

U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF SOILS.
IN COOPERATION WITH THE IOWA AGRICULTURAL EXPERIMENT STATION.

SOIL SURVEY OF DES MOINES COUNTY, IOWA.

BY

T. H. BENTON, OF THE IOWA AGRICULTURAL EXPERIMENT STATION,
IN CHARGE, AND E. P. LOWE, OF THE U. S. DEPARTMENT
OF AGRICULTURE.

[Advance Sheets—Field Operations of the Bureau of Soils, 1921.]

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1925.

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Lindley S.
Davenport
Bremer

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[PUBLIC RESOLUTION—No 9.]

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

Congress, second session,
the printing annually of
"

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

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

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]

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MAP.

Soil map, Des Moines County sheet, Iowa.

SOIL SURVEY OF DES MOINES COUNTY, IOWA.

By T. H. BENTON, of the Iowa Agricultural Experiment Station, in Charge, and
E. P. LOWE, of the U. S. Department of Agriculture.

DESCRIPTION OF THE AREA.

Des Moines County is situated in the southeastern part of Iowa, approximately 135 miles from Des Moines, 200 miles from Chicago, and 40 miles northeast of Keokuk, the extreme southeastern point in the State. The Mississippi River forms the eastern boundary, which is also the Iowa-Illinois State line. Skunk River, flowing in a southeasterly direction, forms its southern boundary. Louisa and Henry Counties form the northern and western boundaries, respectively. The county is irregularly shaped on the east and south by the river boundaries. Its greatest dimension east and west is approximately 22 miles, and north and south about 25 miles. It contains 13 townships, embracing an area of 409 square miles, or 261,760 acres.

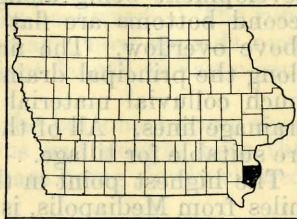


Fig. 37.—Sketch map showing location of the Des Moines County area, Iowa.

The land surface of the county may be roughly divided into two topographic divisions: (1) A gently undulating upland plain having a gentle slope to the southeast; (2) an alluvial belt along the Mississippi, Skunk, and Flint Rivers and their larger tributaries.

The upland is divided into two parts by the valley of the Flint River, which flows southeastward through the center. The inter-stream areas are broad and nearly flat, except close to the edge of the plain, where the cutting of many short tributary streams has resulted in a rough to hilly topography. In the vicinity of Mediapolis, Yarmouth, and Middletown the tops of the broad divides are nearly level and have not been penetrated by any drainage lines.

The entire plain is underlain by stratified limestone at depths ranging from 6 to 50 feet. A mantle of glacial drift covers the rocks, and in turn is covered by silty material, supposed to be loess. The loess forms the surface soil, except where erosion has cut gullies through the loess mantle and exposed the drift on the slopes.

The eastern margin of the plain consists of a line of bluffs with an almost sheer drop of 150 to 175 feet from the crest to the flat alluvial plain of the Mississippi River. The bluffs are formed of heavily

bedded limestone covered by yellowish-brown drift and loess, 5 to 20 feet thick, and underlain by softer shales, which occupy the lower half of the vertical height. The disintegration of these softer shales has left the harder limestone standing out in perpendicular or overhanging ledges at the higher part of the bluff wall. These limestone ledges are very near the main stream channel at Burlington and skirt the water's edge southward for about 5 miles. From Burlington northward to the county line the upper part of the bluff contains much limestone outcrop, forming overhanging or almost perpendicular cliffs 5 to 20 feet high. The lower part is commonly a steep drift-talus slope, becoming gradual at the lower part, the total slope reaching from one-half to three-fourths the distance to the crest.

The border of the plain on the south along Skunk River is less abrupt and rough. The fringing bluffs approach the bottom lands in a more gentle slope. A more uniform bluff line is established because the softer shales have dipped beneath the river channel. The border on both the south and east sides is dissected by small ravines and gorges.

The alluvial lands are extensive in Des Moines County, the greatest development being along the Mississippi River. The terraces or second bottoms are flat and benchlike and lie from 4 to 20 feet above overflow. The first bottoms or flood plains are developed along the principal drainage ways and their tributaries, and include much colluvial material along the heads of the narrow tributary drainage lines. All of the terrace and most of the first-bottom soils are suitable for tillage.

The highest point in the county, in the north-central part a few miles from Mediapolis, is 780 feet above sea level. Other recorded elevations¹ are Mediapolis, 764; Middletown, 724; Sperry, 757; Yarmouth, 704; Danville, 726; and West Burlington, 690 feet. Burlington, at the Union Depot on the river front, is 533 feet above sea level. The lowest point in the county is at the mouth of Skunk River, approximately 511 feet above sea level.

Des Moines County lies wholly within the Mississippi River drainage basin. The larger tributaries, the Flint and Skunk Rivers, carry the greater part of the surface drainage of the county.

The channel of the Mississippi River is near the center of the broad alluvial valley at the northeast corner of the county. A broad alluvial belt 5 miles wide extends southward for 10 miles, then gradually narrows down to $1\frac{1}{4}$ miles at the northeast edge of Burlington, where the Flint River has cut its channel through the Mississippi flood plain. Throughout the entire Mississippi River bottoms there are numerous bayous, sloughs, and lakes. The old bayous and sloughs are most numerous near the active river channel. Only a few contain running water at present, but many of them are partly filled during the rainy season.

A levee, which roughly parallels the river near the bank, extends from the northern county line to a point one-half mile north of the confluence of the Flint and Mississippi Rivers. The first-bottom or

¹ Gannett, Dictionary of Altitudes.

overflow land in most places extends back to the bluff base line. Approximately 30,000 acres of rich bottom land are protected from overflow. Three pumping plants carry the drainage waters of the inclosed levee districts from reservoirs over the levee into the river. Numerous large artificial drainage channels lead the waters from where they are emptied by the upland streams onto the alluvial land and from lakes and sloughs to these reservoirs. Many of the former shallow lakes and sloughs are now completely drained, and a large area of rich black clay soil has been reclaimed.

South of Burlington, where the Skunk River enters the Mississippi River bottoms, the plain opens again. Here it has no levee protection, as the cost of a levee is estimated at more than the maximum value of the protected land at its highest productivity. At this point the big Government power dam at Keokuk has so affected the current and raised the water level that silt, clay, and débris are not carried away, and the river as far north as Burlington is gradually being silted and has an almost lakelike surface. Many of the islands of the Mississippi River below Burlington are wholly or partly under water and the luxuriant stand of hardwood trees is being gradually killed. The raising of the water level has also affected the inundation of Skunk River bottoms for several miles headwards. The runoff from rains, which formerly did little damage, now spreads over the entire river bottom for periods of sufficient length to cause considerable damage.

There are practically no forested areas on the bottoms except close to the river channel and along the old bayous and sloughs near the river. The few remaining timbered areas are being slowly cleared and at present are used for pasture.

Near the center of the wide flood plain in the northeast corner of the county is a narrow disconnected strip of level terrace, 5 to 10 feet above former overflow, which extends southward for about 9 miles and is now protected by levee. Beginning at the base of the bluff south of Snider, a strip of terrace skirts the margin of the valley, extending southward into the business district of Burlington. A small bench-like lobe of sandy land occurs south of Burlington, adjacent to the upland bluff at Spring Grove.

The Skunk River, with its small tributary streams, drains about one-sixth of the county. The valley is narrow and V-shaped. A narrow, flat terrace adjacent to the valley wall extends in an almost continuous bench, nearly the full length of the county line. About 3½ miles below Augusta the river enters the broad Mississippi flood plain, following a meandering course for about 7 miles before it empties into the Mississippi. Spring, Brush, and Long Creeks, the principal tributaries, have deeply cut, V-shaped valleys, with numerous rock outcrops in their lower courses. The channels are flanked by narrow strips of first bottom.

The Flint River, with its branches, carries approximately two-fifths of the drainage of the total area. In its upper course the flood plain is narrow and the valley walls are short and steep. In the lower course the valley widens out, and narrow benches of terrace, with a slight inclination toward the stream, closely follow the bluffs. On

the south side the valley wall is almost perpendicular, and much limestone is exposed. The opposite wall is less steep, except in the last few miles of its course, where the walls become more perpendicular and the stream has cut its bed almost to the level of the Mississippi River.

The drainage in the extreme northern part of the county is largely carried northward into Louisa County and eventually reaches the Mississippi. Several small creeks, flowing in deep, narrow gorges, carry the drainage of the eastern margin of the county directly into the Mississippi River.

The slopes and adjacent bluffs along all of the deeper drainage ways were once densely covered with hardwood trees and underbrush. A scattered forestation is still evident on many of these slopes and bluffs, particularly along the rivers.

The flat areas on the tops of some of the wider divides are most extensive in the western and northwestern parts of the county. With the exception of these level areas, the county is well drained by a network of streams cutting through the loess into the drift and occasionally into the limestone. Erosion is active along the deeper gorges. The prevailing direction of the main drainage channels is southeast. All the first bottoms, except those inclosed and protected by the levee north of Burlington, are subject to annual overflow. However, most of the land along all the larger streams is under cultivation, as the high water usually comes before the cropping season. Many open ditches and canals carry the water through the Mississippi bottoms directly into the river or into reservoirs.

The first permanent settlement was made in the fall of 1832 on the upland plain, 3 miles from the Mississippi River, on land now included in Burlington. A fur-trading post had been established here some years before. Late in the fall of 1832 there was an uprising of the Sac and Fox Indians, resulting in their expulsion. Title to this territory was acquired by the Government in 1833 under the Black Hawk purchase. Burlington was platted in 1834. Settlers from Illinois, Kentucky, Indiana, Missouri, and the Eastern States began coming in rapidly.

Many farmers are of German, Irish, and Swedish descent. Outside of Burlington and West Burlington there are only a few people of foreign birth.

The total population of Des Moines County was 35,520 in 1920, of which 11,463 or 32.3 per cent were classed as rural. The farming population is uniformly distributed over the county, averaging 28 to the square mile. Burlington, the largest town and the county seat, with a population of 24,057, is a city of commercial importance, with many factories and wholesale houses that draw a large volume of business from several States.

West Burlington, with a population of 1,212, has the car and foundry shops of the Chicago, Burlington & Quincy Railroad. With the exception of Mediapolis, with a population of 780, all other towns have populations of less than 300. Yarmouth, Middletown, Danville, Sperry, Spring Grove, Latty, Kingston, Huron, and Roscoe are located on the railroad. Pleasant Grove, Northfield, Dodgeville, and Augusta are inland villages.

Transportation facilities are excellent. The Chicago, Burlington, & Quincy and the Chicago, Rock Island & Pacific lines run 40 trains out of Burlington daily in all directions, serving every part of the county, and connecting directly with Omaha, St. Louis, Kansas City, Chicago, Minneapolis, and St. Paul. The Muscatine, Burlington & Southern Railroad extends north from Burlington, affording transportation facilities to Huron, Ream, Kingston, Mullahy, and Snider. No farm is more than 8 miles from some shipping point. Passenger and freight steamers ply the Mississippi during the season the channel is open.

The roads throughout the county are improved, well graded, and well kept. The Bluegrass Trail (Primary No. 8) has been hard surfaced from Burlington to Middletown. The roads in general follow the land lines. In the hillier parts along the Mississippi and Skunk Rivers, where the tributary streams have cut deeply, the roads follow the ravines or the tops and slopes of the divides.

Des Moines County has an excellent public-school system. Consolidated schools are located at Huron, Mediapolis, Yarmouth, and Sperry. Rural mail routes extend to all parts of the county, and practically all farms have telephone service. Commodious farm homes and buildings are the rule over all parts of the county, the construction being mostly of wood. Agricultural products are marketed mostly in Chicago and St. Louis. Some hogs and a large proportion of the poultry products are shipped to Boston.

CLIMATE.

The climate of Des Moines County, while marked by rather wide variations, is healthful and is favorable for the growing of all staple crops of this region.

The mean annual temperature for the county is 50.5° F., and the mean temperature for summer is 74° F. The summers are usually rather hot, a maximum temperature of 106° F. being the record. Periods of excessive heat and drought are of short duration. The prevailing winds in summer are from the southwest.

The winters are usually of moderately short duration; they were unusually mild the last three seasons. The average snowfall is about 25 inches. The mean temperature for winter is 25.1° F., and the lowest on record is 21 degrees below zero.

The mean annual precipitation is 35.54 inches. The greatest annual rainfall, 51.55 inches, was in 1902, and the driest year, 1901, had a precipitation of 23.24 inches. The rainfall is well distributed over the growing season. Prolonged droughts are of rare occurrence.

The latest killing frost in spring occurred on May 9 and the earliest in the fall on September 22. The normal growing season is 176 days from the average date of the last killing frost in spring, April 20, to the average date of the first killing frost in the fall, October 14. This gives ample time for the maturing of corn. Late frost in spring rarely causes any injury. Farm work in the fields often begins as early as March 20 and continues to the first or middle of December.

The following table, giving the normal monthly, seasonal, and annual temperature and precipitation, is compiled from the records of the Weather Bureau station at Burlington:

Normal monthly, seasonal, and annual temperature and precipitation at Burlington.

[Elevation, 544 feet.]

Month.	Temperature.			Precipitation.		
	Mean.	Absolute max-imum.	Absolute min-imum.	Mean.	Total amount for the driest year (1901).	Total amount for the wettest year (1902).
	° F.	° F.	° F.	Inches.	Inches.	Inches.
December	27.9	66	-16	1.78	0.91	2.13
January	22.4	67	-21	1.73	1.84	.89
February	24.9	66	-18	1.98	1.66	1.16
Winter	25.1	67	-21	5.49	4.41	4.18
March	37.1	88	-4	2.65	3.30	2.52
April	51.2	90	22	3.24	1.86	3.21
May	62.8	95	30	4.10	2.10	3.17
Spring	50.4	95	-4	9.99	7.26	8.90
June	71.9	104	39	4.39	4.95	11.65
July	76.0	105	44	3.54	2.15	7.27
August	74.0	106	44	4.33	.36	10.62
Summer	74.0	106	39	12.26	7.46	29.54
September	66.1	103	32	3.65	2.26	2.77
October	53.7	91	18	2.26	1.08	3.79
November	38.2	80	4	1.89	.77	2.37
Fall	52.7	103	4	7.80	4.11	8.93
Year	50.5	106	-21	35.54	23.24	51.55

AGRICULTURE.

The first permanent settlement in Des Moines County, made in 1832, was interrupted by an Indian war, resulting in the withdrawal of the Indians from this territory. The agricultural development was begun the following year, many settlers arriving. Homes were first built along streams, where water and fuel were abundant and protection was afforded from prairie fires and severe winters. The prairie was covered with coarse native grasses and the hill slopes adjacent to the upland were heavily forested. Corn, wheat, barley, and flax were the first crops. Abundant pasturage on the prairies soon led to the extensive raising of cattle. The growing of corn, oats, and wheat and the raising of livestock have been the main agricultural industries from the first.

The following table gives the acreage and production of the principal field crops, as reported in the last five decennial reports of the Bureau of the Census:

Acreage and production of leading crops in Des Moines County, Iowa, in 1879, 1889, 1899, 1909, and 1919.

Crop.	1879		1889		1899	
	<i>Acres.</i>	<i>Bushels.</i>	<i>Acres.</i>	<i>Bushels.</i>	<i>Acres.</i>	<i>Bushels.</i>
Corn.....	67,228	2,812,975	51,635	2,272,129	66,989	2,361,960
Oats.....	12,710	431,874	24,532	904,267	29,386	921,090
Wheat.....	18,113	263,697	8,003	112,548	1,058	12,020
Barley.....	93	1,655	5	196	196	5,110
Rye.....	915	13,429	1,215	17,913	1,388	18,980
		<i>Tons.</i>		<i>Tons.</i>		<i>Tons.</i>
Hay (all kinds).....	24,129	27,546	30,915	44,156		
Tame hay ¹					28,115	38,601
Wild hay.....					955	1,572
Coarse forage.....					502	1,810
		<i>Bushels.</i>		<i>Bushels.</i>		<i>Bushels.</i>
Potatoes.....		106,275	1,604	144,902	1,532	133,487
Other vegetables.....					1,166	
		<i>Quarts.</i>		<i>Quarts.</i>		<i>Quarts.</i>
Small fruits.....					370	473,650
	<i>Trees.</i>	<i>Bushels.</i>	<i>Trees.</i>	<i>Bushels.</i>	<i>Trees.</i>	<i>Bushels.</i>
Orchard fruits.....			42,737	61,314	180,886	73,239
	<i>Vines.</i>	<i>Pounds.</i>	<i>Vines.</i>	<i>Pounds.</i>	<i>Vines.</i>	<i>Pounds.</i>
Grapes.....					204,396	619,800

Crop.	1909		1919	
	<i>Acres.</i>	<i>Bushels.</i>	<i>Acres.</i>	<i>Bushels.</i>
Corn.....	62,523	2,377,664	57,542	2,341,023
Oats.....	24,460	726,474	25,887	826,160
Wheat.....	8,300	178,139	17,842	341,516
Barley.....	869	19,896	622	12,208
Rye.....	620	9,187	2,718	37,003
		<i>Tons.</i>		<i>Tons.</i>
Hay (all kinds).....				
Tame hay ¹	27,125	41,915	23,779	39,190
Wild hay.....	262	465	47	92
Coarse forage.....	508	1,304	3,550	6,242
		<i>Bushels.</i>		<i>Bushels.</i>
Potatoes.....	1,510	132,558	881	43,881
Other vegetables.....	903		315	
		<i>Quarts.</i>		<i>Quarts.</i>
Small fruits.....	175	255,990	122	207,957
	<i>Trees.</i>	<i>Bushels.</i>	<i>Trees.</i>	<i>Bushels.</i>
Orchard fruits.....	153,746	76,090	83,388	28,325
	<i>Vines.</i>	<i>Pounds.</i>	<i>Vines.</i>	<i>Pounds.</i>
Grapes.....	79,282	233,098	74,394	271,516

¹ Includes all tame or cultivated grasses, grains cut green, and annual legumes cut for hay.

The staple field crops, corn, oats, wheat, and hay, occupied 41 per cent of the total area of the county and nearly 60 per cent of the improved land in 1879. Corn occupied more land than all the other crops reported. Since 1890 a comparatively uniform acreage has been devoted to oats. Wheat was important in the early agricultural development. After the building of the levee in 1895 thousands of acres of rich bottom lands along the Mississippi River north of Burlington were drained, and wheat production increased from 1,058 acres in 1899 to 17,842 acres in 1919, nearly reaching its early acreage. Formerly almost all the wheat was produced on the upland soils, but at present most of it is grown on the Mississippi bottom land. In 1879, 1889, and 1899 the average yield ranged from 14 to

12 bushels per acre, with a tendency to decrease, but in 1909 and 1919 the average yield was more than 20 bushels per acre. The acreage in forage crops has always been large, ranging from 24,000 to 30,000 acres or 10 to 12 per cent of the total acreage of the county. Rye has been a minor but fairly constant crop. Small and variable acreages have been devoted to barley and buckwheat since 1880, but practically no flax has been grown in the last 40 years.

Small fruits, tree fruits, grapes, potatoes, and truck crops were grown extensively from an early date because of the demand from the Burlington city market. As early as 1879, orchard products had a value of \$31,000, and market-garden produce, \$12,705. The production of fruits reached a maximum in this year, there having been a considerable decrease to the present time.

This section of the State attained its agricultural maturity earlier than any other part, because of its location. As early as 1880, 93 per cent of the total area of the county was in farms.

The predominating type of agriculture in Des Moines County at present is a combination of growing corn and raising and feeding hogs and cattle. Corn, oats, wheat, timothy and clover, clover, and rye are the principal crops, in order of their importance. Barley, millet, sorgo (saccharine sorghum), alfalfa, and potatoes are crops of minor importance. Practically all of the corn and most of the oats is fed on the farms. Wheat is an important cash crop.

Corn is grown all over the county on practically all of the soil types. The acreage annually devoted to corn runs fairly constant. Reid Yellow Dent is the favorite, particularly in the northeastern part of the county. Boone County White and Iowa Silvermine are the popular varieties of white corn. The average yield for the county in 1920 was 46 bushels per acre, which is slightly higher than the average annual yield. The black Grundy and Wabash soils, where well drained, give higher average returns, 50 to 55 bushels per acre.

Some corn is planted the latter part of April, but most of it goes in about the first of May. Fall plowing, 5 to 6 inches deep, is a common practice. Except for a small proportion for silage, the crop is all checkrowed. It is usually cultivated three or four times and is usually laid by about the first of July. Field selection of seed corn is becoming a common practice, although much seed is selected from the wagon at picking time and some from the crib. Little of the seed is tested except in poor seasons when the corn has not matured properly. The corn is largely husked from the standing stalk and fed to cattle and hogs. A small part is cut for silage. Hogging down is becoming a more extensive practice. After the corn is picked, cattle are turned into the fields. In good seasons there is considerable surplus in the northwestern part of the county, which is largely shipped to Burlington and Mediapolis for feeding. Some system of rotation is used on nearly every farm. On a few tenant farms corn is grown three or four years in succession. On the heavy bottom lands the cornstalks are usually burned. A quantity of seed corn, mostly Reid Yellow Dent, is shipped out each year. Sweet corn is grown on some farms, mainly in the vicinity of Burlington for the local market and canning factory. A little pop corn is raised.

Oats rank second in importance of the grain crops. Albion (Iowa No. 103), Iowa Silvermine, Richland (Iowa No. 105), Kherson, Early

Champion, and Texas Rustproof (Texas Red) are grown. The red oat is raised for the southern markets, Mississippi and Arkansas, where it brings a premium. Practically all of the seed is home grown. The early varieties usually yield much better than the late ones, especially on the heavier soils. Over half the crop is generally fed, and the remainder is sold as a cash crop, mostly in Chicago and St. Louis. Large quantities are shipped from elevators at Middletown, Yarmouth, and Danville. The seeding is done from March 15 to March 30, usually broadcast on corn land which has been double disked. The crop is largely threshed out of the shock, some of it being sold from the machine. The average yield for the county in 1921 was 25 bushels, but ordinarily the average is higher, around 38 bushels. Maximum yields of 80 bushels per acre on some farms have been reported. Some trouble is caused by smut, but the formalin treatment has been effective in holding this in check.

Wheat is a cash crop of importance. Winter wheat is mostly sown, as it gives the best yield. Turkey is the principal variety. An average yield, according to the local farm bureau, is about 22 bushels per acre. In favorable seasons as much as 40 to 45 bushels are obtained on the soils in the Mississippi River bottom in the northeast corner of the county, where most of the wheat is raised. The crop is largely shipped out of the county. Flour mills at Burlington use a small part of the crop. Elevators at Oakville, just over the northeast county line, and at Huron handle most of the wheat grown on the bottoms.

Rye is grown on a considerable acreage annually, 2,718 acres being reported for 1919. The average yield is 18 bushels per acre, and from 12 to 15 bushels on the sandier terrace soils. It is grown extensively on the sandy soils around Spring Grove, being pastured in the spring and plowed under the latter part of June, when melons are planted. Small patches of buckwheat, kafir, and millet are grown, the millet being used mostly as a catch crop. Barley was grown on 622 acres in 1919. It is fed to hogs and calves.

Hay and forage crops usually occupy third place in acreage of all crops, but sometimes their total acreage exceeds that of oats. Timothy and clover occupy about half of the hay acreage. The seeding is usually with oats. The first cutting will average $1\frac{1}{2}$ to 2 tons per acre, and the second cutting somewhat less. Alsike clover is mixed with timothy and red clover for pasture. Very little wild hay is cut, mostly in old sloughs in the Mississippi River bottoms, in which water stands part of the year.

Considerable timothy is grown alone, mainly in Franklin, Pleasant Grove, and Yellow Spring Townships. In 1919 it occupied 4,752 acres. Seed was harvested from four-fifths of the crop, most of it being shipped out of the county.

Clover alone was grown on 5,030 acres. Very little difficulty is experienced in obtaining a stand. Lime has given very profitable results where used. Seed was harvested from 2,239 acres in 1921, according to the State census. Production of both hay and seed is heaviest in the western part of the county. Most of the hay is fed, but a small quantity raised on the Mississippi River bottoms is baled and marketed at Burlington. The normal yield is from $1\frac{1}{2}$ to 2 tons.

Some Sudan grass is grown, and sorgo (saccharine sorghum) is raised in small quantities for forage and for making sirup.

Alfalfa is found in patches of 1 to 10 acres over the entire county. In some fields it has been grown without either liming or inoculation, but frequent failures are reported under this system. With proper drainage, liming, and inoculation, no trouble is had in obtaining a stand under normal seasonal conditions. A number of thriving patches occupy the lower talus slopes along the bluff road from Snider to the northern county line. Alfalfa is very successful on the well-drained black upland and the sandier terrace and bottom soils. Both liming and inoculation are necessary on the latter. Most of the alfalfa is the Turkestan variety, with a few fields of the Grimm varieties.

Soybeans are becoming recognized as important because of their high protein feeding value and luxuriant growth. They are grown with corn and shredded with the corn for silage. Itosan, Mongol, and Black Eyebrow are used for seeding. The best results are obtained from seed grown in the county, which is adapted to local conditions. Other legumes grown in a small way are beans, peas, vetch, and sweet clover.

Trucking is carried on extensively in the vicinity of Burlington, mostly west and south on the Clinton and Grundy soils, and at Spring Grove on the sandy terrace soils. Some truck is raised on the sandier bottom land. Large quantities of sweet corn, tomatoes, and cucumbers are grown for the canning factory at Burlington as well as the local market. Onions, asparagus, sweet potatoes, celery, and other vegetables are produced for local consumption. Celery does best on the sandier terrace soils and bottom soils. Nitrate of soda, 400 to 500 pounds per acre, is used on asparagus and onions. Acid phosphate is used with the sodium nitrate on onions. Experiments with potash on sweet potatoes have proved profitable on the sandy Plainfield soils. Manure from the stockyards at Burlington is used on the truck farms.

Melons are grown extensively on the sandy terrace and river-bottom soils, which are particularly suited to this crop. Tom Watson, Kleckly Sweets, and Sweet-Heart are grown mostly for the market. Manure is commonly used in the melon hills for fertilizer. Corn usually follows melons on the sandy soils, yielding 15 to 20 bushels per acre. Winter wheat is often grown on the heavier sand and yields from 12 to 15 bushels per acre and as high as 20 bushels. Rye is extensively used as a cover crop to prevent the sand from blowing, and is either cut or turned under for green manure before melons are planted. In some years melons are shipped out, but ordinarily they are sold on the local market.

Potatoes are reported grown on 881 acres in 1919, averaging approximately 50 bushels per acre. Only a small part of the local demand is supplied. On many farms no potatoes are grown and on most farms not enough for home consumption. Several hundred carloads are shipped in annually.

Fruits are produced in parts of the county. Most of the small and tree fruits grown commercially are raised within a radius of 10 miles from Burlington, although orchards are found over the entire county. Farm orchards are usually small, from 10 trees to 1 or 2 acres in extent. The commercial orchards range from 2 to 40 acres, averaging about 5 acres.

Apples are grown chiefly. The favorite varieties are Jonathan, Grimes Golden, Northwestern Greening and Ben Davis, named in order

of preference. Other varieties grown are Wealthy, Winesap, Fameuse (Snow), Maiden Blush, Ralls (Geneton), Missouri Pippin, and Red June. All the commercial and many of the farm orchards are sprayed regularly to combat diseases. The San Jose scale is the most common pest. It does not seem to affect the Jonathan trees badly, but is very harmful to Grimes Golden and Ben Davis. Codling moths and borers are also found. A lime-sulphur and arsenate of lead spray is used mainly. An apple tree 50 feet high, said to be one of the largest in the United States, is located northwest of Danville.

Plums, cherries, and pears do well. The Kieffer, Bartlett, and Seckel are the most popular varieties of pear. Small plantings of Elberta and yellow cling peaches are found, but they do not ordinarily yield well on account of late spring frosts. Seedlings seem to do better than budded stock. In years of a good crop, from 125 to 200 carloads of apples are shipped to larger outside markets.

Small fruits, including strawberries, blackberries, gooseberries, and currants, are grown in quantities for the local market. Strawberries are most extensively grown, usually in patches of 1 to 5 acres in size.

Many vineyards are established along or adjacent to the Mississippi River bluffs, principally south of Burlington. The Concord variety predominates. Grapes are shipped out of the county in normal seasons.

Hogs are the most extensively raised of all livestock. The Poland-China breed predominates, with Duroc-Jerseys, Chester Whites, and Hampshires, named in order of their importance. Purebred sires are generally used. There are a large number of purebred herds in the county, but on most farms the herds are good Poland-China grades. The average number per farm is 43 head. A few stockmen have from 200 to 450 in their herds. On the average farm 7 to 10 sows are kept for breeding purposes. Most of the corn produced is fed to hogs. Some soybeans are grown with corn for hogging down. Stock hogs are shipped into Mediapolis, Danville, and Yarmouth for feeding. Chicago, St. Louis, and Boston are the principal markets for finished hogs. The price in Boston usually controls the price on the local Burlington market. It is estimated by the local farm bureau that half of all livestock shipped is marketed through the farm cooperative shipping associations, of which there are nine in the county. The large feeders ship direct in carload lots.

Cattle raising and feeding is second in importance to hog production. The beef cattle raised on the farms are mostly good grade Shorthorn, with some Angus, Durham, and Hereford. The purebred herds are Hereford, Durham, Shorthorn, and Angus, named in order of their popularity. Many western feeders, grade Herefords, and Shorthorns, are shipped in annually the latter part of September from Kansas City, Omaha, and St. Paul for feeding, mainly around Yarmouth and Mediapolis. A few are carried over, but most of them are marketed the latter part of December or early in January, and some in April. Clover and timothy hay, silage, and fodder constitute the greater part of the roughage. Some cottonseed meal, oil meal, and molasses feed is fed with the corn. As reported by the census, there were 19,814 beef cattle in the county in January, 1920. Most of the finished cattle are marketed in Chicago, and the rest go largely to St. Louis.

Dairy herds are restricted to the vicinity of the larger towns, which they supply with milk. Most of the commercial dairy herds are purebred Holsteins. Some Guernseys, Jerseys, and milking Shorthorns are raised for dairy purposes. Commercial herds range from 10 to 60 head. The average farmer keeps from 7 to 12 cows, mostly Shorthorns. The cream is separated at the farm and sold to local creameries or cream-buying stations, which are found in all the smaller towns. Very little butter is made on the farm. The value of all dairy products in 1919, excluding those for home use, was \$434,429 (U. S. Census). There were 163 silos in the county in 1921, and 11,464 tons of silage put up. Generally the silos are filled with shredded corn. Mixtures sometimes used are soybeans and corn, and sorgo and corn.

There are 8,889 horses and 556 mules in the county, according to the Iowa Year Book for 1921. From six to eight horses are kept on the average farm. A number of purebred stallions are in the county, and a few purebred horses of the Percheron type are raised, largely in the southwestern and northern parts of the county.

Sheep are usually kept in small flocks in the rougher sections. They are mostly grades of the Shropshire and Delaine breeds. The Lindley soils on the steeper slopes are particularly adapted for sheep raising. Western grade feeders are shipped in around Mediapolis, Yarmouth, and Danville. The total number of sheep in the county in 1921 was 3,689. There are also a few small herds of goats. Wool produced in 1919 had a value \$20,554 (U. S. Census). About half of the wool clipped is marketed through a wool growers' association. Practically all of it is shipped to Chicago.

Poultry is kept on every farm and is a considerable source of revenue. Chickens are mostly raised, with some ducks and geese and a few guineas and turkeys. The average farm flock is about 100 fowls. There is a tendency to eliminate the mixed flocks and raise pure strains. Rhode Island Reds, Plymouth Rocks, White Leghorns, Wyandottes, and Orpingtons are the most popular. The annual culling of flocks is widely practiced with profitable results. The number of poultry on farms January 1, 1922, was 248,563, and the egg production in 1921 amounted to 1,026,469 dozen. Local dealers buy all of the products, shipping the eggs and live and dressed poultry to Boston and Chicago.

The adaptation of certain crops to particular soil types is recognized, but is practiced only in a general way. The black Grundy soils of the upland and the heavy Wabash soils of the bottoms are recognized as the strongest corn soils. The lighter colored Clinton soils are best suited to small grains and produce excellent orchard and small fruits. The sandier terrace and bottom soils are best adapted to melons and other truck crops. The rough broken slopes are kept in permanent bluegrass pasture. However, general farming is practiced, and the staple crops are grown on all soil types over the entire county.

Crop rotations are followed to some extent on every farm, varying considerably. Clover or mixed clover and timothy is usually grown once in 4 or 5 years. The 4-year rotation of corn 2 years, oats or wheat 1 year, and clover or clover and timothy 1 year is well adapted to most of the soils in the county. On tenant farms the tendency is to grow more corn, with only an occasional seeding of clover and timothy.

Probably half of the land is plowed in the fall. On the heavier soils care must be taken to plow under proper moisture conditions. Where oats follow corn, the land is usually double disked in the spring and the seed sown broadcast. Most of the wheat is drilled in the latter part of September. Most of the corn is picked by hand, but a few machine pickers are in use. Around Danville, Yarmouth, and Mediapolis a small number of tractors are used for plowing. Ordinarily three to five horses are used with the double gang plow, the 5-horse hitch on the heavier soils.

The Federal census reported the number of farms in Des Moines County in 1920 as 1,926, with an average size of 126.4 acres. The average value of all farm property was \$29,158 per farm, distributed as follows: Land, 74.1 per cent; buildings, 13.2 per cent; implements, 4.2 per cent; domestic animals, 8.5 per cent. The assessed value of the land is given as \$170.89 an acre. About 93 per cent of the area of the county is included in farms, and nearly three-fourths of the land in farms is classed as improved land.

Farm homes and buildings are commodious, substantial, and usually kept in good repair. Nearly one-fourth of the farm homes are lighted by electricity derived from the power plant at Keokuk; a few farms are equipped with individual lighting systems. Many farm homes have furnace heat and baths. Fields are well fenced, mostly with barbed wire.

The usual farm equipment consists of double gang and sulky plows, disk and straight-tooth harrows, corn planters, cultivators, drills, hay rakes, hay loaders, binders, and manure spreaders. Power elevators, gas engines, corn pickers, shellers, silage cutters, rollers, and hay tedders are found on many farms. In 1921 there were 186 tractors, 64 auto trucks, and 1,447 automobiles reported on farms.

According to the Federal census, 69.6 per cent of the farms in the county were operated by owners in 1920, 28.9 per cent by tenants, and 1.5 per cent by managers. The system of renting in most common use seems to be the share-rent system, the tenant furnishing work stock and implements and the owner receiving half of the crop delivered at the elevator. Pasture land is usually rented separately for cash. Where farms are rented on a cash basis the rental is from \$8 to \$15 an acre.

The supply of farm labor is generally adequate, except for a shortage at corn-husking time. On most farms the work is done largely by the farmer and his family. Single men receive from \$40 to \$50 a month with board and lodging. A man with a family receives from \$45 to \$60 a month, and the use of a house, a cow, and garden space. Corn pickers are paid from 5 to 8 cents per bushel, depending on whether corn is unloaded by hand or handled by power elevators. From \$3 to \$4 is paid for day labor. The census of 1920 reported the expenditure for labor in 1919 on 1,149 farms as \$552,870, or an average of \$480.82 per farm reporting.

Commercial fertilizer is used on only a few farms, mainly where truck is grown. Thirty-eight farms reported an expenditure of \$5,477 for fertilizer in 1919. Green manures are being more generally used for augmenting the supply of stable manure. Additional feed was bought on 1,292 farms at an average cost of \$595.38 per farm.

Land values have a wide range. Very few farms changed hands in 1920. Since the deflation from the 1919 land prices, the values are from \$40 to \$300 an acre. A few farms, with special improvements and located adjacent to town, will sell for more. The dark Grundy soils will sell for \$175 to \$300 an acre; the black Wabash soils, \$175 to \$275 an acre; very rough and broken hill slopes suitable only for pasture, \$30 to \$60 an acre; the sandy lands on the terraces, \$60 to \$90 an acre; the Clinton soils, \$100 to \$200 an acre; and the white or Marion soils, \$75 to \$100 an acre. Some of the black silty clay soils on the bottoms which are timbered can be bought at \$40 to \$75 an acre.

SOILS.

Des Moines County lies in the prairie region of the United States, where the topography and the rather high moisture supply favored a heavy grass vegetation over the greater part of the area. The original constructional surface was level, giving poor drainage, which was unfavorable to tree growth, and the remnant of this plain is still treeless. As better drainage was developed through erosion, a forest growth spread over the well-drained slopes, and at the time of settlement by the white man the entire area of the county was fast being invaded by forests.

The native vegetation, therefore, under which the soils of this county were developed, was grass over the relatively smooth upland and trees along the belts of rolling topography adjacent to the stream valleys.

The soils of the area have developed under the influence of a mean annual precipitation of 35.54 inches, uniform for the whole area and well distributed throughout the year. This moisture supply has resulted in the leaching of carbonates from the soil to depths of more than 3 feet. The only exceptions are a few small areas of restricted drainage, where the leaching process has not been permitted to act, and areas of immature soils derived from recently exposed limestone.

Differentiation of soils of the area may be made broadly on the basis of their general color characteristics, into light-colored and dark-colored soils.

The area of the dark-colored soils is almost coextensive with the area of the prairie upland and includes also areas of dark-colored alluvial soils. The dark-colored soils fall into two groups whose differentiation is based on drainage conditions of soil or subsoil, or both, during their development.

The soils of these groups occupy flat areas and have developed under conditions of poor drainage of soil or subsoil, or both. They have surface soils of dark grayish brown or black color and fine granular structure. They are underlain by gray or mottled gray, yellow, and brown subsoils somewhat heavier as a rule than the surface soils. The details of the profiles of these soils vary considerably, depending on the degree and manner in which oxidation, leaching, and other processes have acted. In the better drained soils of the Grundy series there is usually a dark-brown intermediate layer between the black surface soil and the heavy mottled layer, and where this horizon is present the lower part of the 3-foot section is generally lighter and more friable and approaches the parent material in character. In

places the mottled subsoil is discolored by rusty iron stains. With this general group may be placed the soils of the Grundy series on the smooth upland, the Bremer series of the flat terraces, and the Wabash series on the low flat flood plains.

A second group of dark prairie soils was developed under conditions of good soil and subsoil drainage. The typical profile has a surface layer of dark-brown color and finely granular structure ranging in depth from 8 to 15 inches. This is underlain by a transitional layer, normally very thin or a few inches in thickness, which changes in color gradually downward from a dark brown to a brown. The next lower horizon has a brown or yellowish-brown color, a heavier texture than the upper layers, and a coarsely granular structure. At depths ranging from 24 to 30 inches below the surface there is encountered a yellowish-brown, looser, more friable material that approaches in character the parent material. To this group belong the Tama silt loam which has been developed on the more rolling upland slopes, and the Buckner sandy loam, which occupies the well-drained terraces. The Cass series consists of dark-colored surface soils underlain by a sandy or gravelly subsoil; they are confined to the low flood plains.

The area of light-colored soils is very nearly coextensive with the area covered by forests when the country was first settled. These soils, therefore, owe their principal characteristics to their development under a native vegetation consisting of trees. The soil profile has a surface layer, ranging in depth from 3 to 8 inches, of gray, grayish-yellow, or grayish-brown color, and silty, floury structure. This is underlain by a coarsely granular, heavier material extending to depths of 2 or 3 feet, below which the texture is lighter and less compact. The soils which belong to this group are the Clinton and Lindley series on the upland slopes and the Jackson and Bertrand series on the terraces.

A variation of the profile described above is developed on very flat areas. Below the surface soil in such areas there is a layer of 3 to 8 inches of light-gray or grayish-white, silty, floury material, below which the heavy layers are either essentially like those described or they are slightly mottled with gray. Soils which have this whitish subsurface layer have been classed with the Marion series on the upland and with the Calhoun series on the terraces.

The Plainfield series consists of terrace soils over loose porous material, which, on account of their droughty nature, have not developed dark-colored surface soils nor any distinct profiles.

The Genesee, Ray, and Sarpy series are found on recent alluvium mainly of sediment from light-colored upland soils. The Genesee series has a subsoil similar to or heavier than the surface soils, but slightly lighter in color. The Ray series has light-colored surface soils over a dark-colored, heavy subsoil. The Sarpy series has light-colored surface soils and a sandy and gravelly subsoil.

The principal characteristics mentioned above are those imparted to the soil by the great soil-forming processes, such as leaching, oxidation, and the accumulation of organic matter. It is believed that these forces have been predominant in fixing the most important characteristics of the soil. In the differentiation of the soils into series, however, account has been taken of the composition, source, and the processes of accumulation of the material from which the soils have developed. For instance, the soils of the Clinton series,

developed upon loess, are differentiated from the Lindley soils, which are developed on glacial drift, and from the Jackson soils, which are developed upon alluvial terraces. In like manner the Marion soils derived from loess are separated from the Calhoun soils of the terraces.

The Grundy soils are dark-colored upland soils derived from loess and the Bremer and Wabash soils of somewhat similar characteristics have been developed upon alluvial sediments. The Tama series is representative of well-drained dark-colored soils developed on loess, and the Buckner soils are developed on alluvial materials. The Cass, Genesee, Ray, Sarpy, and Plainfield series consist of soils developed on recent alluvium.

The Davenport soils owe some of their important characteristics to the composition of the parent material. They have been developed on limestone, which has been exposed to weathering within comparatively recent times, and sufficient time has not elapsed for the complete development of the normal soil profile of the region. The surface soils are dark brown and the subsoil is a reddish calcareous clay. Partly decomposed limestone is encountered locally at depths of less than 3 feet.

In the following pages of this report the soils of Des Moines County are described in detail and their relation to agriculture is discussed. The differentiation into soil series, indicated by a place name, such as Grundy or Wabash, is based on the details of the soil profile and the other common characteristics described above. The division of the series into soil types, the type being the unit of mapping, is based entirely on differences in texture.

The accompanying soil map shows the distribution of the soils in the county. The table below gives the name and actual and relative extent of each soil mapped:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Grundy silt loam.....	81,344	31.1	Genesee silt loam.....	1,024	0.4
Clinton silt loam.....	56,512	21.6	Sarpy very fine sandy loam.....	1,024	.4
Lindley silt loam.....	29,824	11.4	Plainfield sand.....	896	.3
Wabash silty clay loam.....	25,344	9.7	Plainfield fine sandy loam.....	896	.3
Tama silt loam.....	18,816	7.2	Ray silt loam.....	832	.3
Grundy silty clay loam.....	12,480	4.8	Jackson silt loam.....	832	.3
Wabash loam.....	6,720	2.6	Buckner sandy loam.....	768	.3
Marion silt loam.....	6,080	2.3	Cass sandy loam.....	512	.2
Genesee very fine sandy loam.....	4,160	1.6	Bremer silty clay loam.....	320	.1
Wabash silt loam.....	3,840	1.4	Calhoun silt loam.....	192	.1
Cass loam.....	3,264	1.2	Davenport silty clay loam.....	128	.1
Bremer loam.....	2,432	.9	Riverwash.....	64	.1
Cass silty clay loam.....	1,216	.5			
Bertrand silt loam.....	1,152	.4	Total.....	261,760	-----
Bremer silt loam.....	1,088	.4			

GRUNDY SILT LOAM.

The surface soil of the Grundy silt loam is a dark-brown to almost black friable silt loam about 14 inches deep. The subsoil from 14 to 26 inches consists of a silty clay loam, brown to dark brown in color, with occasional faint gray mottlings in the lower part. This layer changes rather abruptly into a heavy, tenacious silty clay, becoming

lighter with depth. The lower subsoil is highly mottled with gray and yellowish brown, and rusty-brown iron stains. The surface soil has a grayish cast when dry. Both surface soil and subsoil are more or less acid. The humus content is very high.

The Grundy silt loam occupies the highest topographic positions on all of the broader interstream areas over the entire county and constitutes the major soil type. It is most extensive across the northwestern part of the county.

The surface ranges from gently undulating to undulating, and the natural drainage or run-off is fair to good. Because of the heavy subsoil, considerable tile is used in the more gently undulating areas, where very few tributary streams penetrate. Tiling allows earlier cultivation and planting and increases production materially, especially in seasons of abnormal precipitation.

Small depressions and pockets in some of the flatter parts and at the heads of gentle draws are occupied by black silty clay loam. These heavier textured areas are Grundy silty clay loam, but they are included with the silt loam because they are too small to be shown on the map. Where the Grundy silt loam extends bluffwards to the level areas of grayish Marion silt loam, the broad transition zone between types made it necessary to establish the soil boundaries rather arbitrarily. Flat, depressed bodies with an intermediate layer of grayish silt are scattered over the areas of Grundy silt loam, mainly in the western part of the county. These included areas consist of Edina silt loam, but they are too small to show as separate units. On the flat tops of the divides within areas of Grundy silt loam are large level bodies of Grundy silty clay loam. The gradation in texture between the two types made arbitrary boundary lines necessary here also.

The Grundy silt loam is practically all under cultivation. It is the most extensive loessial soil type in the southeast corner of the State. It is considered one of the best corn soils in the county, when adequately drained. Originally it was covered with a heavy growth of native prairie grasses, which accounts for the dark color and high content of organic matter.

Corn is grown annually on about 65 per cent of this type. Yields range from 40 to 65 bushels per acre in normal seasons, with an average between 45 and 50 bushels. Yields of 70 to 90 bushels are obtained on individual farms under most favorable seasonal conditions. Oats are next in importance to corn and yield 30 to 60 bushels per acre. Timothy and clover hay, the principal hay crop, yields from 1 to 3 tons per acre. Small quantities of alfalfa, millet, and barley are grown. Considerable timothy is grown alone for seed, which is shipped out of the county. Some winter wheat is raised. Soybeans are grown for seed, silage, and hogging down.

The rotation of crops is practiced to some extent. Clover and timothy are usually left for two years in rotation. Some permanent pastures are kept, but generally the more rolling adjacent types are used for pasture. Many cattle and hogs are raised and fed, together with a few sheep. Western feeders, both cattle and sheep, are nearly all fed on farms on this type. In the region west of West Burlington considerable quantities of truck, mostly sweet corn, cabbage, tomatoes, and cucumbers, are grown for the Burlington canning factory and

market. A few commercial orchards are found on this type, and farm orchards of 10 to 30 trees are common.

Practically no commercial fertilizer is used except where special crops are grown. Barnyard manure is applied as a top-dressing on sod.

Land values vary widely, according to improvements, location, and state of productivity. The average price for Grundy silt loam is from \$225 to \$250 an acre, with a range from \$200 to \$350. A few farms with exceptional improvements and location near town will command even higher prices.

The growing of more clover or other legumes is needed to maintain the present high state of fertility. Applications of limestone would be beneficial and profitable. A systematic rotation including legumes should be followed. The 4-year rotation of corn, corn, oats, and clover is well adapted to this soil. Deeper plowing would be beneficial on many farms. Because of the heavy, impervious nature of the subsoil, tilting out fields in many places would bring good results.

GRUNDY SILTY CLAY LOAM.

The Grundy silty clay loam consists of a black heavy silty clay loam to a depth of 10 to 12 inches, grading into a dark-brown to black tenacious clay loam to silty clay. This changes abruptly at 20 inches into a yellowish-brown silty clay to clay highly mottled with yellowish brown and gray. Rusty-brown iron stains and concretions are numerous below 30 inches. In places the subsurface layer from 10 to 20 inches is a dark grayish brown silty clay faintly mottled with gray and brown in the lower part. The whole soil horizon becomes lighter in color and more tenacious in structure with depth, and the mottlings become brighter and more pronounced. As the black color indicates, the surface soil is rich in organic matter.

The Grundy silty clay loam is typically developed on the high, flat interstream areas, where drainage lines have not penetrated. It occurs in irregular-shaped bodies ranging from 50 acres to several sections in extent. The largest developments are around Danville, west of Yarmouth along the county line, and adjacent to Mediapolis on the west. Small areas are scattered throughout the Grundy silt loam. This type is restricted mainly to the western half of the county.

The topography is level or nearly level and the natural surface drainage is poor. The impervious nature of the subsoil makes artificial drainage necessary to insure normal crop production. Tile should be laid as close as 4 to 6 rods to give the best internal drainage. When adequately drained, this is one of the strongest corn soils in the State.

The Grundy silty clay loam is known as a gumbo soil. Unless plowed and cultivated under proper moisture conditions, the soil will bake and clod. Large cracks sometimes form in extremely dry weather, injuring the roots of the grain. Deep plowing and careful mulching or stirring of the soil after rains will tend to eliminate this danger.

All of this type, formerly prairie, is under cultivation, mostly to corn. Where well drained by tile, corn will yield from 40 to 70 bushels per acre, with an average around 50 bushels. Clover and clover and timothy yield from $1\frac{1}{2}$ to $3\frac{1}{2}$ tons per acre. Oats is next

to corn in acreage and yields from 40 to 60 bushels per acre, depending largely on favorable seasonal conditions when filling. There is some danger of oats lodging in wet seasons because of rank straw growth due to the fertility of the soil.

The rotation on this type is largely corn and oats, with an occasional seeding to clover. Corn is usually grown two or three years, somewhat longer than on other upland types.

No commercial fertilizers are used. The soil is nearly neutral to slightly acid, and lime seems to have a very beneficial effect, probably due to flocculation of the soil particles, improving the tilth, and the liberation of the plant-food elements.

The price of the land of the Grundy silty clay loam ranges from \$225 to \$350 an acre.

The soil needs on this type are (1) adequate drainage, (2) deep plowing, (3) cultivation under favorable moisture conditions. Fall plowing has the advantage of permitting early working of the field in the spring and earlier seeding.

TAMA SILT LOAM.

The surface soil of the Tama silt loam is a dark-brown, friable silt loam, which passes at 14 inches into a yellowish-brown silty clay loam free from mottling. At 22 inches the subsoil becomes heavier in texture, being a silty clay, yellowish brown in color. In places below 30 inches faint yellowish-brown mottlings and iron stains are present; this is in the zone of gradation between this type and the Grundy silt loam, and is not characteristic of the type as a whole. No large amount of lime is present in the subsoil and the surface soil is acid.

The Tama silt loam is developed quite generally over the county at the heads of most of the smaller drainage channels. It occupies the stream slopes rising up to the Grundy silt loam plain, extending in narrow continuous strips to the lighter colored, forested, and more eroded hillsides toward the mouth of the streams. The subsoil differs from that of the Grundy silt loam in being of lighter texture and free from mottling.

The topography differs from that of the Grundy in being more rolling, as the type has been developed on slopes where natural drainage is well established. Internal drainage is better than in the Grundy because of the less compact subsoil. The Grundy silt loam, which occupies the more gently undulating prairie, extends to the tops of the Tama slopes, the transition between the two types being gradual.

Erosion has affected the Tama silt loam only to a small degree. On the steeper slopes the surface soil varies from 2 to 6 inches in depth. In a few spots the lighter colored silty clay subsoil is exposed. Near the bottoms of some of the steeper slopes there are small outcrops of glacial drift. The soil typically is free from stones or grit.

The Tama silt loam is nearly all in use, about 70 per cent being in cultivated crops and the remainder in pasture. In a few places scattered growths of hardwood trees are found. In favorable seasons the better parts of the type will produce crops comparable to those on the Grundy silt loam. Only a small part of any individual farm is composed of the Tama silt loam; it is always farmed and sold with the Grundy silt loam with which it is closely associated.

CLINTON SILT LOAM.

The Clinton silt loam has a smooth, floury surface soil, yellowish brown, or grayish brown in color. This passes at 10 inches into a subsoil of deeper yellowish brown heavy clay loam to silty clay, which grades at about 20 inches into a buff or light yellowish brown impervious silty clay to clay, with faint gray mottlings and dark-brown iron stains in places in the lower part. The subsoil is very tenacious when moist and very hard and compact when dry. The surface soil has a brownish appearance when wet and is more grayish brown when dry. The content of organic matter in the soil is low.

The Clinton silt loam is second in extent of the soils in Des Moines County. It is developed along all of the larger drainage ways, and back along their deep, gulchlike tributaries, occupying the bluffs and ridges and in many places extending well down the slope to the exposed drift materials or limestone outcrops. The type is extensive in all parts of the county except the extreme northwestern part and the broad interstream areas which have been only slightly altered from the original flat plain by the carving of shallow drainage channels. Large areas occur along Flint River, Skunk River, the Mississippi River bluffs, and on the narrow ridges between the numerous creeks. The largest continuous body starts on the bluffs 3 miles south of Burlington and extends northward in an almost unbroken strip, one-fourth mile to 3 miles in width, to the Louisa County line. The strips are of irregular shape and width and follow the bluffs along most of the deeply cut tributaries of the larger streams headwards for a short distance.

The topography is gently rolling to hilly. The surface drainage is adequate and in places excessive. Small patches and narrow strips along some of the steeper slopes have been badly eroded by the rapid cutting of gullies and washing after heavy rains, so that the surface soil is entirely removed or only a thin covering of 1 to 3 inches is left. Here the soil has little value for cultivation. This type is normally very susceptible to erosion because of the fineness of the soil particles, and care must be taken to prevent gullying. Small ditches will often start after one heavy rain and in a short time become deep gullies. Brush, straw, and manure are used to control this wash in fields where erosion is active.

On the flat tops of some of the interstream divides, between the rolling Clinton areas, occur areas of a whitish-gray soil, the Marion silt loam, which extend well into the more rolling Clinton silt loam. In the western part of the county the Marion soil characteristically extends well down the slopes, which are largely covered with eroded areas of Clinton silt loam instead of the usual drift. The soil boundaries between the closely associated Marion and Clinton silt loams in many places is arbitrarily placed, as transition is gradual.

This soil type was once entirely forested, but most of it has been cleared and is used for general farming. The original tree growth was largely hickory, red, black, scarlet, white, and bur oaks, walnut, maple, pines, and hazel brush. The remaining timber is scattered and mostly small in size. These forested areas are used for pasturing sheep and cattle.

The ordinary staple crops are grown on this soil. Corn is not grown as often as on the black upland soils, usually about once in three years.

Yields range from 25 to 45 bushels per acre. Maximum yields are obtained following clover or bluegrass sod top-dressed with barnyard manure. Oats do well, yielding 20 to 40 bushels per acre. Hay crops yield 1 to 2½ tons. Clover and alfalfa will do well where properly handled. Timothy and clover mixed is the principal hay crop. Wheat and rye are grown to some extent. Wheat yields 15 to 30 bushels, with an average of 22 bushels.

Most of the tree and small fruits produced in commercial quantities are grown on this soil, as it is particularly adapted for this purpose. Orchards range from 5 to 40 acres in size. The principal tree fruit is the apple. Peaches, plums, pears, and cherries do well, although the peach crop is rather uncertain. Raspberries, blackberries, and strawberries are grown in considerable quantities in the vicinity of Burlington for the city market. Sweet corn, tomatoes, cucumbers, onions, cabbage, and other vegetables are produced for the pickling and canning factory and also the city markets.

Many sheep and beef cattle and a few dairy herds are raised on this type. The thinly forested land furnishes a large acreage of good bluegrass pasture.

Crop rotation is practiced in a general way. Corn is usually grown one year, followed by oats or wheat and timothy and clover.

Some commercial fertilizer is used where vegetables and small fruits are grown for market. Barnyard manure is practically the only fertilizer used on staple crops, but it is not produced in sufficient quantities for keeping up productiveness.

Farm buildings and improvements on this type are good and comparable with those on the Grundy silt loam. The land values have a wide range, depending on topography, improvements, proportion of land cleared and tillable, and conditions of the soil. The selling price varies from \$60 to \$200 an acre, with an average of \$125 to \$140.

This soil type is all acid and readily responds to lime, the effects of which are especially noticeable on clover or other legumes. The more rolling land should be kept in pasture or crops whose roots cover the surface soil, to prevent destructive erosion. The more extended use of clover and green-manure crops is recommended for increasing the fertility and lessening erosional tendencies.

MARION SILT LOAM.

The surface soil of the Marion silt loam is a grayish-brown to whitish-gray smooth silt loam to a depth of 10 inches. Underlying this is a light-gray to white, floury, compact silt layer, 5 to 8 inches thick, which is sometimes very faintly mottled with brown. This silt layer rests on the subsoil proper, which is a light-brown or grayish-brown, plastic, silty clay to clay, mottled with gray and yellowish brown. The mottlings are faint in the upper subsoil but increase with depth, being very pronounced in the lower section, the yellow mottlings predominating; usually many scattered iron stains are also present. At about 40 inches a more friable and lighter brown silty clay or clay loam is reached, and in places this occurs at 30 inches. As the color indicates, the soil is low in organic matter. When dry the surface appears whitish. The subsurface layer of gray to white silt is characteristic of the Marion soils. The subsoil is very tough and impervious and is locally called hardpan.

The Marion silt loam occurs mainly in small, irregular areas on the flat tops and tongues of the interstream ridges, the slopes of which are covered with the more rolling Clinton silt loam. The development extends over the entire county in association with the Clinton silt loam. Because of the flat topography and heavy impervious subsoil, the drainage is restricted.

The Marion silt loam was once covered with a forest growth similar to that on the Clinton soil. This has all been removed and the entire type is in cultivation. Corn, oats, wheat, timothy, rye, and millet are the chief crops. The yields are slightly lower than on the Clinton silt loam on the average. In extremely dry or extremely wet seasons, crop production is affected adversely by the heavy subsoil.

Tile drainage would be beneficial, but the tile must not be laid too deep or too far apart. Additional organic matter is much needed; this can be supplied by green-manure crops and heavy applications of manure. This type is usually very acid and needs limestone to correct this condition. Phosphatic fertilizers greatly stimulate crops.

This soil type usually makes up only a small part of the individual farm. Alone it has a value of \$65 to \$100 an acre on the average.

LINDLEY SILT LOAM.

The Lindley silt loam to a depth of 6 inches is a light yellowish brown or grayish-brown silt loam containing much very fine sand. Below this is a yellowish-brown gritty silty clay, containing much coarse material, including fragments of limestone and sandstone, small particles of white flint, granite, quartz, and chert, coarse sand, small pebbles, and occasional boulders. The surface soil varies in depth and texture from a thin covering of silt loam or coarse loam to strips and spots of exposed drift ranging from sandy to gravelly clay. However, the silt loam texture predominates. Small patches of grayish-brown or black residual clay loam overlying limestone are included in this type because they are too small to be mapped separately.

The Lindley silt loam occurs along steeper hill slopes adjacent to the stream bottoms and deeper gulches where stream action has cut through the loess into the underlying glacial drift. Large developments occupy continuous strips along the slopes and bluffs abutting the bottoms of the Mississippi, Flint, and Skunk Rivers and Yellow Spring Creek. In many places along the Mississippi River, sheer bluffs of solid limestone 10 to 50 feet high, with short talus slopes at the bottom, fringe the valley walls. Small bodies of limestone outcrop are exposed along many of the smaller stream slopes.

The topography is steep, usually rough, and more or less eroded. Deep gullies are common throughout the type. A considerable part of this type is sparsely covered with a scrubby forest growth, mostly oak, ash, hickory, walnut, red haw, and underbrush.

A negligible proportion of this type is under cultivation. Most of it is nonagricultural and affords only meager pasturage. The lower talus slopes, particularly along the bluff road north of Burlington to the county line, are used for field crops and support many small patches of alfalfa. These talus slopes are darker than the typical soil, being brown to dark brown in color.

The Lindley silt loam is always sold with adjacent types, the Clinton silt loam on the upland or the bottom-land types below. Where the farm comprises half bluff and half bottom, the selling price is from \$100 to \$125 an acre. Separate areas of the type would probably have a value of \$30 to \$60 an acre.

DAVENPORT SILTY CLAY LOAM.

The Davenport silty clay loam is limited in Des Moines County to one area, three-fourths mile north of the city of Burlington. It lies in the large loop or oxbow bend of Flint River where it emerges from the upland and turns southward into the Mississippi River bottoms.

The surface soil to a depth of 6 inches is a dark-brown to chocolate-brown, heavy, tenacious silty clay loam to clay loam. The subsoil is a plastic chocolate-brown silty clay or clay, which gradually becomes lighter in color and at 18 inches changes to a lighter reddish brown clay, faintly mottled with gray and yellowish brown in the lower part and having a pinkish cast when moist. The lower subsoil gave a calcareous reaction with hydrochloric acid in a few instances.

The limestone rock under this bench is usually well below the 3-foot depth, but in a few places it is within 12 inches of the surface. Drainage is poor, owing to the impervious soil structure and flat surface.

All the common field crops are grown. The yields are comparable to those on the Grundy silty clay loam under similar conditions of cultivation and care.

BREMER LOAM.

The surface soil of the Bremer loam consists of 12 inches of dark-brown loam of variable texture, ranging from almost a sandy loam to a heavy silt loam. The upper subsoil is a chocolate-brown or dark reddish brown friable silty clay loam containing considerable sand and grit and some gray and reddish or yellowish-brown mottlings. Below about 20 inches the subsoil is a heavy silty clay to clay loam, light reddish or pinkish brown, highly mottled with reddish brown, yellowish brown, and gray. This lower subsoil layer contains numerous brown iron stains and some coarse material, such as coarse sand, pebbles, and small pieces of white flint rock. There is no lime carbonate in the entire soil section.

The Bremer loam occurs mainly in three areas situated 2 miles northeast of Snider and 1 and 3 miles northeast of Kingston. These areas lie 6 to 14 feet above the Mississippi River bottom lands on flat terrace benches which extend out to about one-half the distance between the bluff and the present river channel.

One small area in sections 33 and 34, Union Township, and one area in section 19, Tama Township, one-third mile south of Starrs Cave, are mapped as Bremer loam, but vary somewhat from the typical soil in that they all have a somewhat lighter subsoil, a yellowish-brown sandy clay, without the reddish tinge of the representative areas near Kingston and Snider. The bench south of Starrs Cave is underlain by limestone on the east side and sandy clay on the west side of Flint River, below the 24-inch depth.

The principal crops are corn, wheat, oats, clover, and timothy. Yields in seasons of normal rainfall are comparable to those on the heavier Bremer silt loam. Potatoes ordinarily do well on this soil. More wheat is grown on this type than on any other terrace in the county.

As with practically all of the terrace soils in Des Moines County, this type is combined with other soils in the farm unit. The selling value of this land alone would be from \$100 to \$175 an acre.

BREMER SILT LOAM.

The Bremer silt loam is a dark-brown friable silt loam underlain at 10 inches by a brown silty clay loam with faint gray or yellowish-brown mottlings. At 20 to 26 inches this changes to a yellowish-brown or brown silty clay mottled highly with gray and yellowish brown. The type is fairly uniform. The surface soil varies a little in texture, a few small areas approaching a silty clay loam in texture and being darker in color. There are some patches of lighter colored colluvial material at the back of the terrace, washed down from the abutting drift slopes, and a few small alluvial fans formed by short streams and gullies emptying onto the terrace. The subsoil is more friable and less plastic than of the typical Bremer silt loam as mapped in other surveys.

The Bremer silt loam attains its greatest development along Flint River. The terraces are flat, with an almost imperceptible slope toward the bottom land, so gradual that the soil boundaries between the bottom and terrace soils are in many places arbitrarily placed. The type usually lies 2 to 10 feet above overflow. It occupies three small areas northwest of Augusta along Skunk River, two on Brush Creek, one on Long Creek $2\frac{1}{4}$ miles northeast of Augusta, one at Kingston, and several small disconnected areas along Yellow Spring Creek and Cedar Fork of Flint River.

As the flat topography and the compact subsoil indicate, the drainage is only fair. Open ditches and tiling have been used in places to carry away the water emptied at the back of benches by small streams issuing from the uplands.

This type is all in cultivation. The common field crops are grown, and yields comparable to those on the Grundy silt loam of the upland are obtained. The selling value is from \$100 to \$225 an acre. Farms on this type usually include some bottom land, hill slope, and upland.

The more extensive use of green-manure crops and applications of more barnyard manure are needed, as on many other types in the county, to bring the soil to a maximum production capacity. Tiling of some of the more poorly drained flat areas would be beneficial.

BREMER SILTY CLAY LOAM.

The surface soil of the Bremer silty clay loam is a heavy silty clay loam for about 20 inches, becoming heavier with increasing depth. The subsoil is a dark-brown to black clay, usually mottled slightly with brown or gray and containing faint iron stains below 30 inches. In places the black unmottled clay extends to the full depth of the 36-inch section.

The type occurs in depressions and poorly drained pockets on flat terraces. The natural drainage is poor, and artificial drainage by means of tile and open ditches is needed to produce better crops.

The Bremer silty clay loam is inextensive and unimportant. It occupies small, disconnected areas and is farmed with the adjoining terrace types. Several small areas occur along the lower course of Flint River. Other bodies, closely associated with the Bremer loam, lie $2\frac{1}{2}$ miles southeast of Kingston, and one lies 3 miles northeast.

BUCKNER SANDY LOAM.

The Buckner sandy loam consists of a dark-brown sandy loam to a depth of 24 inches, where it passes into a dark reddish brown or chocolate-brown sandy loam to loamy medium to coarse sand. In a few small depressions the surface soil is a somewhat heavier sandy loam to loam, and the subsoil is a clayey sandy loam. This type differs from the Bremer loam, with which it is closely associated, in having a sandier surface soil and a lighter and more porous subsoil.

The Buckner sandy loam has a total area of less than 800 acres. The largest bodies lie 2 miles northeast of Kingston and $2\frac{1}{4}$ miles northeast of Snider. A small body lies 2 miles east of Prairie Grove on Flint River.

The soil is mellow, easily tilled, and all under cultivation. Although the surface is flat, the drainage is good, owing to the porosity of the entire soil section. The common field crops are grown and yield well in favorable seasons. In periods of drought, however, crops are liable to be affected. More barnyard manure and green-manure crops should be used to increase the content of organic matter.

The table below gives the results of mechanical analyses of samples of the soil and subsoil of the Buckner sandy loam:

Mechanical analyses of Buckner sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
334609	Soil, 0 to 24 inches.....	2.8	21.6	15.3	17.3	16.0	17.4	9.5
334610	Subsoil, 24 to 36 inches.	3.4	25.5	15.6	15.0	13.8	17.5	9.4

BERTRAND SILT LOAM.

The surface soil of the Bertrand silt loam is a friable light-yellowish silt loam to a depth of 10 inches, where it passes into a friable light yellowish brown silty clay loam, only slightly heavier than the surface soil. From 30 to 36 inches the subsoil is a very friable yellowish-brown silty clay mottled with grayish brown. In places this type is lighter in texture, ranging from a very fine sandy loam to a loam. This is due to its location, usually at the back of the terrace at the foot of the bluffs, where it receives considerable wash from the light-colored drift material on the slopes.

The total area of this type is about 2 square miles. The most extensive developments are several disconnected strips at the base of the bluff line, beginning at Burlington and extending northward to

Snider. Small areas are found at Kingston and 3 miles west of Spring Grove. The area east of Dry Branch School and the one in section 20 of Tama Township are very spotted, ranging in texture from a fine sandy loam to a fine sand or sand.

The topography varies from flat to gently undulating, and the natural drainage is adequate. All of the type is in cultivation and is farmed with the adjoining terrace soils, except the strip along the bluff at Burlington, which is used for building sites.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Bertrand silt loam:

Mechanical analyses of Bertrand silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
334644	Soil, 0 to 10 inches -----	1.2	4.8	3.8	13.4	16.8	50.1	10.1
334645	Subsoil, 10 to 30 inches-----	1.6	4.8	2.8	11.2	14.2	45.8	19.5
334646	Subsoil, 30 to 36 inches-----	.4	1.2	.8	3.6	13.6	48.3	32.1

JACKSON SILT LOAM.

The Jackson silt loam to a depth of 8 inches is a dark yellowish brown or grayish-brown floury silt loam, which passes into a yellowish-brown light silty clay loam mottled with gray, some yellowish brown, and iron stains. The subsoil becomes heavier with depth and at 16 inches grades into silty clay loam to clay loam, light brown or brown in color, strongly mottled with light yellow and some gray, and with many iron stains in the lower subsoil. The texture is uniform, except in the areas adjacent to the upland slopes, where the surface layer contains an admixture of fine drift material which was washed down from the bluff slope.

The Jackson silt loam occupies small areas on flat terraces 12 to 20 feet above the adjacent bottomlands. Drainage is usually adequate. The type is developed along Skunk River, beginning 1 mile east of Augusta and continuing up the course of the river to the county line. The bodies here are small and disconnected and skirt the base of the bluffs. More extensive developments begin one-half mile north of Burlington, extending northeastward. Several isolated areas are found along Flint River.

Most of this type is under cultivation to staple crops. The fields usually include land of other types. Corn yields 35 to 50 bushels, oats 30 to 45 bushels, and wheat 18 to 35 bushels per acre. The soil is friable and easily cultivated, and the drainage normally good. Additional organic matter is needed. Limestone would be beneficial in obtaining better stands of clover and alfalfa. Land values range from \$100 to \$175 an acre.

CALHOUN SILT LOAM.

The surface soil of the Calhoun silt loam is a smooth light grayish brown silt loam to a depth of 10 inches. This is underlain by 6 to 8 inches of whitish-gray floury silt loam, mottled faintly with brown. This intermediate layer is almost pure silt and corresponds to the

intermediate layer of the Marion silt loam on the upland. Below this silt layer is a yellowish-brown silty clay highly mottled with gray and yellowish brown. Many rusty-brown iron stains are scattered throughout the subsoil, increasing with depth. The subsoil is very stiff and tenacious when moist, but somewhat crumbly and friable when dry. In a few small pockets the subsoil contains considerable fine gritty material. This type is similar to the Jackson silt loam, except for the intermediate silt layer, which characterizes the soils of the Calhoun series.

The type is restricted to four small bodies. The largest is 1 mile north of Burlington, where Flint River enters the Mississippi River bottoms. Two bodies occur along Flint River about 4 miles northwest of West Burlington and one in the southwest corner near where the Skunk River first touches the county.

The Calhoun silt loam has a flat surface and, owing to the heavy subsoil, the natural drainage is poor. Nearly all of this type was once covered with timber. All is now in cultivation.

PLAINFIELD SAND.

The Plainfield sand is a yellowish-brown, loose, medium sand of uniform texture to a depth of 18 inches, where it gradually changes into a lighter yellowish brown, loose, incoherent uniform sand. Small quantities of coarse waterworn gravel are found locally in the first few inches of the surface soil.

The Plainfield sand is an inextensive terrace type. Its largest development is east and west of Spring Grove, lying 15 to 20 feet above the bottom lands and extending back to the bluffs. The surface is flat except for a few slightly billowy ridges formed largely by the shifting of the sand under high winds. Small areas lie 2 and 3½ miles northeast of Kingston, 1 mile east of Mullahy, and 1 mile west of Timber Lake. These smaller areas lie 6 to 10 feet above the associated Mississippi bottom lands. Drainage is thorough to excessive, and crops suffer during dry periods.

All the areas of the type are in cultivation. Except for the area around Spring Grove, where extensive trucking is carried on, the common field crops are grown. Corn yields on the average about 20 bushels, and wheat in favorable seasons yields 12 to 15 bushels and sometimes as high as 20 bushels per acre.

Barnyard manure, supplemented by an occasional green-manure crop, is ordinarily used to supply organic matter. Where truck crops are grown, manure is received in carload lots from the Burlington stock yards, and is supplemented by nitrate of soda and acid phosphate in the growing of onions, asparagus, melons, celery, and sweet corn (applied at tasseling time). Potash has been used successfully in growing sweet potatoes. Alfalfa is grown successfully where limestone is used liberally. Rye is used as a cover crop early in the spring to prevent the blowing of the soil, and is turned under at the time of planting the truck crops.

Around Spring Grove considerable trouble is experienced with gophers. Poisoning is considered the most effective means of riddance.

The selling value of Plainfield sand is from \$60 to \$90 an acre. The more highly improved truck farms may command a higher price, depending on improvements.

The incorporation of sufficient organic matter for profitable crop production is the soil need on this type. More green manure and cover crops should be grown and liberal quantities of manure applied to increase yields. Plant food is readily lost through leaching on account of the loose soil structure.

PLAINFIELD FINE SANDY LOAM.

The Plainfield fine sandy loam is a light-brown to brown uniform fine sandy loam underlain at 16 inches by a slightly lighter brown, loose fine sandy loam to very fine sandy loam.

The type occurs north and west of Spring Grove, on the same terrace and in close association with the Plainfield sand, and in five small areas $2\frac{1}{2}$ to 4 miles northeast of Snider. The subsoil under the latter areas contains coarse materials not found in the terrace subsoil near Spring Grove, and the surface soil here varies from a fine sandy loam to a sandy loam. The topography is flat to gently undulating and the drainage is good to excessive. This soil is inclined to be droughty except in seasons of most favorable rainfall distribution.

The Plainfield fine sandy loam is all cultivated and is handled and cropped like the Plainfield sand. The trucking industry is confined to the neighborhood of Spring Grove and is of limited extent on the type. Land values are approximately the same as on the Plainfield sand.

WABASH LOAM.

The Wabash loam to a depth of 20 inches is a dark-brown to black friable loam containing considerable very fine sand and a little coarse material. The subsoil is a yellowish-brown to dark-brown silty clay loam mottled with yellowish brown and gray. Some iron stains occur below 30 inches. In the Mississippi River bottom northeast of and around Huron the subsoil is a heavy loam, only slightly heavier than the surface soil, and in places has a distinctive reddish cast. Along the smaller streams and tributaries inland, the darker colored, heavier clay loam subsoil predominates.

The Wabash loam occurs along Spring, Brush, and Long Creeks, and in considerable areas along Flint River and in the Mississippi bottoms. Other developments are along the creeks flowing northward into Louisa County.

The type is fairly uniform in texture, except in the northeastern part of the county in the Mississippi River bottom. Here both surface soil and subsoil vary toward a lighter texture, and the boundaries between this type and the Cass loam are fixed arbitrarily because of the gradual transition. Along the channels of Flint River the soil is characteristically lighter in texture.

The areas along Flint River and in the Mississippi River bottoms are nearly all under cultivation to common field crops. Yields are about the same as on the Wabash silt loam. The strips along the smaller streams and their tributaries are largely in pasture and contain scattered clumps of trees. The value of this type ranges from \$60 to \$150 an acre.

WABASH SILT LOAM.

The surface soil of the Wabash silt loam is a dark-brown heavy silt loam, 18 inches deep. This is underlain by a dark-brown or brown tenacious silty clay loam, somewhat mottled with yellowish brown and light gray.

This type is widely distributed over the county. It occurs mainly along the smaller creeks and their tributaries in the Grundy silt loam plain. Much colluvial material is included in the soil near the heads of the smaller branches. Along Spring and Brush Creeks, light-colored silt loam is mixed with the predominating darker silt loam.

In the western part of the county continuous strips are mapped along the upper courses of Cedar Creek and Flint River, and small disconnected areas of 10 to 30 acres occur along the lower course of the river. Two of the larger areas lie southwest and east of Spring Grove, bordering the terrace. Narrow broken strips occur along Skunk River. A few scattered bodies lie in the Mississippi River bottoms north of Burlington and several areas in the vicinity of Huron.

This type is of minor importance because of its small extent. Most of it is under cultivation. The narrower strips along the smaller streams are largely used for pasture. Corn is the most important crop. Land values on the type vary from \$50 to \$175 an acre.

WABASH SILTY CLAY LOAM.

The Wabash silty clay loam is a black tenacious silty clay loam to clay loam, passing at 6 to 8 inches into a black stiff clay or silty clay, which is sometimes mottled faintly with gray and brown from 18 to 24 inches. The lower subsoil below 24 inches is a dark-brown or grayish-brown impervious clay mottled with yellow, brown, and gray, and containing iron stains. In some places a dark-brown or black clay extends the full depth of the 36-inch layer with faint gray or brown mottlings only in the lower part. Coarse sand and small pebbles are found here and there in surface and subsurface layers in small areas adjacent to the more sandy types.

The Wabash silty clay loam is the most extensively developed of the bottom-land types. It occurs principally in the Mississippi River bottoms, where it is the dominant soil. A few strips lie along the heads of the smaller creeks in the northwestern corner of the county. These areas and also those lying south of Spring Grove are subject to overflow. All of the type north of Burlington to the county line, except a small area adjoining the city, through which Flint River flows, is protected by a large Government levee, which keeps out the highest flood waters.

The surface of most of this type is flat. It is cut by a network of old sloughs and channels along the river and extending back 1 to 1½ miles toward the bluffs. Many shallow lakes were formerly scattered over the entire area, but most of these have been drained.

A variation of this type is found in old sinks, depressions, and poorly drained sloughs where water stands part of the summer. The difference between this soil and the typical Wabash silty clay loam is due to its topographic position. It is inclined to be marshy and

supports a growth of rushes, sedges, and water grasses. Owing to poor drainage the subsoil is a grayish-drab silty clay mottled with gray and iron stains in the lower depths. In a few places a trace of calcareous material was found in the subsoil. Traces of alkali were seen around the edges of some of these bodies during the driest part of the summer. Thin layers of peat and muck, 1 to 3 inches deep, cover the surface in spots. These depressed and poorly drained areas are all found north and northeast of Snider, scattered through the bottom land, mainly in old disconnected sloughs near the river. These areas are nonagricultural until drained.

Small bodies of Riverwash and pure sand along the banks of the river, mostly outside the levee, are also included with the Wabash silty clay loam as mapped. Many deposits of sand and Riverwash and patches of Cass and Sarpy fine sandy loams, too small to be mapped separately, are included with the Wabash soil on the islands in the river. The land outside of the levee and on the islands is completely covered in periods of high floods. A few areas on the islands have been cleared and are farmed.

The Wabash silty clay loam was once largely forested. Most of it at present is cleared, the remaining timber being confined to the region of old sloughs near the river and to the islands. Many drained and improved farms are found on this type. The soil is very tenacious and impervious and the drainage is naturally poor. Tile and open ditches take care of the drainage on part of the type, but more drainage is needed over the greater part. Locally the soil is known as gumbo. It has a very high content of organic matter and may be compared with the Grundy silty clay loam on the uplands.

About three-fourths of the type is in cultivation. It is one of the strongest soils in the county for corn, which is often grown for a number of years in succession and in favorable seasons will yield 60 to 90 bushels per acre. Wheat is raised in large quantities and yields from 20 to 42 bushels per acre. Oats produce 40 to 60 bushels, and hay $1\frac{1}{2}$ to 3 tons. Some wild hay is cut from the more poorly drained areas. The forested tracts are pastured. Some truck is grown in small clearings just behind the levee, by people owning house boats, who move up from the towns with the opening of the farming season. A rotation of corn, wheat or oats, and clover and timothy is used on some farms.

Land values vary with improvements and drainage. The selling price of cleared farm land ranges from \$150 to \$300 an acre. Timbered tracts sell for \$40 to \$100 an acre, depending on location, and whether cut up by old sloughs, ponds, and drainage channels.

Efficient drainage is the principal need of this soil. Where drainage is adequate, the soil is not difficult to handle. Care must be taken to plow and cultivate under proper moisture conditions to avoid baking and cracking. The soil should be stirred as soon as possible after rains. Applications of limestone will be of material benefit. Deeper plowing, in the fall where possible, should be practiced.

CASS SANDY LOAM.

The Cass sandy loam is a dark-brown sandy loam to a depth of 12 inches, passing into a loose brown sandy loam to fine sandy loam, which grades at 30 inches into a light yellowish brown sandy loam.

Considerable coarse sand and waterworn assorted gravel is scattered throughout the entire soil section but mostly below 30 inches.

This is an inextensive first-bottom type, developed mainly in the Mississippi River bottoms, 1 to 2 miles north of Huron, with a few small scattered areas between Huron and Kingston and along Skunk River.

The surface of the Cass sandy loam is nearly flat. Some areas occur in strips slightly ridged or raised above the associated soils. Most of the type has levee protection and is not overflowed. The soil is inclined to drift slightly under high wind. Its open structure causes injury to crops during droughts. Corn, wheat, oats, and rye are the principal crops. Yields are generally lower than on the Cass loam.

The principal need of this soil is the maintenance of an adequate supply of organic matter for good crop production and the retention of moisture.

CASS LOAM.

The surface soil of the Cass loam consists of 15 inches of dark-brown to black, friable, heavy loam. This is underlain by a light-brown to brown loamy sand mottled with faint gray and some yellowish brown. Iron stains are present in the lower part of the subsoil, with considerable coarse material and very fine sand. The subsoil is rather variable in texture throughout the type; in places it is a light-brown loam only slightly lighter than the surface soil; in other places the lower subsoil below 30 inches is a fine to very fine, very loose sand.

The Cass loam is inextensive and is developed mainly in the Mississippi River bottoms. Three small areas of 10 to 40 acres each lie east of Spring Grove. A number of small areas are scattered among the sloughs along the river in the northeastern corner of the county. Other areas are north and east of Huron, near the county line. The largest unbroken body, approximately 650 acres, lies 1 mile north of Snider.

The surface is nearly flat, but the drainage appears to be good. The subsoil is porous enough to carry down the excess of surface water, and yet is retentive of moisture. This type is protected by levees.

The Cass loam is practically all in cultivation, a small proportion being thinly forested and used as pasture. Corn, oats, wheat, and hay are the chief crops. Corn yields 35 to 60 bushels, oats, 30 to 55 bushels, wheat 18 to 35 bushels, and hay about 1½ to 2 tons per acre. A few patches of alfalfa and rye are grown. Many hogs are raised and fed on this and adjacent types.

The soil is mellow and easy to cultivate. Both soil and subsoil are acid. No fertilizer except barnyard manure is used. Land values range from \$70 to \$175 an acre, depending on improvements.

CASS SILTY CLAY LOAM.

The Cass silty clay loam is a dark-brown to black silty clay to clay loam to a depth of about 8 inches, where it passes into a dark-brown or brown silty clay which has pronounced gray and yellowish-brown mottlings. This passes at about 24 inches into a brown heavy loam,

faintly mottled with gray and yellowish brown. There is considerable variation in the subsoil. Locally below the black silty clay surface layer, the subsoil is a reddish-brown silty clay, slightly mottled with brown or reddish brown, and the lower subsoil below 26 to 28 inches is a sandy clay or clayey sand, grayish brown in color and mottled with gray, reddish brown, and iron stains, or the lower subsoil may be a yellowish or reddish-brown sand or sandy loam.

This type is of little importance because of its small extent. It is developed only in the Mississippi River bottoms, usually near the main channel on ridges between the network of sloughs and old channels, or on the shoulders of the banks. Many patches of this soil too small to map were included with the Wabash silty clay loam. The largest area of the Cass silty clay loam lies 1 mile northeast of the pumping plant on Tama Slough, and several smaller bodies are scattered near here. Four miles southeast of Kingston there are a few narrow strips along sloughs near the river. Small bodies lie one-half mile south of Concordia School and on the county line east of Iowa Slough Lake.

Less than half of the type is under cultivation; the remainder is covered sparsely with basswood, elm, cottonwood, sycamore, oak, and maple, and used for pasture. It is protected from overflow by levee. The drainage is rather restricted because of the heavy surface soil.

GENESEE VERY FINE SANDY LOAM.

The surface soil of the Genesee very fine sandy loam consists of 18 inches of light yellowish brown to brown very fine sandy loam, which passes into a subsoil of lighter brown to brown very fine sandy loam to silt loam, as heavy as or heavier than the surface soil. The subsoil is always lighter in color than the surface layer. Spots of light-colored sand are numerous over this type.

The Genesee very fine sandy loam is a first-bottom soil subject to overflow by high flood waters. Usually it occurs in narrow continuous strips along the short tributary streams which dissect the light-colored Clinton soils, leaving drift-exposed slopes. Small strips lie along some of the short branches of Skunk and Flint Rivers. A few areas are found in the Skunk River bottoms and along Flint River, mainly 3 miles south of Pleasant Grove.

The type is not extensive. The strips along the tributary streams are largely subject to overflow after heavy rains and are used for pasturing stock. The bodies along Flint and Skunk Rivers are overflowed less frequently and are cropped, mostly to corn, which yields 25 to 55 bushels per acre, depending on seasonal conditions. Although the surface is flat, the drainage between flood stages is good. Occasionally high floods early in the summer do considerable damage to crops.

Most of this type is sold with other farm land. When sold alone, the value ranges from \$80 to \$125 an acre.

GENESEE SILT LOAM.

The surface soil of the Genesee silt loam consists of a light-brown heavy silt loam containing considerable very fine sand. At 12 inches this passes into a subsoil of friable light-brown to brown silty clay loam. In places the subsoil has about the same texture as the surface layer but is lighter in color.

The Genesee silt loam occurs in a few scattered areas northwest of Augusta in the Skunk River bottoms and along the bluff road north of Burlington in the Mississippi bottoms. The largest area lies southwest and south of Spring Grove, adjacent to Skunk River. The type is subject to overflow except north of Burlington, where the levee protects all bottom lands.

Corn and oats are the principal crops. Corn yields from 30 to 55 bushels per acre. The soil is easy to handle and cultivate. The content of organic matter is low and should be increased by means of barnyard manure or green manure. Land values are about the same as for the Genesee very fine sandy loam.

RAY SILT LOAM.

The Ray silt loam is a light yellowish brown heavy silt loam, 12 inches deep. The subsoil is a black tenacious silty clay or clay, which contains much grit, principally coarse sand. Faint gray mottlings are usually present in the lower subsoil, becoming more pronounced with depth.

This type has been developed on colluvial material which was brought down from the light-colored Clinton silt loam and Lindley silt loam on the hill slopes and spread out over the black alluvial clay deposited during floods of the Mississippi River before the building of the Government levee. These short streams issuing from the uplands have not cut channels deep enough to carry the run-off, consequently the waters spread out soon after striking the level bottom land and deposit the light-colored silt held in suspension, thus forming alluvial fans. The surface soil may contain some coarse materials but usually is a uniform silt.

This type is not extensive, occurring only in the northeastern corner of the county on the Mississippi River bottoms. It occupies small areas in the vicinity of Kingston and Snider. The largest development is one-half mile south of Huron. The drainage is poor to fair. After heavy rains thin layers of fresh colluvial material are deposited on many of these areas.

The Ray silt loam is for the most part in cultivation or pasture. Yields are comparable to those on the Genesee silt loam. The deepening and straightening of the stream channels which carry the upland run-off would confine the flood waters to the channels and stop the overflow and sedimentation of these areas.

The results of mechanical analyses of samples of the soil and subsoil of the Ray silt loam are given in the following table:

Mechanical analyses of Ray silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
334629	Soil, 0 to 12 inches-----	0.2	0.0	0.1	0.6	11.8	72.2	15.0
334630	Subsoil, 12 to 36 inches.	2.0	8.4	7.8	23.4	15.4	26.3	16.8

SARPY VERY FINE SANDY LOAM.

The Sarpy very fine sandy loam is a light-brown to brown very fine sandy loam containing a high proportion of silt and occasionally small pieces of gravel. At 18 inches this changes to a lighter brown uniform very fine sandy loam. Scattered over this soil type are patches of sandier and also heavier soil, ranging from silt loam to very fine sand or fine sand in texture. Because of their small size these areas can not be shown separately.

This type occurs in small irregular areas and strips lying from 6 to 15 feet above the stream channel. Most of it is in the Mississippi River bottoms and is protected from overflow by the levee. Owing to the loose structure the soil can be worked almost immediately after rains.

A fair-sized area lies north of Burlington along Flint River, just below where it enters the Mississippi bottoms. The area southeast of Spring Grove is a sandy loam to sand. Other small areas are one-half mile north of the pumping plant near Tama Slough, $1\frac{1}{4}$ miles southeast of Huron, near Gates Lake, and near the mouth of Yellow Spring Creek. The area at Snider, lying close to the bluffs, is a pure medium sand.

The Sarpy very fine sandy loam is largely under cultivation. Corn is the principal crop, yielding 25 to 50 bushels per acre, depending on seasonal rainfall distribution. The soil is adapted to growing potatoes, celery, and truck crops. It has approximately the same selling price as the Genesee very fine sandy loam, the variation in price depending largely on the liability and frequency of overflow.

RIVERWASH.

A small area of Riverwash has been mapped along the Mississippi River in the extreme northeast corner of the county. This material, which can hardly be regarded as a soil, consists of recently deposited sediments, usually unassorted. It may be composed of a heterogeneous mixture of both coarse and fine materials; in one place it may make up a sand bar and in another a mud bank. These deposits of Riverwash are reworked in every period of high water and the areas are subject to change of outline or even total removal by any flood. This material has little agricultural value. A few trees, mostly willows, are scattered over the more permanent areas and a sparse growth of grass establishes itself on some of the better soil material.

SUMMARY.

Des Moines County is situated in the southeastern part of Iowa. It has an area of about 409 square miles. The Mississippi River flows along the eastern side and receives the drainage of the entire area.

The county has two principal types of topography, the rolling upland and the flat alluvial terraces and flood plains. The range in elevation in different parts of the area is from 511 to 780 feet above sea level.

Des Moines County was first settled in 1832. In 1920 the population was 35,520, of which 32.3 per cent was rural. Several main lines of railroads traverse the county, providing good facilities for shipping by rail, and some freight goes by river steamers. The country roads are generally good and some of the highways are well improved.

The climate is favorable for the growing of the general farm crops suited to this latitude.

The mean annual temperature is 50.5° F., with a mean for the summer of 74° F. The mean annual precipitation is 35.54 inches, and is well distributed throughout the growing season. The normal frost-free period is 176 days.

The prevailing type of agriculture in the county is a combination of corn production and the raising and feeding of livestock. Corn, oats, wheat, timothy, clover, and rye are the principal crops. Practically all the corn and oats are fed on the farm. Wheat is an important cash crop.

The soils of the area may be broadly divided into two groups, the dark-colored soils of the prairie and alluvial lands, and the light-colored soils of the forested upland slopes. The dark-colored soils, with the exception of a few poorly drained alluvial types, are the product of the soil-forming processes acting under certain conditions of temperature and precipitation and under the influence of a grass vegetation. The light-colored soils have been developed under a forest cover.

The soils of the Grundy series include the dark-colored upland soils having loose finely granular surface soils and heavy mottled subsoils. They have been developed from loess under former conditions of somewhat restricted drainage. They are highly productive soils and are used for corn and general crops. A silt loam and a silty clay loam have been mapped in this area.

The Tama silt loam is a dark-colored soil with a brown, friable subsoil. It is developed from loess under good drainage conditions. It is one of the most valuable soils of the area and is especially adapted to corn.

The Lindley silt loam and the Clinton silt loam have light-colored fine granular surface soils and heavy brown subsoils. They occupy sharply rolling slopes, and only a part of these types can be cultivated. The Lindley type is developed on drift, the Clinton on loess.

The Jackson silt loam is a terrace soil having a profile similar to that of the Lindley silt loam. It has a flat topography and the greater part can be cultivated.

The Marion silt loam occurs in flat wooded areas where it is developed over loess. It has a light-brown or grayish-brown surface soil, a light-gray or ashy-gray subsurface layer, and a brown or mottled, compact lower subsoil. It has a rather low agricultural value.

The Calhoun silt loam is similar in its profile to the Marion silt loam, but it occurs on old river terraces. Its agricultural value is slightly higher than that of the Marion silt loam.

The Bertrand silt loam has a light-colored surface soil and a friable subsoil. It is a valuable farming type.

The Plainfield types have porous subsoils and are droughty. They warm up early in spring and are used largely for truck crops.

The Buckner sandy loam has a surface soil consisting of dark-brown sandy loam. The subsoil is a brown sandy loam similar in texture to the soil to a depth of more than 3 feet.

The Bremer series consists of very dark colored surface soils underlain by heavy mottled subsoils. These soils occur on terraces. Where well drained they are highly productive. The loam, silt loam, and silty clay loam have been mapped in this area.

The Wabash soils have profiles similar to the Bremer series, but they occupy lower bottoms.

The Cass and Sarpy types have loose, sandy, or gravelly subsoil^s. The Cass types have dark-colored surface soils and the Sarpy are light colored.

The Genesee series consists of light-colored soils on the first bottoms. The subsoils are slightly lighter in color than the soils and the texture may be similar or slightly heavier.

The Ray silt loam consists of colluvial material over an older deposit of black alluvium.

The Davenport silty clay loam occupies erosional benches and is developed wholly or in part from limestone. The soil is dark brown and the subsoil is brown or yellowish brown.

