade ago, corn was picked largely by hand, but shortage of labor has necessitated the use of more corn-picking machines.

According to the Federal census, the average-sized farm in 1935 contained 188.2 acres and 99.4 percent of the land was in farms. The total number of farms was 1,453 and included 273,499 acres. Improved land consisted of 87.2 percent of the total land in farms, or 164.1 acres a farm.

The value of farm land and buildings was $22,556,823 in 1935, or an average of $15,524 a farm. The average value of land an acre was $82.47. This shows a material decrease over values previous to the deflation period.

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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 [5] and its content of lime and salts are determined by simple tests.[6] Drainage, both internal and external, and other external features, such as relief, or lay of the land, are taken into consideration, and the interrelation of soils and vegetation is studied.

The soils are classified according to their characteristics, both internal and external, special emphasis being given to those features influencing the adaptation of the land for the growing of crop plants, grasses, and trees. On the basis of these characteristics soils are grouped into mapping units. The three principal ones are (1) series, (2) type, and (3) phase. In places, two or more of these principal units may be in such intimate or mixed pattern that they cannot be clearly shown separately on a map, but must be mapped as (4) a complex. Areas of land, such as coastal beach or bare rocky mountainsides that have no true soil, are called (5) miscellaneous land types.

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

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, Clarion loam and Clarion silt loam are soil types within the Clarion series. Except for the texture of the surface soil, these soil types have approximately the same internal and external characteristics. The soil type is the principal unit of mapping, and because of its specific character it is usually the soil unit to which agronomic data are definitely related.

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

[6] The total content of readily soluble salts is determined by the use of the electrolytic bridge. Phenolphthalein solution is used to detect a strong alkaline reaction.

A phase of a soil type is a variation within the type, which differs from the type in some minor soil characteristic that may have practical significance. Differences in relief, stoniness, and the degree of accelerated erosion are frequently shown as phases. For example, within the normal range of relief for a soil type, there may be areas that are adapted to the use of machinery and the growth of cultivated crops and others that are not. Even though there may be no important difference in the soil itself or in its capability for the growth of native vegetation throughout the range in relief, there may be important differences in respect to the growth of cultivated crops. In such an instance the more sloping parts of the soil type may be segregated on the map as a sloping or a hilly phase. Similarly, soils having differences in stoniness may be mapped as phases even though these differences are not reflected in the character of the soil or in the growth of native plants.

The soil surveyor makes a map of the county or area, showing the location of each of the soil types, phases, complexes, 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

Ida County is in the Prairie soil region of the United States, where the soils have formed under a luxuriant growth of grasses. The decayed grass roots incorporated each year with the mineral constituents of the soil have imparted a dark grayish-brown or almost black color to the surface layers.

The entire county was once covered by a mantle of loess, ranging from a few to more than 30 feet in thickness, and from this parent material have developed the mellow silty soils of the upland, which cover a large part of the county and dominate the agriculture. Sediments from areas of this material have washed down into the stream valleys and built up terraces and river bottoms, on which soils similar to those of the upland have developed. From a few comparatively small areas the covering of loess has been removed by erosion and the underlying glacial drift has been exposed. From such areas the Clarion soils have been developed.

With the exception of small areas, the soils are highly productive; more than 96 percent of the land is tillable, and none of the soil is worthless. Unfavorable features of texture, slope, or drainage have reduced productivity to some extent, but no considerable areas have had their value seriously impaired.

The character of the soils, the level to undulating relief, and the climate combine to make this an ideal section for the production of corn. Corn is, therefore, the major crop, and it is grown on all types of soil. In fact, the value of land is determined largely by its capacity to produce corn economically over large acreages with the use of labor-saving machinery. In ordinary years more than 50 percent of all land in farms is planted to corn.

Oats, as is common in the greater part of the Corn Belt, is the most important small-grain crop used in rotation with corn. The usual acreage of oats is a little more than 50 percent of the corn acreage. The rest of the cropland is devoted to other small-grain

and hay crops. This ratio between the acreages in corn, oats, and other crops is maintained year after year with slight variations.

Several reasons exist for the relationship between corn and the small grains.[7] It has been recognized that (1) larger yields are obtained when the land is used alternately for different crops than when planted continuously to the same crop, (2) the diversification of crops makes possible a more uniform distribution of labor, and (3) land rotated with corn and small grains is not so subject to accelerated erosion as when planted continuously to corn. In recent years the latter reason has had greater weight than the others, as the farmers have become aware of the damage being done by the slow, almost imperceptible removal of the surface soils by erosion. Some fields planted continuously or frequently to corn have become so badly eroded that little of the original dark-colored surface soil is left, and the productivity of the land has been impaired. Nearly all of the soils of the rolling upland have been influenced to some extent by accelerated erosion, but the damage has been especially severe on the soil indicated on the soil map as Marshall silt loam, light-colored phase.

The soils do not present wide differences in characteristics and therefore do not determine the systems of farming and crop adaptations in different parts of the county. The soils that adversely affect agriculture are the comparatively small areas of Marshall silt loam, light-colored phase, and Marshall fine sand. The first soil is so eroded that special care is necessary in its management, and the second soil is so porous and sandy that it is not retentive of moisture. Crops on this soil suffer even during short droughts. The Wabash soils of the first bottoms are subject to occasional flooding, but their high average production compensates in large measure for this hazard.

On the basis of topographic position the soils of this county may be placed in three groups as follows: (1) Soils of the rolling uplands, (2) soils of the flat terraces and gentle slopes, and (3) soils of the stream bottoms. This grouping brings out the surface features and consequent drainage conditions but does not indicate other features that determine productivity.

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

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

Type of soil	Acres	Per-cent	Type of soil	Acres	Per-cent
Marshall silt loam	172,992	62.8	O'Neill silt loam	320	0.1
Marshall silt loam, light-colored phase	32,832	11.9	O'Neill loam	320	.1
Marshall fine sand	576	.2	Wabash silt loam	28,608	10.3
Clarion loam	576	.2	Wabash silty clay loam	384	.1
Clarion loam, steep phase	192	.1	Ray silt loam	256	.1
Clarion silt loam	2,176	1.0	Wabash-Judson silt loam	24,960	9.0
Waukesha silt loam	8,832	3.1	Total	275,200	
Judson silt loam	2,176	1.0			

[7] HURD, EDGAR B. THE CORN ENTERPRISE IN IOWA. Iowa Agr. Expt. Sta. Bull, 259, pp. 225–256, illus. 1929.

SOILS OF THE ROLLING UPLANDS

The soils of the rolling uplands are by far the most extensive soils of the county. Marshall silt loam, the dominant member of this group, occurs in all parts and is broken only by the soils of the stream valleys and by patches of Marshall fine sand and the Clarion soils. An eroded phase of Marshall silt loam occupies comparatively small areas on eroded slopes. Marshall fine sand is inextensive. Small areas of soil developed from glacial drift in the extreme northwestern part of the county have been identified as Clarion loam and Clarion silt loam. A steep phase of Clarion loam covers the steeper slopes in the more rolling areas.

Marshall silt loam.—Marshall silt loam is the most extensive soil in every township and dominates the agriculture of the county. It ranges from undulating to rolling and hilly. The more rolling areas are in the southern half, in the extreme northwestern part, and in a strip from 1 to 3 miles wide north of Ida Grove along the western side of Maple River.

Marshall silt loam, as typically developed, is dark grayish-brown mellow silt loam to a depth of 14 or 16 inches, the lower few inches of which are slightly lighter in color. When wet the material is almost black. The upper part of the subsoil is yellowish-brown silty clay loam or heavy silt loam, which is uniform in color and texture to a depth of 36 inches, where the texture becomes slightly lighter and the soil material consists of yellowish-brown friable heavy silt loam containing some very fine sand and a few black iron stains. At a depth ranging from 50 to 60 inches, the parent material is grayish-brown or pale yellowish-brown floury silt loam which in general is very high in free lime. Some lime nodules and concretions are present in the upper part of the lower subsoil layer. On slopes where sheet erosion has been active the dark-colored surface soil is much thinner, and on the sharp shoulders of many slopes and narrow ridges it is entirely lacking. Where the original surface soil has been entirely or almost completely removed, the present surface soil is light brown or yellowish brown, and a light-colored phase is mapped. A variation from the typical soil occurs on flat or undulating areas where the surface soil is darker and generally thicker than the typical soil.

Drainage of Marshall silt loam is good; the subsoil absorbs moisture readily, and the rolling surface carries off excessive rainfall rapidly. The soil is easily cultivated and has no grit, boulders, or gravel to slow down work with machinery. Although moisture penetrates the soil readily, owing to its porous structure, the moisture-holding capacity is exceptionally good. Fields can be cultivated early, as the soil warms quickly in the spring. Crops withstand prolonged periods of drought without much damage.

Marshall silt loam in this county is part of a broad belt of this soil along the western side of the State, bordering the Missouri River and extending eastward the width of about two counties. Because of its high productivity for corn, agriculture on this soil is centered around the growing of corn. Generally corn is grown 2 years in succession and is followed by a small grain and a seeding of timothy and clover. Oats are the principal small grain, although some barley and wheat are grown. Sweetclover and alfalfa do well on this soil

where the fertility has been maintained. On the less fertile areas, winter-killing may damage weak young plants considerably during an open winter.

Corn yields range from 40 to 60 bushels an acre, sometimes more on well-maintained farms. Under favorable seasonal conditions, 90 bushels are sometimes obtained following a crop of alfalfa or sweetclover. Continuous hot winds occasionally lower the yield of corn markedly. Where the land has been cropped heavily and sheet erosion has been severe, yields are reduced to as low as 20 to 35 bushels, depending on the actual condition of the soil.

Oats yield from 30 to 60 bushels an acre, depending on the season. Dry hot winds reduce the yield appreciably if they occur during the dough stage. Ordinarily wheat yields range from 10 to 25 bushels, but higher yields are obtained in favorable seasons. Barley generally yields from 30 to 50 bushels, depending on seasonal conditions. Barley should be planted as early as possible, so that it may mature before hot weather.

In the east-central part of the county, principally around Arthur, popcorn is considered to be an excellent crop on this soil and is produced in large quantities. It is sold at Arthur and Ida Grove and stored in large warehouses. Yields are about 1,500 pounds an acre.

Alfalfa is extensively grown, as the lime in the subsoil and the porous structure of the soil material favor rapid development of the plants. Yields ranging from 3 to 4 tons an acre are obtained. The surface soil should be tested for acidity before alfalfa or sweetclover are sown, because much of the soil will show a lime requirement of 1½ to 2 tons an acre. Clover and timothy do well without liming. A good seedbed is essential in obtaining the best results with alfalfa.

Nearly all of the corn is planted in checkrows, and the rows are allowed to run up and down hill in most fields. Very little contour cultivation is practiced. Contour strip cropping, sodding of waterways, diversion terraces, improved rotations, and other soil-conservation practices should be adopted on many farms. This soil erodes easily, because of its mellow physical structure, and loses much fertility each year because of lack of adequate conservation practices. This soil is deep in this county, and in places where the surface soil has been eroded and carried away the friable subsoil can be made very productive in a short time by the growing and turning under of sweetclover. With soils having heavy clay subsoils, however, it is very difficult and expensive to build up productivity after the surface soil is removed.

Pastures are composed largely of timothy and clover, although sweetclover alone and alfalfa alone are used for pasture to a considerable extent. The permanent pastures are chiefly bluegrass. Because of the extensive cattle-feeding operations, considerable barnyard manure is available, and an effort is made to give the land an application once in a 4-year rotation. From 5 to 10 loads an acre are applied, depending on the amount available. Experimental tests have proved that phosphate fertilizers give good results on this soil.

Marshall silt loam, light-colored phase.—The surface soil of Marshall silt loam, light-colored phase, in virgin areas is dark-brown

silt loam to a depth of 4 inches. Below this the soil material is dull yellowish brown, as the subsoil material is darkened somewhat by the incorporation of organic matter from the decayed roots of crops. Below a depth of 14 inches, the subsoil is normally yellowish-brown heavy silt loam or friable silty clay loam, which is uniform in color, except for a few iron stains scattered through the lower part. The parent material, a pale-yellow floury highly calcareous silt loam, lies at a depth ranging from 20 to 60 inches below the surface, depending on the slope and the amount of erosion that may have occurred. When plowed, the thin dark-colored layer is mixed with the material below, and the soil to the entire depth of plowing is much lighter colored than that of typical Marshall silt loam. In places the parent material is exposed, generally in narrow strips or bands, and forms the topmost soil layer. Nearly all of this soil is under cultivation, but a few areas are used for pasture. It is less productive than typical Marshall silt loam because of the low humus content.

Marshall silt loam, light-colored phase, occupies slopes along drainageways, where nearly all of the surface soil has been removed by erosion. It also occupies rounded hills with sharp slopes in the southern and northwestern parts of the county. Steep slopes, ranging from 20- to 30-percent gradient, have lost all their surface soil and the upper part of the subsoil, leaving the pale-yellow calcareous silt parent material exposed. Small areas of these eroded strips are included with the light-colored phase. A few areas are included that would be mapped as Knox silt loam if their total acreage warranted the separation. The soil of these areas differs from soil of the light-colored phase of Marshall silt loam in that they have a still lighter colored surface soil; the principal bodies of this included soil are 3 miles north and 4 miles southwest of Battle Creek, respectively.

The relief of this soil generally is more rolling than that of typical Marshall silt loam, and run-off consequently is more rapid. Some hills are cut by gullies, which enlarge rapidly if not stopped promptly. Where improperly managed the Marshall soils erode rapidly because of the fineness and uniformity of the soil grains and the looseness of the material, and sheet erosion is going on at a rapid rate over much of the Missouri loess area. Waterways should be and generally are seeded down to prevent destructive gullying. If this were not done, fields would be destroyed in the course of a very few years in the more hilly country. Evidences of such destruction are numerous.

Corn is the principal crop, but yields are considerably lower than on typical Marshall silt loam, ranging from 20 to 40 bushels an acre, depending on the season and the fertility of the soil material. A sweetclover crop turned under will increase the yield from 10 to 25 bushels an acre in places where the soil is low in organic matter. Oats yield from 20 to 35 bushels an acre and clover and timothy hay from 1 to 1½ tons. This soil needs applications of barnyard manure and green manure plowed under, such as the second crop of red clover or a crop of sweetclover. This land should be farmed on the contour where possible, and soil conservation methods should be used in all field operations. Contour strip cropping, seeding of waterways, and good rotations are three vital factors in increasing the crop yields

and conserving the soil. Corn should be grown only 1 year in a rotation on this land, and followed with a small-grain and clover seeding. Most of this soil is neutral or slightly calcareous, and liming ordinarily is not necessary in order to obtain stands of clover and alfalfa. Phosphate fertilizers are used with good results on a few farms.

Marshall fine sand.—Marshall fine sand has formed on deposits of fine sand over loessial silt and drift. It occurs principally south of Arthur, southwest of Ida Grove, southeast of Battle Creek, and along the west side of Maple River 4 miles south of Galva.

The 8-inch surface soil is dark-brown fine sand. It is underlain by pale yellowish-brown fine sand containing some silt in places. The lower part of the subsoil, below a depth of 28 inches, is bright yellowish-brown fine sand, in places mixed with some silt and clay. The subsoil consists of loose open porous sand to a depth ranging from 3 to 4 feet.

The surface soil differs considerably in color from place to place, ranging from dark to moderately dark within the same area, and light-colored spots also may be included. In other counties a light-colored phase is mapped to include areas in which the color is lighter than typical, but in this county such areas are included with the typical soil because of their small extent and similarity. The lighter color of the surface soil is largely the result of depletion of the organic matter by continuous cropping without plowing under green-manure crops.

This soil is used for the production of corn and small-grain crops, but low yields are obtained because of the susceptibility to drought. Corn yields range from 10 to 30 bushels an acre, depending on the season and management, and small grains from 15 to 25 bushels.

This soil warms early in the spring and in a normal season will produce a fair small-grain crop. It is very low in organic matter, and green-manure crops should be turned under frequently so as to supply the deficiency. Phosphate fertilizers have a beneficial effect. Melons, vegetables, and truck crops are especially adapted to this soil.

Drainage is excessive, owing to the loose incoherent sandy subsoil, and droughts affect crops quickly. This soil is slightly acid in the upper soil layers and in most places neutral below a depth of 20 inches.

Clarion loam.—Clarion loam is developed chiefly in the extreme northwestern part of the county along two short tributaries of Little Sioux River. It occupies the eroded slopes within a few scattered areas having gently rolling relief. The thin mantle of loess, which at one time covered these areas, has been removed, and the glacial drift has been exposed. This soil covers a small total area and is of little agricultural importance.

The surface soil, to a depth of 10 inches, is dark-brown friable loam containing some small gravel. The upper subsoil layer is yellowish-brown silty clay loam containing considerable gravel and coarse sand. At a depth of 24 inches there is yellowish-brown gritty silty clay loam containing some gravel and a few boulders. Lime is present in the parent glacial drift, at a depth ranging from about 24 to 30 inches, in the form of nodules and free lime. Iron stains are numerous in the lower part of the subsoil. A few glacial gravel deposits ranging from 10 to 25 feet in width occur in this soil.

Typical Clarion loam is farmed with the adjacent Marshall soil areas and produces somewhat lower yields. In periods of drought it is likely to be affected more adversely than is Marshall silt loam, as the heavier subsoil does not provide so large a store of available moisture as does the lighter textured Marshall subsoil. Corn, oats, and clover and timothy hay are the principal crops.

This soil needs the incorporation of organic matter in order to increase its productivity, and it also will respond to fertilizer treatments. Experiments with superphosphate have given excellent results on this soil.

Clarion loam, steep phase.—The steep phase of Clarion loam occurs along the steeper slopes of Little Sioux River. The 4- to 8-inch surface soil is dark grayish-brown loam. The content of sand is high in some places, and the surface soil approaches a fine sandy loam in texture. The subsoil is grayish-yellow or yellowish-brown clay loam which is underlain, at a depth ranging from 24 to 30 inches, by calcareous glacial till. Boulders and gravel left by removal of the soil through erosion are more abundant than on the typical soil.

Only a small part of this soil is cultivated, on account of its tendency to wash and gully. Under cultivation the soil returns lower yields of corn than the typical soil—about 10 bushels an acre less. The untilled areas furnish good pasture, and nearly all of the land is used for this purpose.

Clarion silt loam.—Clarion silt loam is an inextensive soil developed in small isolated areas on eroded slopes along stream banks. Most of it is in the extreme northeastern part of the county along the upper reaches of Maple River, and in the northwestern part along Ashton Creek.

The 12-inch surface soil is dark grayish-brown silt loam. The upper subsoil layer is yellowish-brown silty clay loam containing considerable grit and some small gravel. Below a depth of 22 inches, the material is heavy silty clay loam containing much coarse sand, gravel, and a few boulders. Lime concretions and splotches are numerous, and many rust-brown iron stains are scattered through the lower subsoil layer.

This soil occupies slopes adjacent to the alluvial lands. Most of it is in cultivation, but a small proportion is in pasture grasses. It is unimportant agriculturally because of its small extent. Crop yields are about the same as those obtained on the adjoining areas of Marshall soils which generally occupy the more thickly loess covered slopes above Clarion silt loam. Incorporation of organic matter is the chief need of this soil.

SOILS OF THE FLAT TERRACES AND GENTLE SLOPES

The soils of the flat terraces and gentle slopes are scattered throughout the entire county along the larger tributary streams but are developed most extensively along Maple River. Extensive terraces also occur along Little Sioux River, which cuts through two sections in the extreme northwestern part of the county.

Most of the areas of terraces are nearly flat, with a gentle slope streamward, and they lie from 4 to 25 feet or more above overflow. For the most part they have silt loam surface soils and friable sub-

soils which afford excellent internal drainage. These soils are highly productive and, where the fertility is maintained, return some of the best yields of crops in the county. Waukesha silt loam is the most extensive soil developed on terraces, but O'Neill silt loam and O'Neill loam are also mapped. Judson silt loam is developed on colluvial slopes.

Waukesha silt loam.—Waukesha silt loam occurs along the larger streams over the entire county but is most extensively developed along Maple River. The benches occupied by this soil are flat, in most places having a gentle slope toward the stream, and all lie well above overflow.

The surface soil, which is about 14 inches thick, consists of friable dark grayish-brown silt loam. The upper part of the subsoil is brown silt loam or light silty clay loam. This layer is underlain, at a depth of 20 inches, by yellowish-brown silty clay loam. At a depth ranging from 4 to 5 feet the soil material is faintly mottled with rust-brown iron stains.

A few areas, which are similar to Marcus silt loam as mapped in Cherokee County to the north, are included in mapping. The soil in these areas, although similar in profile to the typical soil, occurs on benches having a 2- to 3-percent slope. These gently sloping areas occupy a position between the more rolling uplands and the bottom lands. The included soil is developed from loess deposited on old terraces or stream bottoms. The largest developments are along Maple River southwest of Battle Creek.

Waukesha silt loam is a "strong" soil and produces excellent crops. Because of its flatness, it is subject to a minimum amount of erosion. It lies from 5 to 20 feet above the first bottoms.

Drainage and the moisture-holding capacity of the soil are good. Crops are rarely injured by drought, and crop yields are about the same as on the better areas of Marshall silt loam of the uplands. Corn, the principal crop, yields from 40 to more than 60 bushels an acre, depending on the fertility of the soil and on the management. Oats, clover, and timothy are used chiefly in rotation. Oats yield from 35 to 65 bushels an acre, depending on seasonal conditions. Clover does well on most fields.

This soil has an excellent physical structure, which makes it easy to farm. The surface soil generally is only slightly acid and the subsoil slightly to moderately acid. Phosphatic fertilizers make good returns on this soil, especially where the land has been farmed for some time. The growing and turning under of green-manure crops is needed to build up and maintain the productivity.

Judson silt loam.—Judson silt loam occurs in small areas on colluvial fans at the bases of slopes and in places where small tributary streams enter the bottoms.

The surface soil is dark grayish-brown or almost black silt loam to a depth of 20 inches or more, and below this is dark-gray heavy silt loam which continues to a depth of 26 or 28 inches. The subsoil is yellowish-brown or brown heavy silt loam or light silty clay loam, with black and some faint gray mottles. Rust-brown iron stains are numerous in the lower part of the subsoil. The parent material consists of colluvial silts washed down from the dark-colored upland soils onto the low terrace or bottom lands, and characteristically it

does not change much in color and texture to a depth of 24 inches. In places the mellow dark-colored silt loam is more than 36 inches thick.

This is one of the most productive soils in the county. It is developed from materials accumulated through surface erosion from adjacent or nearby slopes. All the land is under cultivation. Corn, oats, and hay are the principal crops. Depending on the season, corn yields range from 50 to 70 bushels an acre, oats from 45 to 65 bushels, and hay from 1½ to 3 tons. The soil is well drained and easy to cultivate and is an ideal cropping soil. Crops withstand longer periods of drought on this soil than on the other soils of the county and produce high yields.

Generally corn is grown for 2 or 3 years in succession on this soil, after which clover or timothy is seeded, with oats as a nurse crop. No commercial fertilizer is used. No farms are entirely on this soil, but the land is farmed in conjunction with the adjacent soils. In places it merges into the soils of the bottom lands so gradually that the boundaries appear to be more or less arbitrary.

O'Neill silt loam.—Only a few small areas of O'Neill silt loam are mapped. The largest area is along Little Sioux River in the extreme northwestern part of the county, another is 3½ miles north of Galva, and a few are along small tributary streams. The areas along Little Sioux River vary slightly in texture of the surface soil. In places there is a considerable content of very fine sand.

For the most part the land is flat, but some low wavelike ridges are adjacent to the bottom lands or in places where swales or small streams carry drainage waters from the hills in times of overflow.

The 12-inch surface soil is dark grayish-brown silt loam that contains considerable very fine sand in places. The upper subsoil layer is yellowish-brown gritty sandy clay loam, which is underlain, at a depth ranging from 20 to 28 inches, by a layer of stratified gravel and sand.

This soil has only fair moisture-holding capacity, owing to the sandy and gravelly subsoil; it is inclined to be droughty and only in seasons of unusually heavy rainfall will it produce as well as the Waukesha and Marshall soils. Corn yields range from 15 to 45 bushels an acre, oats 18 to 40 bushels, and hay 1 to 2 tons.

O'Neill loam.—O'Neill loam occupies a few small isolated areas, most of which are west of Galva and in the vicinity of Ida Grove. Some are in the extreme northwestern part of the county bordering Little Sioux River and its tributary streams.

The 10-inch surface soil is dark grayish-brown loam containing considerable coarse sand and gravel. The soil beneath, to a depth ranging from 20 to 24 inches, is yellowish-brown sandy clay containing a high proportion of sand. In places this layer is sandy loam. The substratum is composed of unconsolidated sand and gravel, together with some boulders.

This soil is unimportant agriculturally because of its small extent. The common field crops are grown. Corn yields from 15 to 40 bushels an acre, oats 15 to 35 bushels, and hay 1 to 1½ tons in favorable seasons. Drainage is excessive and crops suffer in periods of drought. With good management, however, this soil will produce fair average crops. The incorporation of organic matter is commonly the greatest need of O'Neill loam.

SOILS OF THE STREAM BOTTOMS

The soils of the stream bottoms occupy the lower positions along the larger drainageways, where they have developed over sediments deposited by the streams during periods of high water. The sediments, which were deposited by local streams flowing from areas of loess and have a high content of silt, are of rather recent origin compared with those from which the terrace soils have developed. Wabash silt loam and Wabash silty clay loam are dark-colored soils developed over silty material. The parent material of Ray silt loam also was silty, but the upper layer has developed over lighter colored silt recently deposited over a dark-colored soil. The Wabash-Judson silt loam complex occupies a position partly in the bottoms of small drainageways and partly extending up the better drained slopes. The soils of the larger stream bottoms are nearly level and are so low that they are subject to overflow at intervals of 2 or 3 years, but drainage, although slow, is sufficient in most places to remove floodwaters before serious damage is done to crops.

Wabash silt loam.—Wabash silt loam, the most extensive soil in this group, borders almost every stream in the county. The largest development is along Maple River.

The 16-inch surface soil is dark grayish-brown or black silt loam. The upper subsoil layer is dark grayish-brown silty clay loam which is discolored with organic infiltration and contains some rust-brown iron stains. The lower subsoil layer, below a depth of 22 inches, is gray silty clay loam or silty clay, mottled somewhat with brown and rust-brown iron stains. The surface soil varies in texture from place to place. In some of the flat depressed areas the soil is nearly a silty clay loam in texture, being heavier than the typical soil. A few small areas of Wabash loam, differing only in having more sand incorporated in the surface soil, are included with this soil in mapping. These areas would be mapped as Wabash loam if their size warranted the separation.

A few scattered trees, mainly cottonwood, elm, maple, and willow, grow along the larger streams. Most of the wider areas bordering the larger streams are cultivated, but the narrow ribbonlike strips of bottom land bordering the smaller tributaries are used largely for pasture. Corn is the principal crop and is grown for 3 or 4 years in succession in many fields. Oats are the chief small grain, and some wheat is grown. Timothy and clover mixed is the principal tame-hay crop, and some clover is grown alone. The permanent pastures are chiefly of bluegrass. Corn yields from 35 to more than 65 bushels an acre, depending on the season; oats 25 to 60 bushels, wheat 18 to 35 bushels, and clover and timothy hay 1½ to 2½ tons. Wild hay is cut from a few small areas.

Better management and better rotations are needed on many areas of this soil. Deeper plowing and more frequent seeding to grass would greatly improve the yields on many farms. Cornstalks ordinarily should be turned under rather than burned, as is the common practice on many farms. Practically no commercial fertilizer is used on this soil.

Wabash silty clay loam.—Wabash silty clay loam covers a small total area and occurs principally in the stream bottoms of Maple

River in the extreme northeastern part of the county and of Little Sioux River in the extreme northwestern part.

The surface soil is dark grayish-brown or black silty clay loam to a depth of 12 inches. Below this is very dark gray silty clay loam or silty clay, mottled somewhat with brown and rust-brown iron stains. The lower subsoil layer is grayish-brown silty clay loam mottled with brown, gray, yellow, and rust-brown iron stains.

Surface drainage is slow, owing to the flat or depressed character of the land, and internal drainage is retarded by the heavy impervious substratum. In a few places areas of 2 or 3 acres each are ponded during a part of the year. About one-half of this land is used for pasture, and the rest is cultivated, principally to corn. Yields of corn are variable because of moisture conditions, but they range from 30 to 50 bushels an acre in favorable seasons. Too much rain in the early part of the growing season will retard the crop materially. Clover and timothy grow luxuriantly and yield from 2 to 3 tons of hay an acre. Oats are apt to lodge because of the high organic content of the soil. Short stiff-strawed varieties of small grains should be grown.

The principal need of this soil is incorporation of coarse materials, such as cornstalks and sweetclover, to aid in aeration and drainage. Continuous cropping to corn lowers crop yields, but this practice prevails on many of the soils in the bottom lands. Drainage of these areas by tiling or open ditches would increase crop yields.

Ray silt loam.—Ray silt loam is developed principally southwest of Battle Creek along Maple River where light-colored colluvial or alluvial materials are washed over the darker colored Wabash soils. The light-colored material is carried down from the surrounding slopes by small tributary streams and deposited near the uplands as alluvial fans, or is deposited along the channels of the larger streams and spread back over the bottom land for a distance of a few hundred feet.

The surface soil is yellowish-brown smooth friable silt loam to a depth of 16 inches, where it is underlain by darker yellowish brown heavy silt loam that is only slightly heavier in texture. The depth of the light-colored soil layers ranges from a few inches to 3 feet and averages about 20 inches. The light-colored soil rests on dark grayish-brown or almost black light silty clay loam or heavy silt loam.

Drainage is good, but the organic content of this soil is low, as is indicated by the light color. The alluvial fans occupied by this soil are built up above the surrounding bottom lands but are farmed with the Wabash soils.

Yields of corn are somewhat lower than on the dark-colored Wabash soils. Small grains do well. The soil generally is neutral or slightly calcareous in the upper layers.

Wabash-Judson silt loam.—Wabash-Judson silt loam, which is a complex mixture of soils, occurs in small draws at the heads of drainageways, which extend fingerlike into all parts of the upland. The parent material consists chiefly of silt and clay brought down from the adjacent slopes by sheet erosion. The soils of these shallow valleys differ according to position. On the slopes, especially on the lower part, the soil is thick and consists of Judson silt loam or ap-

proaches that soil in its principal characteristics. The surface soil is dark grayish-brown silt loam ranging from 1 to 2 feet in thickness. Below this is grayish-brown or brown silt loam which shows evidence of fairly good drainage. Along the lower parts of the drainageways the soil has developed under conditions of excessive moisture and has a profile similar to that of typical Wabash silt loam. The surface soil in these situations is dark grayish-brown or black heavy silt loam to a depth ranging from 12 to 16 inches. It is underlain by dark grayish-brown or black silty clay loam. Below a depth ranging from 20 to 28 inches the soil material is dark grayish-brown silty clay loam mottled with yellowish-brown and rust-brown stains.

In general the Judson soil occurs along the slopes in narrow strips separated by a still narrower strip of lower lying Wabash silt loam. The combined width of the strips in most of the areas ranges from 100 to 300 feet, and their length from one-fourth to one-half mile.

Nearly all of this type of land is in cultivation. It comprises only a small part of most of the farms on which it occurs and may be the best part if drainage is good. The productivity is naturally high, and more moisture is available for crops than in most soils. In the few places where drainage is deficient, the soil can be improved by tiling. Corn, the principal crop, returns higher yields than those obtained on the adjoining areas of Marshall silt loam.

A variation of this complex soil condition in the north-central part of the county in the vicinity of Holstein has similar topographic position but is developed under conditions of more deficient drainage. Here the 16-inch surface soil is black or nearly black heavy silt loam, underlain to a depth of 26 inches by grayish-brown silty clay loam, highly mottled with rust-brown stains. Below this is mottled gray, brown, and yellow silty clay loam or silty clay, containing many rust-brown iron stains and concretions. The soil is highly productive where properly drained. About 60 percent of the included areas is cultivated, and crop yields are about the same as on other parts of this complex soil material.

PRODUCTIVITY RATINGS

In table 6 the soils of Ida County are rated according to their capacity to produce the more important crops of the Corn Belt and are listed in the approximate order of their general productivity under current farming practices.

The rating compares the productivity of each soil for each crop to a standard, namely 100. This standard index represents the approximate average acre yield obtained without amendments on the more extensive and better soil types of the regions in which the crop is most widely grown. An index of 50 indicates that the soil is about half as productive for the specified crop as are those with the standard index. Soils given amendments, such as lime, commercial fertilizers, and irrigation, and unusually productive soils of comparatively small extent may have productivity indexes of more than 100 percent for some crops.

TABLE 6.—*Productivity ratings of soils of Ida County, Iowa*

Soil [1]	Crop productivity index [2] for—							General productivity grade [3]	Land classification [4]
	Corn	Oats	Barley	Clover and timothy	Alfalfa		Pasture		
					Without lime	With lime			
Judson silt loam	110	100	100	100	80	95	110	1	Excellent cropland.
Wabash silt loam, better drained areas.	105	95	100	100	45	90	110		
Wabash-Judson silt loam, better drained areas.	105	95	100	100	70	95	110		
Waukesha silt loam	100	100	100	100	45	95	100		
Marshall silt loam	90	90	90	95	55	95	95		
Clarion silt loam	85	90	90	85	40	85	90		
Clarion loam	80	80	80	80	35	75	85	2	Good cropland.
Ray silt loam	65	80	80	90	65	70	70	3	
Marshall silt loam, light-colored phase. [5]	65	65	65	65	50	60	70	4	
Wabash silty clay loam [6]	60	50	50	110	-------	-------	110		
O'Neill silt loam	55	65	65	50	10	50	50	5	Fair cropland.
O'Neill loam	50	60	60	40	10	40	50		
Marshall fine sand	25	30	30	25	-------	25	30	7	Poor cropland.
Wabash-Judson silt loam, poorly drained areas.	-------	-------	-------	-------	-------	-------	110	8	Pasture land.
Wabash silt loam, poorly drained areas.	-------	-------	-------	-------	-------	-------	110		
Clarion loam, steep phase	-------	-------	-------	-------	-------	-------	35	9	

[1] The soils are listed in the approximate order of their general productivity under the average current practices, the most productive first.

[2] The soils of Ida County are given indexes that indicate the approximate average production of each crop in percent of the standard of reference. The standard represents the approximate average yield obtained without use of amendments on the more extensive and better soil types of the regions in which the crop is most widely grown. The indexes are largely estimates, especially for pasture, as yield data are yet too fragmental to be adequate.

[3] This classification indicates the comparative general productivity of the soils under dominant current practices. Refer to text for further explanation.

[4] This is a general classification to indicate the physical suitability of the soils for farming or grazing uses. In the actual delineation of land classes on a map other considerations such as the pattern of distribution of soil types are important.

[5] These indexes refer to the more extensive and better areas.

[6] Applies to better drained areas. Poorly drained areas are used largely for pasture.

The following tabulation sets forth some of the acre yields that have been set up as standards of 100. They represent long-time average yields of crops of satisfactory quality on the better soils without the use of amendments.

Crop:		
Corn	bushels	50
Oats	do	50
Clover and timothy	tons	2
Alfalfa	do	4
Pasture	cow-acre-days [1]	100

[1] Cow-acre-days is a term used to express the carrying capacity of pasture land. As used here it is the product of the number of animal units carried per acre multiplied by the number of days the animals are grazed without injury to the pasture. For example, the soil type able to support 1 animal unit per acre for 360 days of the year rates 360, whereas another soil able to support 1 animal unit on 2 acres for 180 days of the year rates 90. Again, if 4 acres of pasture support 1 animal unit for 100 days the rating is 25.

Drainage is not an important problem in this county, except on a few flat depressed areas in the first bottoms. Two ratings have been given to Wabash-Judson silt loam and Wabash silt loam, on the basis of differences in drainage. These two ratings represent the estimated yields obtained under extremes of good and poor drainage, and some areas of intermediate drainage fall between these two in productive capacity. On account of its limited acreage, Wabash

silty clay loam was not given two ratings on the basis of drainage differences. Drainage is slow on this soil, and the wetter part—approximately one-half of the area—is in pasture. The better drained areas are cultivated. Artificial drainage doubtless would raise the productivity of most of this soil.

The principal factors determining the productivity of land are generally stated to be climate, soil (this includes a long list of physical, chemical, and biological characteristics), slope, drainage, and management. Actually, no one of these factors operates distinctly from the others, although some one may dominate. The soil type itself is conceived by the modern soil scientist as representing "the combined expression of all those forces and factors that, working together, produce the medium in which the plant grows." Crop yields over a long period of years furnish the best available summation of these associated factors and, therefore, are used where available. In this rating of the soils of this county, many of the indexes are based on inductive estimates rather than on actual reported yields. This is necessary because of lack of definite information. It is thought, however, that the rating gives a fairly accurate picture of the relative productivity of the soils of the county.

The soils are listed in the order of their general productivity, under dominant current practices, and productivity grade numbers are assigned in the column General productivity grade. The general productivity grade is based upon a weighted average [8] of the indexes for the various crops, using the approximate areal extent and value of the various crops in the county as bases, except in instances of a few soils upon which certain crops are not grown, as some of the poorly drained soils. If the weighted average falls between 90 and 100 the soil type is assigned a grade of 1; if it falls between 80 and 90, a grade of 2 is given, etc. Since it is difficult to measure mathematically either the exact significance of a crop in local agriculture or the importance and suitability of certain soils for particular crops, the weightings set up were used only as guides. Certain modifications dictated by personal judgment have been permitted in the general rating of the soils.

The column Land classification summarizes in a simple way the productivity and use capabilities of the various soils by placing them in a few groups on the basis of their relative suitability for farming and grazing.

Productivity tables do not present the relative roles that soil types, because of their extent and the pattern of their distribution, play in the agriculture of the county. The tables give a characterization to the productivity of individual soil types. They cannot picture the total quantitative production of crops by soil areas without the additional knowledge of the acreage of the individual soil types devoted to each of the specified crops.

Economic considerations have played no part in determining the productivity indexes. Therefore, they cannot be interpreted into

[8] The weights in percentage given each crop index to arrive at the general productivity grade were (with a few exceptions) as follows: Corn, 50; oats, 30; timothy and clover hay, 10; alfalfa, 5; and pasture, 5. In the case of Wabash silty clay loam the weighting was adjusted to compensate for the lack of an index for alfalfa, and in that of the soils rated only for pasture a weighting of 25 was given to the pasture index.

land values except in a very general way. Distance to market, relative prices of farm products, and other factors influence the value of land.

LAND USES AND AGRICULTURAL METHODS[9]

Ida County has a high percentage of cultivable land. According to the 1935 Iowa Yearbook, 196,835 acres, of the 271,370 acres in the county in farms, were in crops. Of the land in crops, 46.9 percent was in corn, 30 percent in oats, 9.1 percent in tame hay, 8.9 percent in barley, and the remainder in minor crops. Of the total acreage in farms, pasture occupied 29 percent.

Farming centers around the production of corn for feeding livestock. The raising and feeding of cattle and hogs constitute the chief livestock activities, although dairying has become an important source of income within the last decade. Most of the grain produced on the farm is marketed through the feeding of livestock, but a small proportion is sold locally.

Ordinarily cornland is plowed in the fall, but some of the steeper land is not plowed until spring. Large areas in the county are strongly rolling and should be plowed and cultivated along the contours, but very little contour plowing is done. Much sweetclover is used for pasture and for a green-manure crop. It is sometimes plowed under after the first severe frost but generally is left until spring. Much sheet erosion takes place in late fall and early spring when the land is unprotected by a cover of vegetation, as is evidenced by the light-colored strips and spots on hillsides. In places the soil on the entire slope is yellowish brown, indicating the removal of all or nearly all the original surface soil. The plowing under of sweetclover systematically on these sheet-eroded slopes will build up the fertility of the soil rapidly.

In this county the soils developed from loess dry rapidly in the spring and can be worked early. Fields are double disked and harrowed, and corn generally is planted from May 10 to May 20, depending on the season. Practically all of the corn, except that used as silage or for hogging down, is planted in checkrows. The first cultivation is done with a harrow. Ordinarily corn is cultivated three times but sometimes four, if the growth of weeds makes it necessary. The last cultivation is usually done between July 10 and July 20, depending on the growth of the corn. Corn is harvested from the last of October through November. Corn-picking machines are used more extensively each year, as there is not sufficient labor available to harvest the crop. Much of the corn is still husked by hand by the farmer and his family. Covered cribs are used for the storage of corn, except in seasons of heavy production, when additional open cribs of wire or slat fencing are used. In 1935, 91,724 acres were in corn; 92 percent of the corn was husked or snapped for grain, 3 percent cut for silage, 4 percent cut for fodder, and 1 percent hogged down; and 17,684 tons of silage was stored.

Popcorn is grown extensively in the eastern part of the county. It is planted in checkrows that are somewhat closer together than those of field corn. The White Rice variety is planted from 48 to 60

[9] All statistics in this section are taken from the annual Iowa Yearbook of Agriculture for 1935. See footnote 4, p. 6.

inches apart, and the Japanese Rice from 30 to 36 inches apart. This crop is cultivated four or five times during the season, depending on seasonal rains and the growth of weeds. In 1935 a total of 6,239 acres were devoted to this crop.

Oats, the second most important crop, were grown on 58,968 acres in 1935, with an average yield of 30.4 bushels an acre. Yields ranging from 50 to 70 bushels are common in favorable seasons on the better farms. Oats follow corn in the rotation. The cornstalks are disked after the field is dragged, and the oats are sown broadcast at the rate of 2 to 3 bushels an acre. The grain is cut in July and threshed from the shock. Most of the oats are fed on the farm, but some are sold for cash to local elevators. Barley also is an important feed crop, and 17,415 acres, averaging 23.8 bushels an acre, were grown in 1935. Only 310 acres were reported in wheat for that season.

Tame hay was cut from 17,926 acres in 1935, or approximately 10 percent of the land in cultivation, of which 9,042 acres were in alfalfa, 3,649 acres in clover and timothy, 1,679 acres in soybean hay, and 3,556 acres in all other tame grasses. Practically all of the hay crop is fed to livestock. Alfalfa is cut three times during the season, and yields range from 3 to 4 tons of hay an acre. Clover and timothy yield from 1½ to 2 tons an acre. Both alfalfa and mixed timothy and clover are used for pasture. In fields where the second crop of clover is turned under, large yields are obtained from the following corn crop.

In many places, especially in the northern and eastern parts of the county, the surface soils are slightly to moderately acid, and lime is needed in some fields to insure stands of alfalfa. Tests of the soils should be made in order to determine their need for lime. Bluegrass is an important pasture grass. It grows on almost all of the soils and is especially luxuriant on the bottom lands. Much of the pasture is rotation pasture, consisting of timothy and clover (principally), alfalfa, or sweetclover. Because of the intensive livestock raising and feeding in this county, rotation pastures are necessary and generally are carefully grazed and maintained.

Grain sorghums are grown extensively for feed. Small acreages of millet, Sudan grass, and rape are grown for feed. Flax was grown extensively in the early days, but at present only a small acreage is planted.

Crop rotations are practiced on most farms, but improved rotations are needed. Common rotations are: Corn, corn, and oats; and corn, corn, oats, and clover. The 3-year rotation is not adequate. In places where the soil is low in organic matter, corn should be grown only 1 year and should be followed by a small grain, with a seeding of clover and timothy, or sweetclover. Improved rotations, contour plowing, contour strip cropping, seeding of waterways, the use of diversion terraces around the tops of the slopes where needed, and control of gullying are required for adequate conservation of the soils in this county.

Average results obtained by the Iowa Agricultural Experiment Station on experimental plots on Marshall silt loam in northwestern Iowa, which are similar to the soils in Ida County, are given in table 7. The experimental plots are one-tenth acre in size and are established on farms where the soil is typical and where definite rotations are practiced. The farmer cooperator handles the plots along with his regular field, doing the planting and cultivating. Applications of fertilizers and lime are made by a fieldman from the experiment station, who harvests the crops and records the results obtained.

The experiments include tests of different fertilizers under the livestock system of farming. A series of nine plots was used, three of which were check plots. Crop residues were plowed under after having been cut by a disk or cutter. Raw rock phosphate, superphosphate, muriate of potash, and complete commercial fertilizer, together with lime and manure, are used in the tests. Manure is applied at the rate of 8 tons an acre once in a 4-year rotation. The first cutting of clover is used for hay, and the second is either pastured, harvested for seed, or plowed under.

Tests are made of the soil for acidity, and the soil is supplied with sufficient limestone to neutralize. Tests of the lime requirement for plots are made once in the rotation, and additional lime is applied every fourth year if needed.

Both rock phosphate and superphosphate are used. 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. Since 1932, 500 pounds an acre has been used. Superphosphate (16 percent) was applied annually at the rate of 200 pounds an acre at first; in 1923 a reduction to 150 pounds annually was made for all grain crops and the application was omitted for the legume crop; and since 1929, 120 pounds of 20-percent superphosphate has been used.

Complete commercial fertilizer—a 2–8–2 [10] mixture—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 used at the rate of 200 pounds an acre.

Potash was applied as muriate of potash at the rate of 50 pounds annually on all grain crops, and was omitted only on the legume crop.

Five experiment fields located on Marshall silt loam in northwestern Iowa are representative of this soil in that section of the State. These fields are located in Cherokee, Woodbury, Sioux, and O'Brien Counties.

Table 7 gives the average acre yields and increases due to manure, lime, and fertilizer treatments on Marshall silt loam for the fields located in the counties named above.

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

TABLE 7.—*Average acre yields*[1] *of crops and increases due to fertilizer treatment on Iowa experiment fields*[2] *on Marshall silt loam in northwestern Iowa*

Treatment	Corn		Oats		Alfalfa	
	Average yield	Increase from treatment	Average yield	Increase from treatment	Average yield	Increase from treatment
	Bushels	*Bushels*	*Bushels*	*Bushels*	*Tons*	*Tons*
Check[3]	45.5		49.4		2.64	
Manure	48.3	2.8	56.0	6.6	2.80	0.16
Manure+limestone	50.4	4.9	58.1	8.7	2.95	.31
Manure+limestone+rock phosphate	50.6	5.1	61.2	11.8	3.08	.44
Manure+limestone+superphosphate	51.7	6.2	60.6	11.2	3.05	.41
Manure + limestone + superphosphate + muriate of potash	52.2	6.7	62.4	13.0	3.06	.42
Manure+limestone+complete commercial fertilizer	52.1	6.6	64.1	14.7	3.07	.43

[1] Corn yields averaged from 22 crops on 5 fields, oat yields from 10 crops on 5 fields, and alfalfa yields from 10 crops, representing 22 cuttings, on 4 fields. (Includes 1935 data.)
[2] Primghar field, series 1; Lawton field, series 1; Ireton field, series 3; Orange City field, series 2; and Cherokee field, series 1.
[3] The yields given for the checks are the average of the yields on all check plots on all fields.

The effectiveness of barnyard manure on all crops is evident. Lime with manure almost doubled the increase in yields of corn and alfalfa over those obtained when manure was used alone.

The results of acre yields in a field experiment, from 1922 to 1934, inclusive, on the Cherokee field in Cherokee County, are given in table 8.

TABLE 8.—*Acre yields in field experiment on Cherokee field*,[1] *series 1, on Marshall silt loam, in Cherokee County, Iowa*

Plot No.	Treatment	Corn		Oats, 1924	Timothy and clover, 1925	Corn			Oats, 1929	Clover, 1930	Corn		Barley, 1933	Alfalfa, 1934[3]
		1922	1923			1926	1927	1928			1931[2]	1932		
		Bu.	*Bu.*	*Bu.*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Tons*
1	Check	59.8	51.2	49.0	1.87	34.6	47.9	43.5	88.5	1.59	----	54.8	31.8	1.90
2	Manure	64.9	56.1	54.7	2.03	32.8	52.9	45.5	91.8	1.62	----	56.2	38.6	1.88
3	Manure+limestone	66.6	59.8	55.5	2.18	35.2	53.7	49.2	99.8	1.97	----	62.2	46.1	2.16
4	Manure + limestone + rock phosphate	69.8	60.8	60.6	2.16	37.6	54.8	49.1	103.3	1.99	----	64.7	46.5	2.22
5	Manure + limestone + superphosphate	70.8	61.3	61.6	2.37	46.2	57.9	47.2	106.7	2.24	----	64.3	52.2	2.30
6	Manure + limestone + superphosphate + muriate of potash	72.6	61.9	62.0	2.29	49.2	55.7	44.5	102.2	2.32	----	63.0	57.1	2.27
7	Manure + limestone + complete commercial fertilizer	74.2	62.8	70.3	2.38	46.0	49.7	47.3	103.3	2.21	----	62.7	51.4	2.19
8	Check	61.1	52.7	55.2	1.99	36.3	43.6	44.5	90.8	1.72	----	58.7	41.2	1.27

[1] Cherokee field, series 1, was established in the fall of 1921, on the State hospital farm at Cherokee, in Cherokee County. It is located in the NE¼SE¼ sec. 20, T. 92 N., R. 40 W.
[2] Hot dry weather seriously damaged the corn; no harvest.
[3] Total of two cuttings.

The consistent and ready response of Marshall silt loam to manure and lime combined with rock phosphate and superphosphate is shown in both tables 7 and 8, which indicate them to be the most economical and valuable fertilizers for this soil. Fertilizers should first be tried in small strips in the field, in order to determine their efficiency and economic use on the individual farm. Fields should be tested carefully before lime is applied. The soils are neutral in many places

in this county, especially where erosion has removed part or all of the original surface soil. All the soils respond strongly to green manures. Sweetclover can be grown without lime on most of the farms, and is especially valuable in helping to build up the fertility of the soils. Phosphates seem to be beneficial and economical on most farms, as phosphates improve the quality of the grain and hasten maturity. In extremely dry seasons commercial fertilizers give little or no increases in yields.

A 3-year rotation of corn, small grain, and clover is recommended by the State experiment station for land that has been depleted of organic matter and is not giving a maximum return. Improved rotations are needed on many farms, as sheet erosion is removing much surface soil annually. The most common rotation practiced is corn, corn, oats, and clover. This rotation is not adequate for the building up of the soil, and corn should be grown only 1 year in places where the fertility is low.

The seeding down of waterways is very important, as gullies form rapidly in drainageways in these mellow and friable soils. Seedings should be extended well up the sides of the drainageways, in order to prevent cutting along the edges.

Drainage is not a problem on any of the soils, except in a few flat depressed areas in the first bottoms, and here tile and open ditches are recommended for remedying this condition.

Control of run-off and prevention of sheet erosion are the principal problems. Because of the fine silty character of the soils, they erode readily. In the more rolling areas the original surface soil has been entirely removed from many slopes, as is shown by the yellowish-brown color of the present surface soil. Only in the nearly level cultivated uplands in the extreme northeastern part of the county is the surface soil of Marshall silt loam as deep as when the prairie was first broken for cultivation.

MORPHOLOGY AND GENESIS OF SOILS[11]

The soils of Ida County lie within the Prairie soil region of the United States. The original prairie grasses established a thick mass of roots, and the annual growth and decay of the root fibers have filled the topmost layer with decayed vegetation and formed a dark-colored surface layer ranging from 10 to 18 inches in thickness. Moisture and temperature conditions were favorable for the maximum bacterial and chemical soil-forming activities, the preservation of a high organic content, and a mature or nearly mature profile for this section.

The 10- to 18-inch surface layer of the typical normally developed soil profile of this section is very dark grayish-brown mellow floury or fine-granular silty material. The subsurface layer, extending to a depth ranging from 20 to 24 inches, is similar to the surface soil in texture and structure but is of a medium-brown or dark-brown color. It grades into a yellowish-brown heavier and more compact layer which extends to an average depth of about 36 inches, though this depth varies considerably according to relief. This is the layer of maximum compaction, and it is heavier than either the layers

[11] Much additional useful information on the morphology and genesis of soils may be obtained from the 1938 Yearbook of Agriculture, Soils and Men.

above or the underlying parent material from which the soil is developed. The parent material is pale-yellow or grayish-yellow loessial material containing a very large proportion of silt. It is high in carbonates, mostly calcium carbonate.

In many places erosion has progressed at a rapid rate since the breaking of the prairies and the planting of cultivated crops. Erosion has been active on the more rolling areas because of the more rapid run-off, and consequently the limy subsoil lies nearer the surface. On undulating ridges, where the surface is more nearly flat, the soil material is leached to a depth ranging from 60 to 80 inches in places, whereas in many places on the narrower rounded ridges the lime zone in the subsoil is within 3 feet of the surface.

The dark-colored surface layer varies in thickness. In the smoother areas, where sheet erosion has removed little or none of the original surface soil, and where run-off was slight and the native vegetation grew luxuriantly, the surface soil is from 12 to 16 inches thick. On the gentle to rolling slopes the original dark-colored surface soil was thinner. Also where poor rotations have been used, sheet erosion has removed much or all of the original surface soil. The thickness of the original surface soil, in general, decreases as the slope increases. The soil-forming processes acted most completely on the more level areas, and the soil formed has not been removed by rapid erosion.

The upland soils belong principally to the Marshall series.[12] They have developed from a loessial mantle which ranges from a few feet to more than 30 feet in thickness. The relief ranges from almost level to strongly rolling. Drainage is good, owing to the friable consistence of the subsoil, which is due in part to the high content of silt. A description of a representative profile of Marshall silt loam, observed in a pit in sec. 5, T. 88 N., R. 40 W., follows:

1. 0 to 3 inches, very dark grayish-brown silt loam filled with a dense mat of grass roots. Faint laminations appear in this layer.
2. 3 to 12 inches, very dark grayish-brown or almost black smooth silt loam which is medium granular and breaks into aggregates from one thirty-second to one-eighth of an inch in diameter. Crushing of the aggregates lightens the color somewhat.
3. 12 to 17 inches, dark-brown friable silt loam slightly lighter in color than the material in the layer above. The uniform dark color is due to organic infiltration. When crushed between the fingers, the color is brown. This is a transitional layer.
4. 17 to 36 inches, moderately dark yellowish-brown light silty clay loam which is uniform in color and texture. This is the zone of maximum compaction. The material breaks into small aggregates less than one-fourth inch in diameter. It includes much fine loose silt.
5. 36 to 48 inches, yellowish-brown heavy silt loam containing a high proportion of clay. Some black iron stains occur, mostly in fine myceliallike threads. The material contains a few fine grains of quartz. No effervescence takes place with hydrochloric acid.

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[12] Physical and chemical analyses of the Marshall soils in Iowa are given in the following: ROBINSON, W. O., and HOLMES, R. S. THE CHEMICAL COMPOSITION OF SOIL COLLOIDS. U. S. Dept. Agr. Bull. 1311, 42 pp. 1924.

MIDDLETON, H. E., SLATER, C. S., and BYERS, HORACE G. PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE SOILS FROM THE EROSION EXPERIMENT STATIONS. U. S. Dept. Agr. Tech. Bull. 316, 51 pp. 1932.

——— SLATER, C. S., and BYERS, H. G. THE PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE SOILS FROM THE EROSION EXPERIMENT STATIONS—SECOND REPORT. U. S. Dept. Agr. Tech. Bull. 430, 63 pp., illus. 1934.

6. 48 to 64 inches, pale yellowish-brown very friable silt loam containing some very fine sand, grains of which are visible when exposed to the sunlight. Many rust-brown iron stains occur in fine threads, with here and there a small nodule. A faint mottling of gray occurs in this horizon as dull-gray silt in a thin platelike layer, apparently the result of stratification by wind.
7. 64 to 90 inches, grayish-brown or grayish-yellow smooth highly calcareous silt loam, in which lime appears as white nodules and in finely divided form. Rust-brown iron stains and splotches are scattered through this layer.

The soil in strongly rolling areas of lighter colored Marshall silt loam differs from typical Marshall silt loam mainly in (1) the thickness of the surface layer, which generally is from 4 to 7 inches, and (2) the lighter color of the surface soil. In places the original surface soil is entirely lacking and the pale yellowish-brown subsoil is exposed. Carbonates are present at a much slighter depth than in typical Marshall silt loam. They occur at a depth ranging from 12 to 40 inches and averaging about 30 inches. On badly eroded slopes lime is abundant at the surface in nodules and in finely divided form. Owing to the superabundance of lime, which may constitute from 15 to 30 percent of the soil mass, many of these eroded spots, distinguished by their pale-yellow or, in dry weather, almost white color, are rather infertile, and the crops are said to "burn out" during droughty periods.

Waukesha silt loam has a profile, to a depth ranging from 50 to 60 inches, similar to that of Marshall silt loam, but the Waukesha soil occupies terraces. The land is almost flat and in general has a gentle slope toward the drainage channels.

The O'Neill soils are developed on terraces and are characterized by a gravel substratum at a depth ranging from 24 to 40 inches. The upper subsoil layers are yellowish-brown silty clay loam, similar to the subsoils of the Waukesha soils.

The soils of the flood plains are classed with the Wabash and the Ray series. The channels of the streams have been cut deeply, and these soils are seldom flooded. The channels are still becoming deeper in all except the larger streams.

SUMMARY

Ida County is in the high corn-producing section of the State, in northwestern Iowa and within the region occupied by Prairie soils. It comprises an area of 430 square miles, or 275,200 acres.

The relief ranges from gently undulating to rolling in the east-central, northeastern, and north-central parts of the county to gently rolling and strongly rolling in the central, western, and southern parts. The prevailing slope is toward the southwest. The elevation above sea level ranges from 1,225 to 1,443 feet.

All the drainage is toward and into the Missouri River. Maple River drains more than three-fourths of the county. The extreme northwestern part is drained by Little Sioux River and the southern part by Soldier and Boyer Rivers.

The county was organized in 1858. The population was 11,933 in 1930, all classed as rural. Ida Grove, the county seat, had a population of 2,206 in that year.

The climate is temperate and favorable to the production of all the general farm crops grown in this section. The mean annual temperature at Washta, Cherokee County, near the northwestern corner of Ida County, is 45.8° F., and the mean annual precipitation is 28.73 inches. The average frost-free period is 142 days.

All parts of the county are served by paved or graveled trunk highways, and nearly every section is traversed by well-graded dirt roads. Telephone and electric power lines reach many farm homes.

The agriculture consists chiefly of the production of corn, small grains, and hay; crops grown mainly for the feeding of cattle and hogs, which are the main sources of income. Dairying and poultry raising rank next in importance. Only a small part of the grain produced is sold for cash.

The soils of the county, as a whole, are highly productive. Only a very small proportion of them is unsuited for cultivation.

Most of the soils of the upland are developed largely from loess, although a small area is from glacial drift. The soils from drift—the Clarion soils—are for the most part exposed on sharp slopes where the original thin covering of loess has been removed by erosion.

Waukesha silt loam is similar to Marshall silt loam in profile, is high in natural fertility, is well drained, and produces crop yields comparable to those obtained on the better areas of Marshall silt loam. It occupies terrace benches well above overflow. Judson silt loam, a deep black soil, which occupies low terraces, also is highly productive. Wabash silt loam, the most extensive soil of the bottom lands, is very high in natural fertility and productiveness. It is estimated that about 70 percent of this soil is in cultivation. Wabash-Judson silt loam is extensively developed at the heads and along the upper parts of drainageways. It is highly productive. Wabash silty clay loam and Ray silt loam, soils of the first bottoms; O'Neill loam, developed on terraces; and Clarion loam, a soil developed on sharp slopes from glacial till, are inextensive and of minor importance.

U. S. GOVERNMENT PRINTING OFFICE: 1939

This soil survey is a contribution from

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