Issued January 30, 1917.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE STATE OF NORTH DAKOTA. AGRICULTURAL EXPERIMENT STATION, THOMAS P. COOPER, DIRECTOR. AGRICULTURAL AND GEOLOGICAL SURVEY, R. C. DONEGHUE, DIRECTOR. HERBERT A. HARD, DIRECTOR, 1913.

SOIL SURVEY OF LAMOURE COUNTY, NORTH DAKOTA.

BY

A. C. ANDERSON, IN CHARGE, F. Z. HUTTON, AND T. M. BUSHNELL, OF THE U. S. DEPARTMENT OF AGRICULTURE, AND MELVIN THOMAS AND MURRAY E. STEBBINS, OF THE NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION.

THOMAS D. RICE, INSPECTOR, NORTHERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1914.]

WASHINGTON:
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1917.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., April 5, 1916.

SIR: In the extension of the soil survey in the State of North Dakota a project was undertaken in Lamoure County in 1913 and carried to completion in 1914. This work was done in cooperation with the State of North Dakota, and the selection of the area was made after conference with State officials.

I have the honor to transmit herewith the manuscript report and map covering this work and to request their publication as advance sheets of Field Operations of the Bureau of Soils for 1914, as authorized by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

CONTENTS

	Page.
SOIL SURVEY OF LAMOURE COUNTY, NORTH DAKOTA. By A. C. ANDERSON, IN CHARGE, F. Z. HUTTON, and T. M. BUSHNELL, OF THE U. S. DEPARTMENT OF AGRICULTURE, and MELVIN THOMAS and MURRAY E. STEBBINS, OF THE NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION	5
Description of the area	5
Climate	8
Agriculture	11
Soils	17
Barnes silt loam	20
Barnes loam	23
Barnes silty clay	24
Williams fine sandy loam	25
Williams gravelly loam	26
Williams loam	27
Edgeley loam	28
Sioux gravelly loam	29
Sioux sandy loam	31
Sioux fine sandy loam	32
Sioux silt loam	33
Sioux loam	34
Bearden silt loam	36
Fargo silty clay	37
Fargo loam	38
Rogers silty clay	39
Maple clay loam	41
Valentine fine sand	43
Valentine fine sandy loam	44
Lamoure silt loam	45
Lamoure loam	46
Lamoure silty clay loam	47
Lamoure silty clay	48
Lamoure clay	49
Rough broken land	51
Summary	52

ILLUSTRATIONS.

FIGURE.

	Page.
FIG. 1. Sketch map showing location of the Lamoure County area, North Dakota	5

MAP

Soil map, Lamoure County sheet, North Dakota.

SOIL SURVEY OF LAMOURE COUNTY, NORTH DAKOTA.

By A. C. ANDERSON, in Charge, F. Z. HUTTON, and T. M. BUSHNELL, of the U. S. Department of Agriculture, and MELVIN THOMAS and MURRAY E. STEBBINS, of the North Dakota Agricultural Experiment Station.—Area Inspected by THOMAS D. RICE.

DESCRIPTION OF THE AREA.

Lamoure County lies in the southeastern part of North Dakota, being the third county from the east State line and the second from the south line. It is bounded on the north by Stutsman and Barnes Counties, on the east by Ransom County, on the south by Dickey County, and on the west by Logan County. It is rectangular in shape, being about 48 miles long and 24 miles wide, and comprises an area of 1,140 square miles, or 729,600 acres.

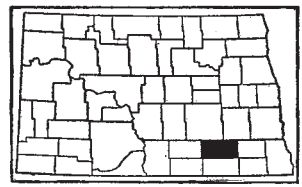

FIG. 1.—Sketch map showing location of the Lamoure County area, North Dakota.

Lamoure County occupies parts of two distinctly marked physiographic divisions. The lower of these, sometimes called the Prairie Plains, includes about three-fourths of the county. It is, broadly considered, a plain sloping toward the southeast, smooth in general surface configuration, but broken in a minor way by the valleys of the James River and its tributaries. The topography is typical of much of the eastern half of the State, consisting of long, symmetrical swells, with minor indefinite depressions and occasional low hills. In detail the relief is typically that of a ground moraine, practically unmodified by erosion, except for the trough through which the James River flows. The range in elevation of this plain in Lamoure County is from 1,300 to about 1,600 feet above sea level.

The second main physiographic division of the county consists of two types of topography, the eroded border of the Missouri Plateau and the plateau proper, with its covering of morainic hills. The first type occurs as a belt 4 or 5 miles wide extending across the county in a north-south direction from the vicinity of Alfred to the neighborhood of Kulm. The slope is gentle in the eastern part but becomes gradually steeper toward the west, until in places near the

plateau surface the slope becomes precipitous. The drainage system here is well defined, but the land is not materially eroded, considering its rise in elevation, which amounts to 300 feet in a distance of 4 to 8 miles.

The second type of topography is that of the hilly region where the eastern edge of the plateau was covered by the Altamont Moraine. The elevation here is 300 feet higher than the general level of the country to the east. The topography is characterized by sharp hills and ridges, inclosing a rather large number of deep depressions forming natural grass lands. An exception is found over much of Swede Township, which lies in the same belt but is more level in character.

The James River Valley consists of level first bottoms and well-defined terraces. It ranges from one-half mile to 4 miles in width and lies about 100 feet lower than the surrounding country. This valley extends through the county like a broad ditch, with steep bluffs and practically no tributaries. The contiguous country shows no evidence of the development of this valley except at the border. Little drainage water enters the river from the country through which it flows.

Bearden Hillock Creek bottom and the line of terraces extending from the Sand Prairie region in Barnes County are parts of an old glacial spillway which form a conspicuous feature of the eastern part of Lamoure County.

A modification of the topography of special geological interest is a number of more or less well defined abandoned valleys in a belt extending north and south through the center of the county. One of these extends from Bone Hill Creek near Nortonville to the Maple River system in Nora Township. An intermittent drainage way leads south through the center of Adrian Township. The topography suggests that at one time a large volume of water left the James River near the Stutsman County line and flowed southward toward Bone Hill Creek.

There are other conspicuous irregularities in the surface construction. Bearing some relation to these stream cut-offs are numerous level sandy tracts extending northwest over the southeastern part of Willowbank Township. Large wind-blown deposits of fine sand carried from a loop in the James River valley southwest of Lamoure have modified the topography in that region. North of Lamoure and extending from the northwest to the southeast there is a series of deep depressions that are very well defined and have precipitous slopes. Two of the largest, about 60 feet deep, are partly occupied by the Twin Lakes. The formation of these depressions is difficult to explain. There is nothing to indicate that they are part of old stream channels.

The soil formation indicates that a large volume of water has in times past flowed from the James River at a point near Grand Rapids toward a point on Cottonwood Creek near Berlin. South of Edgeley there is an area whose topography has been influenced by the erosion of shale, the surface appearing level at a distance but choppy when viewed near at hand.

Lamoure County was organized from parts of Buffalo and Pembina Counties in Dakota Territory in 1873. In 1881 its southern part was separated and organized as Dickey County and the present boundaries of Lamoure County were established. The real development of the county began shortly after this time. By 1890 most of the eastern and central parts of the county were settled, but the population was only 3,187. During the following decade the western part of the county was settled. By 1900 the population had increased to 6,048, and in 1910 it was 10,724. This is entirely rural, and gives a density of 9.3 inhabitants per square mile, while the average density of population for the State is only 8.2 persons to the square mile. About 76 per cent of the population is native, the remainder being mostly of German and Scandinavian birth. The western part of the county was settled largely by immigrants from Russia. They are almost entirely of German stock, however, and class themselves as Germans. The northeastern part of the county was settled largely by Scandinavians. Settlers from the Central States comprise most of the American-born population.

Lamoure is the county seat and the largest town. Its population in 1910 was 929. Lamoure has an advantageous location in the James River valley and is an important trading point. Edgeley, with a population of 749, is the largest town in the western part of the county. It has good railroad facilities. Kulm, with a population of 645, is a trading point in the southwestern part of the county. Other towns are Marion, Verona, Berlin, Nortonville, Jud, Alfred, Medberry, Grand Rapids, Dickey, Adrian, Independence, and Deisem.

There are four railway lines in the county, with a total length of about 117 miles. They are the Northern Pacific (the Streeter, the Fargo & Southwestern, the Casselton, and the James River branches), Midland Continental, Minneapolis, St. Paul & Sault Ste. Marie, and the Chicago, Milwaukee & St. Paul. Most of the farms are quite accessible to shipping points, all the county except 110 square miles lying within 8 miles of a railroad, and no part is at a greater distance than 14 miles from a shipping point.

The public roads are quite good, especially in the fall when the greater part of the hauling is done. They consist largely of highways on the section lines with dirt fills in the more poorly drained places. There are very few heavy grades. All section lines are

legal highways and are traveled to some extent. During exceptional winters snow drifts to such an extent that travel is difficult. The split-log drag is coming into use as a means of road improvement.

Mail is delivered to every section of the county and a large proportion of the farmers have telephones. The county has a good public-school system, especially in the larger towns. One of the five State agricultural high schools is located at Lamoure.

CLIMATE.

The climate of Lamoure County is subhumid, with comparatively long winters and short summers. Thawing weather usually begins about the middle of March and field work is begun by April 10. The weather is usually cool, and plant growth is comparatively slow until about May 10, after which the higher temperature and the long hours of sunshine result in a much more rapid growth, which continues until the small grains mature. Occasionally crop growth is retarded by periods of drought. There are few very warm days, and the nights are cool.

As a rule the fall season is somewhat dry and includes many days of fair weather. The ground seldom freezes before the middle of October and often fall plowing can be done until the middle of November. The ground may freeze to a depth of 5 feet or more. During short periods in the winter the thermometer may occasionally register as low as —40° F., but the dry air makes the cold less penetrating than in more humid regions. These cold periods are usually less disagreeable than those storms known as "blizzards," in which somewhat higher temperatures are attended by high winds.

The average length of the growing season is 102 days, as determined by the Weather Bureau observations at Berlin, the average date of the last killing frost in the spring being June 2 and that of the first in the fall, September 12. This is the average for a period of 19 years. Killing frost has occurred in the spring as late as June 21 and in the fall as early as August 31.

Some damage to crops is done by hail almost every year, but on account of the local character of the storms the aggregate loss for the county is seldom large.

The following tables, compiled from the records of Weather Bureau station at Berlin and from records kept by the department station at Edgeley, indicate the normal and extreme temperature and precipitation by months and seasons, and for the year:

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

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
December	13	55	−36	0.6	0.7	0.6	6.6
January	8	63	−38	.6	.6	.6	5.6
February	6	54	−44	.9	1.0	1.9	8.7
Winter	9	63	−44	2.1	2.3	3.1	20.9
March	22	68	−41	1.4	1.3	1.4	13.5
April	42	85	−18	2.3	2.9	5.1	3.8
May	52	99	20	1.8	.7	4.0	Trace.
Spring	39	99	−41	5.5	4.9	10.5	17.3
June	62	101	23	3.7	1.5	3.2	.0
July	67	104	36	2.7	1.5	1.3	.0
August	66	102	29	3.6	.7	4.6	.0
Summer	65	104	23	10.0	3.7	9.1	0.0
September	56	99	8	1.3	0.3	.9	Trace.
October	44	89	−21	1.2	.7	2.0	2.1
November	26	71	−31	.7	.2	3.2	2.1
Fall	42	99	−31	3.2	1.2	6.1	4.2
Year	39	104	−44	20.8	12.1	28.8	42.4

Normal monthly, seasonal, and annual temperature and precipitation at Edgeley, 1901–1913.

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*
December	16.0	57	−30	0.43	0.00	0.87
January	8.3	57	−41	.26	.24	.21
February	11.1	60	−35	.32	.06	.57
Winter	11.8	60	−41	1.01	.30	1.65
March	27.1	86	−25	1.00	.21	6.25
April	41.6	90	0	1.71	.35	2.47
May	53.5	95	11	2.64	1.89	3.94
Spring	40.7	95	−25	5.35	2.45	12.66

Normal monthly, seasonal, and annual temperature and precipitation at Edgeley, 1901–1913—Continued.

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.
	°F.	°F.	°F.	Inches.	Inches.	Inches.
June	63.3	104	26	3.36	1.73	5.90
July	67.6	105	33	2.66	2.77	1.56
August	66.7	104	31	2.44	1.21	4.84
Summer	65.9	105	26	8.46	5.71	12.30
September	57.5	97	17	1.88	1.47	.95
October	45.5	89	6	.99	.40	.91
November	29.4	74	−27	.35	.00	.14
Fall	44.1	97	−27	3.22	1.87	2.00
Year	40.6	105	−41	18.04	10.33	28.61

The following table, compiled from the records of the substation at Edgeley, where the climatic conditions are practically the same as at Berlin, shows the relation of the amount of evaporation from a freely exposed water surface to the rainfall of the three months of active crop growth:

Evaporation and precipitation at Edgeley for the months of May, June, and July, 1907–1912.

MONTHLY PRECIPITATION.

	1907	1908	1909	1910	1911	1912
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
May	1.89	3.53	4.01	0.36	2.31	3.25
June	1.73	3.26	2.80	1.57	1.19	3.82
July	2.77	1.19	3.04	.60	1.76	5.70
Total	6.39	7.98	9.85	2.53	5.26	12.77

MONTHLY EVAPORATION.

May	3.41	4.08	4.40	5.68	5.47	4.40
June	5.46	5.21	4.19	6.72	5.43	3.06
July	5.98	7.04	5.63	8.19	7.56	5.70
Total	14.85	16.33	14.22	20.59	18.46	13.16
Evaporation times rainfall	2.32	2.05	1.44	8.14	3.51	1.03

Average evaporation times rainfall for 6-year period, 3.08.

AGRICULTURE.

The first permanent settlers came to Lamoure County in the late seventies. Being distant from railway facilities and lacking in equipment and capital, the early settlers were greatly handicapped in developing the agricultural resources. After the Fargo & Southwestern branch of the Northern Pacific was built into the county agricultural development progressed more rapidly. By the late eighties settlement was general though sparse throughout the county, with the exception of the northwestern part, which is rough and was considered suitable only for cattle ranches.

As in most new prairie regions, grain farming was exclusively practiced. Wheat at once became the principal money crop, followed in importance by oats and barley, which were principally fed to live stock, the surplus being marketed. Oxen, milch cows, and sheep subsisted largely on the prairie grass in summer and on native hay in winter. Flax was introduced in 1896 and for a number of years, while abundant new land was available, it ranked close to wheat as a money crop. In late years flax has not been of much importance, owing to the fact that flax diseases became prevalent on land after it had grown this crop for several years.

The early settlers broke the prairie sod in the spring or early summer, backset it in the fall, and prepared the land and sowed it to small grain the following spring. This method of tillage usually produced good crops, but returns were slow, as it was difficult for farmers to prepare more than a small acreage each year. With the introduction of flax, methods were materially changed, the land being broken in the spring and sowed to flax. This plan had the advantage of supplying the farmer with working capital at the end of the first season, and, while it was not commendable from the standpoint of good tillage, it was followed for economic reasons.

Little corn was grown in Lamoure County prior to 1890. Trials made by farmers about this time demonstrated that early varieties could be grown successfully with proper tillage. One of the greatest handicaps was the lack of varieties which would mature early enough to escape the early fall frosts. By 1910 most of the better class of farmers were growing corn to some extent. This time marks a period of change over much of the county from the exclusive grain-farming system to the more practical and safer method of crop diversification. This change is attributable partly to the fact that corn made fair yields in 1910 and 1911 when other crops were almost a failure. Another important factor was the increasing prevalence of noxious weeds in the small-grain fields and the general decrease in yield of the small grains when grown to the exclusion of cultivated and forage

crops. The acreage of corn has steadily increased, and the farmers at present are keeping more live stock in order to utilize this crop to the best advantage.

The relative acreage of the different crops is much the same on all the soil types that are under cultivation. This is largely due to the fact that the agriculture is comparatively new and a limited number of crops or classes of crops which demand certain soil conditions are grown.

Spring wheat is the principal crop grown in Lamoure County, occupying 60 per cent of the cultivated area. The average yield is about 13 bushels per acre, the yield varying greatly with the season. The so-called hard wheats, Fife and Bluestem, predominate. About 30 per cent of the wheat grown in the area is durum. Variety trials have shown that durum wheat yields on the average about 5 bushels per acre more than Bluestem and 6 bushels per acre more than Fife.[1] Until recently durum wheat has commanded a lower price than other hard wheats, but there seems to be an increasing demand for it. Some Velvet Chaff wheat is grown in the county. This variety has given some very good yields, but it shatters badly when allowed to stand after ripening. From 4 to 6 pecks of ordinary wheat per acre or 6 to 7 pecks of the durum varieties has proved to be the most profitable rate of seeding.[2] There are two flour mills in the county, with a combined capacity of 180 barrels a day, but most of the wheat is shipped to terminal markets at Minneapolis and Duluth. The wheat grown in this region makes flour of the best quality and much of it is used for blending with inferior wheat grown in other districts, to improve the grade of the flour.

Oats are the staple stock feed. A number of varieties are grown. The early oats, such as the Sixty Day and Kherson, yield more in dry years than the medium and late ripening strains, though late oats, for example the White Russian, are more resistant to rust. The medium-maturing varieties, such as the Siberian White, lead in point of average yield for a term of years. The Kherson and Sixty Day oats yielded 20 to 25 bushels per acre in the dry seasons of 1910 and 1911, when most of the other varieties were a failure. Evidence indicates that it is good practice to sow about one-half the oat acreage to one of the earliest varieties and the remainder to medium-ripening strains. On an average the early oats ripen about 15 days before the other varieties. As hot, dry weather usually does not occur until after the middle of July, which is the ripening period of the earlier varieties, they suffer little damage from drought.[3] The yield of oats

[1] Reports of Edgeley Substation, North Dakota Agr. Expt. Sta.
[2] Tenth Annual Report, ibid.
[3] Ibid.

ranges from 27 to 80 bushels per acre. From 7 to 10 pecks per acre has proved to be the most profitable rate of seeding oats.[1]

In acreage barley ranks close to oats. The average yield is about 20 bushels per acre. Barley is fed to all classes of live stock. Barley is a short-season crop and is grown largely to clear the land of weeds and to prolong the seeding season, since fairly good yields can be obtained even when sowing is done late in the spring. A large proportion of the barley shipped is of high quality and suitable for malting purposes. The 6-rowed barleys are grown principally. In experiments they have yielded a little higher than the 2-rowed barleys, 12 varieties of each being compared for a period of four years.[2]

Flax is still grown to quite an extent in the county. The average yield is about 8 bushels per acre. Though flax has been declining in relative importance, indications are that it will continue to be grown to some extent, especially on sod when timothy or other grass land is broken. Flax is grown exclusively for seed, and the surplus production is shipped out of the county. The straw is not utilized under the present methods of handling. The wilt has been destructive to the crop, but the ravages of this disease have been overcome to some extent by growing wilt-resistant strains and by treating the seed. More careful preparation of the seed bed and the development of cropping systems, in which flax is not grown too frequently, also insure better yields.

Corn has recently become an important crop in the region. At first it was grown mostly for fodder and largely because of the need of an intertilled crop to take the place of summer fallow. Corn produces profitable yields if early varieties suited to the region are grown, and furthermore, its culture increases the yields of succeeding crops. For these and other reasons it is considered one of the most profitable crops grown. A considerable proportion of the acreage planted is cut with corn binders and the fodder fed to live stock during the winter months. The rest is husked in the field and the stalks pastured. The yields of corn range from 15 to 40 bushels per acre. The average yield of shelled corn is less than 25 bushes.

The yields of corn are increasing, owing to the fact that farmers are exercising more care in selecting seed from their own fields. The dent varieties most commonly grown in the county are Northwestern Dent, Rustler White Dent, Golden Dent, and Dakota White. The common flint varieties are Mercer, Dakota White Flint, Gehu, and Squaw. The Dakota White Flint, Gehu, and Squaw are the earliest strains of corn grown in the region. They yield well, but the ears are borne low on the stalk, making harvesting difficult. They are

[1] Eleventh Annual Report, ibid.
[2] Tenth Annual Report, ibid.

exceptionally good varieties for hogging down. The Mercer is a large corn with the ears borne high on the stalk and is somewhat later in maturing than the other flint varieties. It is an especially good silage corn. The silo is particularly well suited to this region because of the greater convenience in handling silage than fodder during the severe winters. Furthermore, the chances of making efficient use of the immature crop in unfavorable years are much better when a silo is available.

Considerable winter rye is grown in Lamoure County. The crop is usually sowed between August and the middle of September. Rye is usually drilled in stubble after grain harvest, without preparation of the seed bed. When seeded in this way the cost of growing the crop is low. Many farmers give the land a light disking prior to seeding, and report better results with this treatment. Rye is also sowed on summer fallow or between rows of corn. Seeding with corn usually gives the better yields, but the labor cost is very high. Winter rye is grown largely because it helps to keep down weeds, owing to its early harvesting season. Rye is used largely for feed. The yield is about 14 bushels per acre.

Emmer, locally known as speltz, is grown to some extent for feed. It yields about the same as barley.

Potatoes are grown mainly for home use. They are of excellent quality. The Early Ohio is the most common variety. It yields approximately 80 to 90 bushels per acre, though yields occasionally reach as much as 250 bushels.

Broom-corn millet (hog millet) is a crop recently introduced that seems to do very well, and is gaining in favor. It yields as well as barley or better, and has an advantage in that it can be sowed late in the spring so as to prolong the seeding season. German, Siberian, and Hungarian millets are grown to some extent for hay.

Legume crops are not extensively grown at present. Attempts at clover growing have not been successful. Alfalfa is grown in an experimental way in all parts of the county. It does best on the lower lying, rich, well-drained lands. Canada field peas do fairly well in seasons of good rainfall, but only a very small acreage is grown, as the crop is not popular under the extensive system of agriculture prevailing. Results obtained at the Edgeley substation indicate that sweet clover (white blossom) is well suited to local conditions. Inoculation is usually necessary for alfalfa and clover.

All kinds of vegetables do well in the county, but vegetables are grown only for home use, as market conditions are not favorable for their production on a commercial scale. Small fruits, such as strawberries, raspberries, gooseberries, and currants, can be grown in abundance, but only a sufficient quantity of berry and brier fruits

is produced to supply home requirements on some of the best farms. Plums and apples of the hardy varieties are grown in suitable locations, but no effort is made to grow them for market.

The principal noxious weeds of the county are wild oats, pigeon grass, yellow mustard, French weed, and the Russian thistle. The first four of these have become so plentiful in some locations where continuous small-grain cropping is practiced that the production of small grains is unprofitable. The Russian thistle does little damage except in dry seasons, while pigeon grass is most troublesome in wet years.

The 1910 census gives the live-stock enumeration for the county as 13,371 horses, 233 mules, 7,331 hogs, 629 sheep, and 14,347 cattle, of which 5,205 are dairy cows. The standard breeds of horses and cattle are fairly well represented, the Percheron apparently being the most popular breed of horse, and the Shorthorn of cattle. Considerable attention is given to the grading up of the live stock by home breeding and selection. Dairying is in an early stage of development, and few good dairy cows are kept. The ration generally fed the dairy stock is not conducive to heavy milk production, and the average return per animal is low. Beef production probably receives more attention than dairying, and a considerable number of beef cattle are fed and finished for market each year.

Fall plowing is practiced as much as possible. Fall preparation of the land permits early spring seeding and thereby minimizes the chances for reduction of yield by plant diseases and insects. The land is in most cases harrowed twice before seeding and often once after seeding. The present tendency is to do more harrowing. Ten or eleven foot single or double disk drills with chains following are used for seeding small grain. This method allows a space of 6 inches between the rows of grain.

The average time of seeding is about as follows: Wheat, April 1 to May 10; oats, April 10 to May 20; barley, April 20 to June 15; corn, May 1 to May 20; and flax, May 20 to June 20.

Grain is usually harvested with 7 or 8 foot binders, shocked, and left in the field until thrashing time. In wet seasons grain standing in the shock often deteriorates considerably in grade, but not to such an extent as it would in a more humid region, and, in consideration of the high price of labor in the fall, most farmers think that any deterioration in grade is compensated for by the saving in labor necessary for stacking. Shock thrashing usually delays fall plowing, however, and as the farmers more generally appreciate the advantage of early fall plowing, stacking is becoming more popular. In the western part of the county much of the grain is cut with headers and is stacked at once, thus leaving the land clear for plowing.

Most of the plowing is done with gang plows, five horses being used. Some farmers use triple gangs, requiring seven or eight horses, and plowing is done to some extent with gas and steam tractors. Four to six horses are used on most of the seeding and harvesting machinery. Corn binders require three horses and cultivators two, while six horses are commonly used on push binders and headers.

Quite a large proportion of the farm labor is performed by the farmers and their families, although most farmers hire one or more hands. The ordinary wage by the month during the summer is about $35 to $40 for a 7 or 8 months' period. The bulk of the labor hired is day labor, the pay ranging from $1.25 a day during seeding time to as much as $3 or more during the thrashing season. Farm labor is in general transitory and is difficult to obtain, especially during the harvesting and thrashing season. Thrashing is usually done with large outfits owned by men who furnish labor, including board for the crew, and charge a stipulated amount per bushel for thrashing.

According to the census, there were 614 farms in Lamoure County in 1890, 906 in 1900, and 1,302 in 1910. The average size of farms has increased from 277 acres in 1890 to 384 acres in 1900 and 479.5 acres in 1910. In 1910 there were only 11 farms of less than 100 acres and 72 farms of 1,000 acres and over. Of the total area of the county, 85.1 per cent is reported in farms, and 89.8 per cent of all the land in farms is improved.

In 1910 owners operated 77.3 per cent of the farms in the county, tenants 22.2 per cent, and managers 0.5 per cent. Tenant farming is becoming more general, as 95 per cent of the farms were operated by owners in 1900. Under the common system of tenure the tenant and owner share the crops equally, the tenant furnishing the labor, work stock, and implements, as well as paying other operating expenses and defraying half the cost of twine and thrashing, while the owner furnishes the seed. Special arrangements are usually made where the land is used for cultivated crops or pasture, the renter usually paying a stipulated cash rental for such land or giving the owner an equivalent share in a small-grain crop. As a rule the term of tenure is short and poorer farming is practiced than on land operated by the owner.

The average land value for the county is reported by the 1910 census as $33.39 an acre, an increase of almost 300 per cent over that reported for 1900. Prices range from $10 an acre for the poorest agricultural land to $60 an acre for the most desirable land. Of the total value of farm property in the county 77.8 per cent is represented by the land itself, 8.8 per cent by buildings, 4.3 per cent by implements and machinery, and 9.1 per cent by live stock.

A fairly good class of dwellings and farm buildings is general throughout the county. In some of the best agricultural sections

modern houses and large barns are quite common. In the northwestern part of the county there are still a few sod and adobe houses. Little attention is paid to sheltering farm machinery.

All this county was originally treeless, except part of the James River bottoms above Grand Rapids. Many farmers now have well-established groves and windbreaks about the farm buildings. With proper care, good shelter belts can be established on almost every farm in the county. They are of great value in furnishing protection against the strong northwest winds in winter, in addition to relieving the otherwise monotonous landscape.

The water supply of the farms is obtained from both deep and shallow wells. Many of the deep wells are flowing and all furnish an abundant supply. The water is slightly alkaline, but is suitable for household purposes as well as for stock. The shallow wells usually furnish good water.

A deficiency in the agriculture of the region is the lack of a systematic crop rotation, including cultivated and leguminous crops to improve the physical condition of the soil and clear the land of weeds. More attention could well be given to the development of raising live stock and dairying, as these branches of agriculture offer a profitable means of disposing of forage crops and other products that can not be marketed directly to good advantage.

SOILS.

The upland soils of Lamoure County are derived by weathering from glacial drift which has not been greatly modified by erosion since its deposition. The drift was laid down as a part of the Dakota lobe of the continental ice sheet and in the time of one of the latest advances of the ice, known as the Wisconsin glaciation.

The presence of limestone and granite bowlders and pebbles in the drift indicates that the glacier derived at least a considerable part of its débris from rocks of these formations. The sandy nature of the soil and the presence of shale fragments indicate that sandstone and shale were also the sources of part of the material. As the glacier receded a deposit of till or drift was laid down over the country, varying from a veneer not over a foot in thickness to a layer as deep as 80 or 90 feet.

The till was modified to some extent by the great volumes of water liberated by the melting of the ice. Weathering, the subsequent action of vegetative life, drainage, and erosion have also brought about some change in the character of the drift. The action of each of these factors has varied from place to place, giving rise to soil

types of different characteristics. The soils of the county may be classed in four main groups, viz, glacial soils, glacial-lake and river-terrace soils, river flood-plains soils, and eolian soils.

The glacial soils occupy by far the greater proportion of the county. This group includes the Barnes, Williams, and Edgeley series. The Barnes series is the most extensive.

The Barnes soils are derived from the weathering of glacial drift that for the most part seems not to have been materially leached since its deposition. The surface soils are black to dark brown in color and are underlain by grayish, greenish-yellow or yellowish-brown subsoils which are of the same or somewhat finer texture and slightly more compact structure, and are calcareous. The topography ranges from level to undulating or rolling, and the soils are well drained. The Barnes silt loam, loam, and silty clay are recognized in Lamoure County.

The surface soils of the Williams series are dark brown to black and differ from the Barnes in having a thinner layer of the dark-colored surface soil. The subsoils are light brown, typically grading quickly into light-gray or ash-colored material showing reddish and brownish shades. The subsoils are of calcareous character and usually of fine texture. These types are glacial in origin and are derived from a variety of rocks. They are similar to the Barnes and Valentine soils. They have a higher lime content in the subsoil and a rougher topography than the Barnes soils and contain more bowlders. In this county the Williams fine sandy loam, gravelly loam, and loam are mapped.

The surface soils in the Edgeley series are similar to those in the Barnes, being dark brown to black. The subsoils are lighter in color, usually grayish or bluish gray to pale yellowish brown. They are highly calcareous and carry dark shale fragments, resting on bedded shale at depths ranging from 18 inches to 4 feet. The soil layer is of ice-laid accumulation and occurs in association with the Barnes soils in regions of low to moderate rainfall. The topography of the Edgeley soils is gently rolling to undulating. In Lamoure County only the Edgeley loam is mapped.

Of the soils in the glacial-lake and river-terrace group the Sioux series is the most extensive. The Sioux soils are the result of glacial stream action and occupy terraces above overflow. On account of their coarse-textured subsoil, they are usually droughty. The surface soils are brown to black in color and are underlain by a gravel subsoil. The soil layer above the gravel varies in thickness, there being practically no soil whatever in places in areas of the Sioux gravelly loam. The Sioux silt loam and Sioux loam in places have a 3-foot layer of fairly fine textured material over the gravel. The

Sioux sandy loam and the fine sandy loam are not extensively developed.

The soils of the Bearden series are developed on high terraces, where they were probably deposited at the time of the recession of the glacier. They occur as terraces above overflow along streams in western prairie regions. They comprise black surface soils with straw-colored subsoils whose textures are as heavy as or heavier than those of the soil. These high-terrace types are productive and easily tilled. Only the silt loam type of this series is mapped in Lamoure County.

The surface soils of the Fargo series are black to a depth of 15 to 30 inches and are high in organic-matter content. Beneath the black layer there is usually a distinct gray layer. The types, especially in the subsoil, are calcareous. They are poorly drained and usually can not be drained artificially with profit, as in this county the areas of Fargo soil occupy small depressions in areas of the Barnes soils and receive much drainage water from the surrounding land. Many of the small areas are covered with water in wet years, especially in early spring, and are often not tillable. The Fargo silty clay and Fargo loam were identified in Lamoure County.

The soils of the Rogers series occupy the same topographic position as those of the Fargo series, but the material is lighter in color and contains a higher percentage of alkali salts. The surface soils are grayish-brown in color. Incrustations of alkali are not infrequently found at the surface and evidence of alkali salts also exists in the subsoil. The types are poorly drained. Only the Rogers silty clay is mapped in this survey.

The soils of the Maple series differ from the Fargo types in that they are not inclosed topographically but occupy abandoned stream channels. The surface soil is gray to nearly black in color and is underlain by a light-brown to yellowish-gray subsoil. Gravel frequently occurs in the lower subsoil. Drainage is poor and the soils are usually water-logged. The one type, the clay loam, mapped in Lamoure County, occupies sloughs or swales and receives drainage water from the surrounding land. The Maple soils have a high alkali content.

The two types of wind-laid or eolian origin or modification are classed with the Valentine series. This series comprises dark-gray to dark-brown surface soils and light-brown to brown subsoils, grading into loose sand. Drainage is usually thorough, though in places during certain periods of the year the water table is near the surface. In Lamoure County the series is of small extent. It is represented by the fine sand and fine sandy loam types.

The River Flood Plains soil province includes the first-bottom soils along streams. The material is grouped into the Lamoure

series. The surface soils of the Lamoure series are dark brown to black. The subsoils vary from yellowish brown to grayish and are highly calcareous. These types are derived from the alluvium of streams that drain highly calcareous, usually glacial, deposits, and occur in a region of moderate to low rainfall. They are usually moderately well drained, except in the heavier members, but are subject to flooding at varying intervals. In Lamoure County the silt loam, loam, silty clay loam, silty clay, and clay members of the series are developed.

Rough broken land comprises areas too rough and steep in topography for extensive cultivation, where the land is utilized only for grazing.

The four soil groups in Lamoure County, embracing 10 series, include, with Rough broken land, 25 distinct types. The distribution of these types is shown on the map accompanying this report, and individual type descriptions follow the table below, which gives the name and the actual and relative extent of each soil mapped:

Area of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Barnes silt loam	378,048	51.9	Lamoure silty clay	5,248	0.7
Barnes loam	111,680	15.3	Lamoure silt loam	5,120	.7
Williams loam	86,912	11.9	Rogers silty clay	4,928	.7
Sioux loam	22,784	3.1	Valentine fine sand	4,672	.6
Lamoure loam	18,496	2.5	Edgeley loam	3,968	.5
Rough broken land	16,768	2.3	Sioux sandy loam	3,904	.5
Valentine fine sandy loam	12,608	1.7	Sioux silt loam	3,456	.5
Fargo silty clay	[1] 12,096	1.7	Lamoure silty clay loam	3,136	.4
Williams fine sandy loam	[2] 9,536	1.3	Lamoure clay	2,112	.3
Maple clay loam	9,152	1.3	Barnes silty clay	2,048	.3
Sioux gravelly loam	5,056	.8	Sioux fine sandy loam	1,600	.2
Rolling phase	768		Total	729,600	
Bearden silt loam	5,504	.8			

[1] Fargo loam included.

[2] Williams gravelly loam included.

BARNES SILT LOAM.

The Barnes silt loam as developed in Lamoure County is fairly uniform in texture. The surface soil ranges from a very fine sandy loam to a heavy silt loam, averaging a silt loam. It is black to dark brown in color. The soil has a mellow, fluffy feel, due to its high organic-matter content, and is easy to till, not baking or cracking on drying. The black layer in most places is 8 to 16 inches in depth, but it may extend to 24 inches, being thinner on the knolls and ridges and thicker in the depressions, especially where they are inclosed on all sides. The average depth is about 12 or 14 inches. At this

depth the soil becomes lighter in color, changing to yellowish brown in the upper subsoil and gradually to lighter grayish yellow, with a greenish tinge, in the lower part of the 3-foot section. In rare cases poor drainage, with consequent retarded oxidation, has caused a grayish color to develop in the subsoil.

The subsoil is usually heavier in texture than the surface soil and somewhat more compact in structure, but there is no perceptible concentration of heavy material in the subsoil and there is not compaction sufficient to interfere in any way with root penetration. There is little difference in the texture of the upper and lower layers of the subsoil. It is not stratified and consists of unassorted fine and coarse material. At an average depth of about 18 feet the material merges into a blue clay.

The texture of the Barnes silt loam east of the James River is somewhat finer than that of most of the type west of that stream. Over most of the country between the James River and the Missouri Plateau the texture is coarser than is typical, especially in the territory surrounding Russell Township and bordering areas of the Valentine fine sandy loam. In these places the soil is characterized by a high content of very fine sand, which takes the place of the usually high percentage of silt, and by its comparatively large content of soil particles grading between very fine sand and silt in texture.

A fine-textured variation of this type occurs west of Edgeley in a belt averaging about 4 miles in width extending from Deisem southward to the county line, occupying a smooth, gentle slope eastward from the Missouri Plateau. Here the soil is a heavy silt loam, retentive of moisture and very productive.

The areas of the type in the vicinity of Kulm, in the southwestern part of the county, are slightly heavier in texture than is typical. The soil has a thicker layer of dark-colored materials and is partly the product of accumulation by the washing of soil from surrounding higher areas. The topography is somewhat smoother than is typical. The soil, on the average, is a somewhat better type for agriculture than the typical Barnes silt loam and resembles the Fargo soils as they are developed in the Red River Valley in the eastern part of the State.

The Barnes silt loam has an unusually high lime content, especially in the subsoil, where calcareous material gives rise to gray streaks or pockets. Lime concretions occur throughout the 3-foot profile. Stone and gravel are scattered through the soil, but in quantities too small to interfere with tillage. The stone and gravel consist of crystalline rocks—granite, schist, gneiss, and dark-colored eruptives—and limestones. A considerable percentage of the small stones are limestone. All the stones embedded in the soil are incrusted with lime.

The boundaries between the Barnes silt loam and the Barnes loam are sometimes drawn arbitrarily, since gradations in texture between the two types are common. The boundary between the type and the Williams loam is also difficult to locate in places, as in this county one type usually grades into the other, and there is no appreciable difference in texture between them along the boundary.

The Barnes silt loam is the predominant soil type throughout the county, except in the western part, which is mainly occupied by the closely related Williams soils. The topography is almost entirely constructional, varying from level to gently rolling. Much of the land is undulating. Belts of destructional topography along the streams are very narrow. No areas of this type are rough enough to make cultivation difficult. Comparatively level areas are located in the northern part of Prairie Township, in much of the territory bordering Russell Township, and in the vicinity of Verona. Although there is not much change in elevation in a distance of about 9 miles in Russell Township, the surface is not a dead level, being very gently rolling and marked by low knobs and ridges and numerous swampy areas. The Barnes silt loam largely occupies ground moraines, where the underlying Cretaceous shale was ground up and mixed with the material deposited by the ice, and streaks of fine sand appear in the subsoil in places.

Drainage on the Barnes silt loam is mostly through percolation of the rainfall into the ground. Melting snow usually produces an excess of water in the spring and the surface flow runs into local depressions, from which the water eventually escapes by seepage and evaporation. The depressions are mostly occupied by minor soil types and very little of the Barnes silt loam type would be benefited by artificial drainage. Cultivation has greatly increased the capacity of the soil to absorb moisture and many depressions that formerly contained water throughout the year are now cultivated.

Alkali in sufficient quantities to injure crops to some extent has accumulated over inextensive areas in eastern Litchville and Black Loam Townships and in an irregular strip of country extending southeast from the northeastern part of Grandview Township.

The Barnes silt loam is naturally a productive soil, being suited to as wide a range of crops as any type in the region. It has a decided advantage over many of the soils in its wide range of crop adaptation, which lessens the loss from possible failure of certain crops. Wheat is the principal crop. The average acreage yields are about 13 bushels of wheat, 8 bushels of flax, 30 bushels of oats, 20 bushels of barley, 1½ tons of millet hay, and 80 bushels of potatoes. The quality of the potatoes grown is excellent, and this type is usually selected for potato production. Corn is grown quite gener-

ally, and the Barnes silt loam is one of the best corn soils in the State. Alfalfa is grown in a small way in many parts of the county and indications are that the legume will become an important source of revenue. The high lime content and the favorable structure of the subsoil make this Barnes soil especially suited to alfalfa. Some fairly good yields of timothy are produced, but the crop is not grown generally.

The moisture supply is usually the limiting factor in crop production on this type. As much as 35 bushels of common wheat per acre has been obtained in seasons of adequate rainfall, and 43 bushels of durum wheat, 75 bushels of oats, 45 bushels of barley, and 22 bushels of flax. These yields indicate the productive capacity of the soil under good management.

The price of land of the Barnes silt loam type ranges from $25 to $55 an acre, averaging about $37.

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

Mechanical analyses of Barnes silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
351304	Soil	1.4	3.4	2.2	11.4	13.9	52.8	14.7
351305	Subsoil	1.0	2.2	1.6	8.3	15.0	56.0	15.8
351306	Lower subsoil	.6	2.6	2.4	11.6	14.0	49.0	19.7

BARNES LOAM.

The surface soil of the Barnes loam is typically a loam in texture, but the material varies from a fine sandy loam or gravelly sandy loam to a silt loam. The dark surface layer averages about 8 inches in thickness, but varies from 5 to 16 inches. In extreme cases the surface soil has been washed away, leaving the yellowish-brown subsoil exposed at the surface. The color of the surface soil is dark brown, indicating a somewhat lower organic-matter content than in the case of the Barnes silt loam. The subsoil varies from a fine sandy loam to a silty clay loam, and grades in color from yellowish brown in the upper layers to bright yellow with a greenish shade in the lower part. Oxidation of the iron compounds has been greater in this soil type than in the silt loam, and this process may account in part for the brown color.

This type differs from the silt loam in thickness of black layer, in topography, and in drainage. Because of its topography and method of formation, it is more variable in texture than the silt loam, and the surface soil and subsoil contain more stone and gravel,

although, with the exception of a few areas, stones are not abundant enough to interfere seriously with cultivation. The highest stone content is usually found on ridges of morainic origin.

The Barnes loam is extensively developed, being mapped in most parts of the county. The topography is predominantly rolling, being morainic or made rolling by erosion. On slopes adjacent to streams the type has been largely formed in places where the edge of the ice sheet remained stationary for a long period, large deposits of unassorted, variously textured materials having accumulated in the form of terminal moraines. The removal of the finer textured material in the eroded areas adjacent to the small streams has caused the development in such places of a coarser textured soil. Where erosion has been more excessive, on the other hand, the black soil material has been largely removed, so that the unweathered drift lies at or near the surface. Except in the eroded areas, the type occupies terminal moraines instead of the ground moraine usually occupied by the silt loam. This is particularly true in that part of the county east of the James River. West of the river the loam is mapped on many more level areas, especially near developments of the Valentine fine sandy loam. Probably the roughest area of the Barnes loam mapped is in a morainic belt extending southeast from the northeast corner of Sheridan Township.

This type lies slightly elevated above surrounding types, except where it occurs on slopes bordering drainage ways. Consequently, it is well drained and free from alkali.

Probably 75 per cent of the Barnes loam is cultivated, the remainder being largely in pasture. The land is used for the same purposes as the silt loam. Average acreage yields are about as follows: Wheat, 12 bushels or less; oats, 25 bushels; barley, 18 bushels; flax, 7½ bushels; potatoes, 80 bushels; millet, 1½ tons of hay; and corn, 25 bushels. Yields are less than on the silt loam, owing largely to the lower water-holding capacity of the loam. The type, however, retains moisture well. The physical condition is usually favorable for crop growth, but the type is not as desirable for agriculture as the silt loam.

The average value of land of this type is about $31 an acre.

BARNES SILTY CLAY.

The Barnes silty clay consists of a uniform black to dark-brown silty clay to a depth of about 20 inches. The soil has a high organic-matter content, a well-granulated, friable structure, and a smooth feel. It is inclined to be rather sticky when wet and cracks slightly on drying, but is less difficult to cultivate than many types of similarly heavy texture. It is entirely free from stone or gravel. The

subsoil is of about the same texture as the soil. It has a brown or somewhat yellowish brown color, in places showing reddish specks. Lime concretions are not as conspicuous as in the Barnes silt loam, but the subsoil is nearly as well oxidized. It is almost free from gravel. The subsoil is well granulated but very compact and retentive of moisture.

The Barnes silty clay is developed only in the southwestern part of the county, near Kulm, and in the northwestern part, near Alfred. The total area is only 3.2 square miles. The type has developed from lacustrine deposits laid down as lake bottoms. In this county it occurs as successive level lake terraces bordering well-defined, deep, inclosed lake bottoms that were developed later in sage between moraines and are occupied by the more poorly drained Fargo soils.

The level topography of the Barnes silty clay is in marked contrast to that of the more elevated and rolling Williams soils by which it is surrounded. Although it lies very level, the drainage is usually sufficient. The type slopes very gently toward the depressions which receive the drainage from it.

The Barnes silty clay was originally covered with a heavy sod of native grass, which made excellent pasturage and hay. It is a valuable agricultural soil. It has many of the good qualities of the Barnes silt loam and is considered even more productive and drought resistant than that type. In productiveness it ranks with the best Lamoure soils of the James River valley. It is all under cultivation. All the crops common to the region do well.

The present value of land of the Barnes silty clay is about $45 an acre.

Results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of this type are given in the following table:

Mechanical analyses of Barnes silty clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
351373.....	Soil.....	0.2	0.6	0.8	5.8	6.6	48.5	37.7
351374.....	Subsoil.....	.0	.4	.6	3.4	4.4	41.8	49.2
351375.....	Lower subsoil...	.0	.2	.2	1.6	3.6	52.9	41.6

WILLIAMS FINE SANDY LOAM.

The surface soil of the Williams fine sandy loam is very dark brown to black in color to a depth averaging about 7 inches, though varying from zero to 18 inches. The variation in thickness is due to the rolling topography, soil material being washed from the hillsides and accumulated at the bottom of the slopes. The texture

varies from a gravelly fine sandy loam to a loam containing a high percentage of coarse material.

The subsoil is of about the same texture as the soil or is somewhat heavier. In color it is practically the same as the subsoil of the Williams loam. It consists of material deposited without stratification as typical drift and is highly calcareous. The drift probably extends to a considerable depth, as the type is developed on terminal moraines.

The type is characterized by the high content of gravel and by glacial bowlders, but only small areas are too stony to cultivate.

The Williams fine sandy loam covers an area of 14.9 square miles. It occurs only in the western part of the county, where it is associated with the Williams loam, and it bears the same relation to that type as the Barnes loam bears to the Barnes silt loam. The topography is generally quite rough, varying from gently rolling to hilly. The type generally occurs in elevated positions on morainic hills and slopes. Occasionally it is developed at the foot of steep slopes where coarse material has accumulated. Owing to its elevated position, the drainage is always good.

As it is necessary to remove the stones from most of the land before it can be plowed, farmers have delayed breaking areas of this type until the less stony land has been utilized. Only about 25 per cent of the type is cultivated at present. The remainder is used largely for grazing, although some hay is cut in the lower lying places. There is a good growth of grass over the type, grama being one of the most important native grasses. The type produces fairly good yields in ordinary years, but crops are apt to suffer from drought in dry years. The crops grown are those common to the region, with wheat of first importance. It yields about 11 bushels per acre.

Land of the Williams fine sandy loam type is held at an average price of about $25 an acre.

WILLIAMS GRAVELLY LOAM.

Areas mapped in Williams fine sandy loam color but marked with gravel symbols represent the Williams gravelly loam. The surface soil of this type consists of a very dark brown to black gravelly loam or gravelly sandy loam. The subsoil is a light-brown to yellowish-brown, calcareous gravelly loam. The type closely resembles the fine sandy loam, but has a higher content of gravel and is somewhat coarser in texture and lighter in color. The high percentage of gravel makes it hard to cultivate and gives it a low water-holding capacity. The gravel usually is not stratified, but occurs in a heterogeneous mass throughout the soil profile.

The Williams gravelly loam is of small extent in this county, occurring in isolated bodies in the western part, where it is associated with other types of the Williams series. It grades into the Williams fine sandy loam, and many small areas are included in that type. It is developed at relatively high elevations—between 1,800 and 2,000 feet above sea level—along hills and ridges where the topography is gently rolling to hilly. The drainage is everywhere excessive, owing to the porous nature of the subsoil and the uneven topography.

Only a small part of the type is cultivated. Crop yields are generally low. Wheat averages about 10 bushels per acre. A good growth of native grass covers most of the land. More of the different species of wild vetches were noticed during the survey on this soil than on other types.

The Williams gravelly loam is best suited to grazing. The average price of the land is about $16 an acre.

WILLIAMS LOAM.

The surface soil of the Williams loam consists of a very dark brown to black, heavy loam to very fine sandy loam, the dark layer having an average thickness of about 10 inches, but ranging from 4 to 24 inches. The soil has a high content of organic matter, but is slightly inferior in this respect to the Barnes soils. It is of good physical structure, does not crack on drying, has a soft, friable feel, and is easy to cultivate. The subsoil is of the same texture as the surface soil or a trifle heavier, and is highly calcareous. At about 10 inches it becomes yellowish brown and at about 14 inches assumes a very light grayish yellow color and often has a somewhat spotted appearance, showing splotches of reddish brown, white, and light yellow. Many reddish specks about the size of a pea are found through the subsoil. It contains a high percentage of white calcareous material, in places enough to make it appear almost white.

Considerable gravel is scattered over the surface and through the soil and subsoil. The stone content is moderately high, but the cost of removal from the fields is nowhere very great. The stones and gravel are mainly of granitic origin, but a large percentage is of limestone. All the stones and gravel embedded in the soil are incrusted with calcium carbonate.

The Williams loam occurs only in the western two tiers of townships, on the Missouri Plateau, where it is the predominating soil type, covering an area of 135.8 square miles. The topography is in general rolling, but varies from undulating to heavily rolling or hilly. The topography is now exactly as it was left at the recession of the continental ice sheet. No drainage system has been developed, but

the rolling topography insures for most of the type good drainage. Any excess of water finds its way into local depressions, where it is eventually disposed of by evaporation and seepage.

About 65 per cent of the type is cultivated at present, the remainder being used mostly as pasture or hay land. The cultivated area is increased from year to year as farmers find time to break up more land. The western part of the county is still comparatively new to development and the demand for cultivated land is increasing.

The type is devoted almost entirely to grain growing, with wheat as the principal crop. Corn is not extensively grown. All the crops do well. Wheat averages about 14 bushels per acre, oats 31 bushels, barley 22 bushels, and other crops proportionately.

The type is usually considered the equal of the Barnes silt loam in productiveness, though it has a lower market value. This is due mainly to its rough topography and higher stone content, which make it harder to till, and to the comparative newness of the country in which it is located. The average value of the land is about $30 an acre.

EDGELEY LOAM.

The surface soil of the Edgeley loam to a depth of about 10 inches is very dark brown to black in color. The texture varies from a heavy silt loam to a fine sandy loam, but the greater part of the type is a loam relatively high in very fine sand. The soil and subsoil are much alike in texture, but in color the subsoil ranges from grayish to brownish yellow or bluish. The bluish shade is noticeable in much of the subsoil, especially where the subsoil grades below into shale. The subsoil is highly calcareous.

The surface soil contains occasional fine shale fragments, and a large percentage of shale fragments is characteristic of the subsoil. The shale occurs as partially disintegrated fragments in the upper part of the subsoil, the quantity increasing downward until the undisturbed rock is struck. The depth to the shale varies from 2 feet in places in the central part of the soil area to more than 5 feet along its border.

Some gravel is found in the soil and a few glacial bowlders are scattered over the surface. The structure of the subsoil is generally loose and with the underlying shale it lowers the water-holding capacity of the type.

A silty variation is included with the typical Edgeley loam. It differs from the typical loam in having a more silty and heavier soil and subsoil and a lighter brown color. It also has a smaller proportion of glacial gravel and bowlders, and is developed in slightly less elevated situations.

The Edgeley loam is inextensive in Lamoure County. It occurs in a broken area, extending south from Edgeley and passing into Dickey County, where the type is more extensively developed. It occurs at the same elevations as the surrounding Barnes types.

The topography varies from level to gently rolling. The type is more nearly a product of erosion than are the associated Barnes soils. Viewed at a distance the surface appears quite level, but at close range it is seen to be choppy; this surface configuration is characteristic of the type. The greater part of the type is well drained and is free from injurious concentration of alkali. A few small, poorly drained areas within the Edgeley loam are, however, impregnated with alkali and have been identified with the Rogers silty clay.

The Edgeley loam is of variable origin. The surface soil is composed of granitic drift mixed with shale drift. The subsoil is derived largely from glaciated and disintegrated shale, which rests upon a substratum of undisturbed shale, presumably of the Pierre formation.

The economic value of the Edgeley loam is low. It is especially unsuited to deep-rooted crops, such as alfalfa, because of the shallow soil and the impenetrable nature of the subsoil. The farm improvements are inferior to those on the Barnes soils, and the general development indicates that the productive capacity is low. A fair growth of native grass covers the land not cultivated. Wheat yields on an average 8 to 10 bushels to the acre, barley 15 bushels, oats 19 bushels, and corn about 18 bushels.

The value of land of the Edgeley loam type ranges from $20 to $27 an acre.

The following table gives the average results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the typical Edgeley loam:

Mechanical analyses of Edgeley loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
351322, 351325	Soil.....	1.3	4.0	3.1	18.3	16.1	36.9	20.2
351323, 351326	Subsoil.....	3.3	6.7	3.6	18.6	13.6	32.8	21.3
351324, 351327	Lower subsoil...	2.7	9.1	4.4	23.0	12.5	26.2	22.1

SIOUX GRAVELLY LOAM.

The Sioux gravelly loam consists of a very dark brown loam or sandy loam to any depth up to 12 inches or more, where it grades directly into the subsoil. This is yellowish in color and consists mainly of coarse waterworn gravel containing some finer material, with occasional layers of pure sand, distinctly stratified. It is high

in content of lime carbonate, is very loose and porous, and has a low water-holding capacity. The surface soil contains considerable organic matter, but is loose in structure. It carries a small quantity of gravel, but is usually free from large bowlders. In places there is no true fine-earth surface soil whatever.

The Sioux gravelly loam is of small extent in this county. It occurs in small, scattered areas along the stream courses. The most extensive areas are encountered in the James River Valley and on some elevated terraces along the lower part of Cottonwood Creek. Many of the smaller bodies occur at the junction of old drainage channels. The soil is everywhere developed on typical terraces. In the James River Valley these lie considerably above the present flood plain. The terraces are almost flat, with a gentle slope, but much of the type occurs in elevated, isolated positions and still other areas are much dissected by erosion, so that the type on the whole has an uneven topography. The drainage is excessive. Much water escapes by percolation and is lost for plant use.

The Sioux gravelly loam consists of alluvial material deposited along the streams at a time when they carried immensely larger quantities of water than they now carry.

Little of the type is cultivated in this county. Only the most desirable land is cultivated, being devoted to the crops common to the region. Wheat yields ordinarily about 10 bushels per acre in favorable years. The type is better suited to intertilled crops than to small grains. The nearness of gravel to the surface in many places makes cultivation difficult, and this disadvantage, together with its droughty nature, makes the soil undesirable for crop production. The type is utilized largely for pasture, as it is covered with a fair growth of native grass. It is also valued for the commercial sand and gravel which it contains.

The average value of land of this type is probably about $17 an acre.

Included with the Sioux gravelly loam are developments of beach sand and gravel occurring as beaches around existing and extinct lakes. The belts are narrow, barely wide enough to be shown on the map, and are rarely cultivated even where the lakes of which they were once the beaches have dried up. In soil characteristics these deposits are essentially like the typical Sioux gravelly loam.

Sioux gravelly loam, rolling phase.—The Sioux gravelly loam, rolling phase, is extremely variable in characteristics. The texture ranges from a sandy loam to a light loam. The color is dark brown, becoming almost black when moist. The thickness of the dark layer ranges from 4 to 30 inches, with an average depth of about 14 inches. The structure is loose and incoherent and cultivation would be easy were it not for the large quantities of gravel present.

Gravel is commonly scattered over the surface and small bowlders occur in places. The gravel consists of rounded pebbles of all sizes up to about 2 inches in diameter. A large percentage of the coarse material is limestone. Below the layer of surface soil are found beds of partially stratified gravel or layers of irregularly assorted clay, gravel, and sand, usually of a yellowish-gray color. These gravel beds seem to average about 14 feet in depth.

The rolling phase is inextensive. It occurs in small areas scattered over the county. Many of the areas are almost too small to map, although they are quite conspicuous, owing to the mode of occurrence of the phase. It is confined to kamelike knolls, ridges, and eskers, and the topography is hummocky or hilly. Owing to the rough topography, high elevation, and loose, porous nature of the soil, drainage is always excessive, and the water-holding capacity of the phase is low.

The land supports a fairly good growth of native grass. The vegetation comprises the prairie grasses of the region, with some patches of sand grass in the more sandy tracts.

The rolling phase is valued mostly for the commercial sand and gravel which it contains. Very little of the land is cultivated. It is sometimes farmed with contiguous types to preserve the regularity of the fields. The common crops are grown, but owing to the droughty nature of the soil the yields are much lower than the average for the county. Wheat yields 4 to 18 bushels per acre, averaging about 8 bushels. Corn and potatoes do better when well cultivated. The soil is probably better suited to use as pasture land than for cultivated crops. Land of the phase has an average value of about $18 an acre.

SIOUX SANDY LOAM.

The Sioux sandy loam to an average depth of about 12 inches consists typically of a dark grayish brown sandy loam. The texture varies from a fine sandy loam to a sand. At 3 to 16 inches the material grades into a grayish-brown, or in places grayish-red or very light gray, sandy loam or occasionally sand. The surface soil contains some waterworn gravel, but is quite free from bowlders. At 3 feet it passes into a grayish, occasionally mottled with brown or red, sandy loam or sand that contains considerable gravel in places. The sand is variable in coarseness. It is stratified and extends to a depth of 10 to 30 feet. Both the soil and subsoil are loose and incoherent in structure, and of low water-holding capacity. The areas in the northeastern party of the county have a more leachy subsoil than those elsewhere. Owing to the very sandy nature of the subsoil, the lime has been leached out of it to such an extent that it does not usually effervesce in acid.

The Sioux sandy loam is of small extent in this county. Small areas are scattered along the minor stream courses, but the largest developments occur in the James River Valley. The largest area is a triangular shaped body southeast of Lamoure, lying in a large loop in the valley contiguous to an area of the Valentine fine sand.

This type lies more elevated than most of the alluvial soils along streams. It often occurs in positions that resemble terraces when viewed at a distance, but on closer examination have somewhat the appearance of river bars. The rainfall escapes rapidly by percolation and is mostly lost for plant use.

Most of the Sioux sandy loam is alluvial material derived from glacial drift. The effect of wind action is noticeable in places, but it does not blow nearly as readily as the Valentine fine sand, owing to the larger amount of coarse material which it contains.

On account of its droughty nature the agricultural value of the Sioux sandy loam is low. About half the type is cultivated. Grain crops are grown mainly, but they do not do well. Wheat averages only about 7 or 8 bushels per acre. Russian thistle, which thrives on sandy soil, is a great nuisance on this type. Sand grass is the prevailing native vegetation. Land of the Sioux sandy loam has an average value of about $22 an acre.

SIOUX FINE SANDY LOAM.

A few small areas of soil confined to the valleys of the James River and the lower part of Cottonwood and Bone Hill Creeks are mapped as the Sioux fine sandy loam, but these are not typical and in reality represent a colluvial phase of the type. The soil to a depth of 10 to 20 inches is a brown to very dark brown fine sandy loam or very fine sandy loam. The subsurface material is often heavier than the surface soil. The subsoil is rather variable. It is usually a fine sandy loam or sandy loam with a considerable admixture of gravel and occasionally containing layers of sand and gravel. It effervesces freely in acid. The surface soil is friable, loose, and porous and has a moderate content of organic matter. In places it contains a small percentage of gravel, but no bowlders.

The total area of this soil is small. Along the James River the type occurs as sloping, narrow fringes at the borders of the valley. Here the soil is largely derived from alluvial-fan deposits superimposed on the flood plain and the low terraces, and located at the mouth of small washes issuing from the higher rough and broken land. In the minor stream bottoms the type occurs on small, segmented terraces more or less dissected by erosion and having a considerable slope, as well as along stream courses and on alluvial fans at the

mouths of small washes. In the smaller valleys the soil is more typical of the Sioux series than in the James River Valley.

Very little of the Sioux fine sandy loam in the minor valleys is cultivated, owing to its occurrence in small, irregular bodies where cultivation is unprofitable. Most of the land in the James River Valley is cultivated. The crops common to the region are grown. Owing to the porous nature of the subsoil, the type is inclined to be droughty, but yields are usually fairly good. Some areas so situated as to be naturally irrigated by small washes during heavy rains produce better crops than the Barnes silt loam. A heavy growth of native grass originally covered this land. It all affords good natural pasturage, for which purpose it is largely used.

In this county land of the Sioux fine sandy loam type has an average value of approximately $25 an acre.

SIOUX SILT LOAM.

The Sioux silt loam consists of a very dark brown to black silt loam to a depth of about 16 inches. In places where considerable deposition has taken place in recent periods of time the black soil extends to a depth of 24 inches or more. In places the percentage of silt is rather low and the clay and sand content high, making the texture tend toward a clay loam. The organic-matter content is high, so that the soil has a black color when wet. It is soft and friable and easy to till, and is free from stone and gravel.

Below an average depth of 16 inches and extending to 24 or 36 inches the type is quite variable. It is usually heavier, becoming a heavy silt loam, but in many cases it grades into a very fine sandy loam or into sand and gravel. This subsurface layer is usually of a grayish-brown color. It is more reddish than the subsoil of the Barnes silt loam.

At depths varying from 18 to 36 inches are found beds of sand and gravel. The depth to gravel or sand is greater than in the case of the Sioux loam. In the areas in the James River Valley the gravel and sand material is of a finer texture than that underlying the Sioux loam and seldom occurs nearer the surface than 24 inches. Elsewhere there is less difference between the subsoils of the two types. The subsoil is in all cases highly calcareous.

The total area of Sioux silt loam mapped in the county is 5.4 square miles. The greater part of the type is developed in the James River Valley. It occurs on low terraces having a very gentle slope. In the James River Valley these terraces slope very gently into the present flood plain occupied by the Lamoure soils. Here the type closely resembles the Lamoure silt loam, the difference being largely in the character of the deep subsoil.

The material composing the Sioux silt loam consists of glacial drift that has been rewashed and redeposited along stream courses.

Drainage is fairly good throughout the type. Much water is absorbed by the porous subsoil, and with the gently sloping surface water runs off readily. The type seldom suffers from excess moisture, but is not inclined to be droughty.

The Sioux silt loam is a valuable agricultural soil. It is naturally productive and ranks as one of the best soils of the county. Practically all the type is farmed. The uncultivated land supports a good growth of native grass and is used largely for pasture. The type is well suited to all the crops that thrive in this region. Corn and potatoes do especially well, and some of the best fields of corn noticed during the survey were on this type. Wheat yields about 14 bushels per acre on the average.

The Sioux silt loam ranks in value about equal with the Barnes silt loam. The price ranges from $30 to $50 or more an acre.

SIOUX LOAM.

The surface soil of the Sioux loam is fairly uniform in texture, but ranges from a sandy or gravelly loam to a heavy loam. It is typically very dark brown in color to a depth of 8 to 16 inches, usually about 12 inches. The upper 6 inches of soil is the darkest, being usually classed as a black soil when wet, and the color becomes more brownish with depth. The soil is free from bowlders and fairly free from gravel. The organic-matter content is fairly high, and the soil is friable and easy to till. It does not puddle, bake or crack, even when handled in a wet condition, and its texture is such that it is not drifted by the wind to any great extent.

At about 12 to 17 inches the soil generally becomes heavier in texture, with a higher content of silt, and continues of brownish color. This heavier subsurface layer is missing when gravel occurs within 18 inches of the surface. It often contains a very high percentage of lime, giving it a grayish color, though this excessively calcareous layer may be absent, and in such cases the soil becomes lighter with depth. In all cases, however, the subsoil effervesces freely in acid. At an average depth of 18 inches the soil grades directly into incoherent, leachy masses of gray, coarse material, consisting of stratified layers of waterworn gravel and sand. The depth to the gravel is nowhere less than 12 or more than 36 inches. This coarse material is unretentive of moisture, and the gravel content increases with depth. In the areas in the James River Valley the substratum contains very much coarse gravel.

A considerable quantity of fragmentary shale rock is mixed with the subsoil in most of the areas in the eastern part of the county and in the territory lying between Edgeley and Nortonville, where the

type has in general been developed on level terraces along streams that are now practically abandoned. The disintegration of the shale has left much fine material in the subsoil, which gives it a slightly finer texture. This variation gives rise to a phase of the type that is much more extensively developed in Ransom County to the east and in Barnes County to the north. The gravelly layer of this variation in Lamoure County extends to a depth of about 10 feet, where it is underlain by impervious blue clay. This heavy layer makes the type more retentive of moisture than it otherwise would be, but even with it the type is inclined to be droughty.

The areas of Sioux loam lying along the foot of the bluffs of the James River constitute a colluvial variation of the type that differs from the typical soil in having a somewhat heavier texture, owing to a mantle of silty material being washed from the adjacent slopes covered by the Barnes silt loam and spread over the type by sheet run-off, rills, and small streams. The gravel subsoil lies at a greater depth than in the typical Sioux loam, making the soil less droughty and a better soil for all the common crops. These areas have a gentle slope toward the axis of the valley, and are slightly influenced in places by seepage waters from the bluffs.

The Sioux loam is widely distributed, although its total area is not large. It is confined to very gently sloping terraces along the James River and smaller streams and abandoned drainage channels. Areas are scattered along the James River Valley on terraces slightly elevated above those occupied by the closely associated Sioux silt loam and the Lamoure soils, but at a lower elevation than those occupied by the coarser textured Sioux types. The type as developed along abandoned channels and minor stream bottoms is well defined, being marked on one side by a distinct drop in elevation where it is bordered by stream-bottom types and on the other side by a distinct rise in topography, it being commonly bordered here by one of the Barnes soils.

The type is mainly derived from glacial drift with an admixture of shale that was reworked and redeposited during glacial times when the run-off was greater than it now is. Much of the heavier surface layer was probably deposited at a later period when the velocity of the currents had decreased.

There is little surface run-off, but nevertheless the type is in most places excessively drained. The water percolates into the porous subsoil, where it is not available for plant use.

Probably 80 per cent of the type in this county is cultivated. The occurrence of much of the type in small, rather irregular, areas adjacent to small streams, where it is difficult to cultivate but desirable for pastures, has tended to deter the subjection of the type. It supports a good growth of native grass.

The crops common to the county are grown on the cultivated areas. The yields are somewhat lower than the average for the county. The soil is naturally productive, but the poor water-holding capacity of the subsoil makes crops readily subject to drought during dry periods. Wheat gives an average yield of about 11 bushels per acre. Corn yields well, and this grain is one of the crops best suited to the type. Crops mature early, owing to the warm, porous nature of the soil and to the early date at which it can be seeded in the spring.

Land of the Sioux loam has an average value of about $30 an acre.

BEARDEN SILT LOAM.

The Bearden silt loam consists of a very dark brown to black silty clay loam to about 8 to 20 inches, the depth averaging 16 inches. The subsoil is similar in texture to the surface soil and is of a characteristic straw color, yellow with a slight shade of red. Both surface soil and subsoil contain a high percentage of silt, but may range in texture to a fine sand. The subsoil of several areas mapped northeast of Edgeley contains more than the usual percentage of fine sand.

The surface soil is dense black when wet. It has a high organic-matter content and a smooth, fluffy structure like that of the most silty areas of the Barnes silt loam. It is very friable in structure and in excellent physical condition for tillage. The subsoil is also friable and is retentive of moisture. The type is quite free from stone, gravel, and coarse sand to a depth of 30 inches, below which such material often occurs. The type has a high lime content, and the subsoil is highly calcareous, but it apparently does not carry as much lime as the subsoil of the Barnes types.

The aggregate area of the Bearden silt loam in Lamoure County is 8.6 square miles. It is almost entirely confined to high terraces bordering Bearden Hillock Creek and the James River in the eastern part of the county, the most extensive and typical area occurring along the former stream. The topography is level, and the surface has been but slightly affected by erosion. The drainage, which is mainly by percolation into the subsoil, is sufficient to dispose of the rainfall.

The mode of occurrence, level topography, and soil formation show that this type is of alluvial origin. The indications are that it was deposited on the flood plains of the present streams at the time they first began to erode their channels. This type occurs at an elevation slightly lower than that of the Barnes soils, but lies considerably higher than the stream-bottom types. Most of the areas are bordered by one of the Barnes soils on one side and by Rough broken land or stream-bottom types on the other.

The Bearden silt loam is a valuable soil for all kinds of farming. A heavy sod of native grass makes it good natural pasture land. The greater part of the type is cultivated, the common crops being grown. Wheat yields on an average about 17 bushels an acre, and other crops yield fully as high as on the Barnes silt loam. This type is held at prices ranging from $30 to $55 an acre.

FARGO SILTY CLAY.

The surface soil of the Fargo silty clay to an average depth of about 18 inches is a silty clay loam to clay, typically black or dark brown, but in places grayish brown. It varies in depth from 12 to 36 inches. A high content of organic matter has accumulated by reason of the rank vegetation and the poor drainage, and this gives the soil in places a mucky appearance. Normally the soil is sticky and impervious and cracks badly on drying, so that tillage is difficult, but the organic-matter content gives it a well-granulated structure in places, especially in the better drained areas.

The subsoil is similar in texture to the surface soil. It is generally gray in color, but varies to light brownish gray and occasionally, where accumulation of organic matter has taken place, it is dark in color to the depth of 3 feet. It is highly calcareous. It has a smooth feel, and the structure is plastic and dense, making it impervious to water movement. A thin layer of fine sand with mottled variations in texture is in places developed below 40 inches.

The Fargo silty clay has a wide distribution. Areas are mapped in all parts of the county, but most of them are small and the total extent of the type is not great. It is developed only in depressed positions, such as old lake and pond basins, poorly drained flats, and water-logged stream valleys. The most typical development is in inclosed lake basins. The surface is flat and the type is separated from the prairie soils by gentle rises or abrupt banks. It receives run-off from surrounding land, and since the only outlet of most of the areas is more elevated than the general level of the type, it is poorly drained. Before the prairie soils were cultivated this type was under water much of the year. As more land has been cultivated rain water has been absorbed to a greater extent by the surrounding soils, and the type now becomes dry during the greater part of the year. Even now, however, much of it is covered with water in the spring, and it is generally too soggy for profitable crop production. More or less alkali exists in land of this type, but not enough seriously to affect plants.

In developments of the Fargo silty clay there occur areas, varying in size from one acre to several hundred acres, whose drainage is so poor that water remains on the surface during the greater part of the year. Such sags, troughs, and pond basins are indicated on the

map with marsh symbols. The vegetation here is usually a rank growth of marsh plants. Some of these areas permit of cultivation after a succession of dry years.

The Fargo silty clay is derived from glacial material which has been subjected for a long period of time to conditions of poor drainage or from glacial material redeposited in lakes, ponds or marshes and subsequently subjected to poorly drained conditions.

The type is valued largely as hay and pasture land, on account of the rank growth of grass on the uncultivated areas. The growth consists mainly of the common tall meadow grasses, which yield on an average about 1½ tons of hay per acre. The soil is naturally productive, but the poor drainage unfits much of it for cultivation. Approximately 30 per cent of the type is cultivated. Of the crops grown, flax and barley seem to do best, although all the grains do well on the best drained land. The crop yields are fully as high as on the Barnes silt loam. The value of the type, however, is much less on account of its more limited range of adaptation, greater difficulty of cultivation, and larger proportion of waste land. The water-logged condition of much of the type in early spring makes it unsuited for corn production.

Nearly all the land of the Fargo silty clay would be improved by artificial drainage, but, owing to its position in depressions and the relatively small extent of the areas, drainage is seldom feasible economically.

The land of the Fargo silty clay type has an average value of about $26 an acre.

FARGO LOAM.

Areas mapped in Fargo silty clay color but marked with inclusion symbols represent the Fargo loam. The Fargo loam is similar to the silty clay type, except in texture. To the depth of 15 inches the soil is typically a black to dark-brown loam, occasionally varying to sandy or fine sandy loam in texture. Stone or gravel is seldom present in the soil. The content of organic matter is high and the soil is quite friable and fairly easy to cultivate. The subsoil is of a light-gray or mottled color. Its texture is on the average the same as that of the soil, but it is in places heavier, approaching a clay. A layer of fine sand and gravelly loam is sometimes encountered below 30 inches.

Only a few small areas of the Fargo loam are mapped. Most of the areas are in the south-central part of the county, associated usually with the Valentine fine sandy loam. The type is confined to small depressions and has poor drainage. The material consists of glacial drift reassorted by water. An admixture of wind-blown material probably occurs in places.

The Fargo loam is covered with a heavy growth of grass and is valuable mainly as hay and pasture land. The best drained areas are cultivated. Grain crops are grown and usually give good yields.

Land of the Fargo loam is held at an average value of about $26 an acre.

ROGERS SILTY CLAY.

The surface soil of the Rogers silty clay typically consists of a brown to grayish-brown silty clay, but varies from clay loam to clay. In places there is a layer of black which may be as much as 6 inches deep. The surface soil is free from stone and other coarse material. The organic-matter content is low, and the structure is very poor, the soil being sticky and puddled when wet and cracking upon drying. It is poorly granulated and difficult to till, and the type is locally known as "gumbo."

The surface soil merges rather imperceptibly with the subsoil at an average depth of 20 inches. The subsoil is light bluish gray in color and of the same texture as the surface soil or finer. It is sticky, dense, and quite impervious to water movement. Large numbers of crystals of earthy salts scattered through the subsoil are a characteristic feature. Both surface soil and subsoil effervesce freely in acid, except where the former is black in color. The substratum of the type is characteristic glacial drift.

A variation of the Rogers silty clay occurs in depressions within the Edgeley loam south of Edgeley. The surface is somewhat gullied and shows slight irregularities. Small isolated mesas or tablelike elevations a few inches high and several rods in extent, with sharply defined boundaries, are a peculiar characteristic sometimes encountered in this phase. The soil is of brownish color and the texture is rather variable, ranging from a light clay loam to clay. The subsoil is light brown to drab or gray, being somewhat darker than that of the typical Rogers silty clay, and in places it has a bluish tinge in the lower part. Shale fragments are often found in the lower subsoil. Reddish specks and mottlings are not uncommon. This variation seems to contain a much higher percentage of iron and a lower percentage of calcium carbonate than the typical Rogers silty clay. The soil is sticky and puddled and has an unfavorable structure, a low organic-matter content, and a high percentage of alkali. It is unproductive.

The Rogers silty clay occurs in small areas in all parts of the county. The total area is relatively small. In topographic position and distribution the type is similar to the Fargo silty clay, differing from that type in its lighter color and higher content of lime carbonate and soluble salts. It occupies small pond and lake basins

and segments along sluggish drainage ways. Gentle slopes or sharp banks mark the line of contact between this type and the prairie soils. Placing the boundary line between it and the Fargo silty clay is more difficult, as gradations between the types are common. This type in some cases occurs in slightly elevated outer belts or in loops in depressions where the predominating soil is the Fargo silty clay.

The drainage of all the areas of the Rogers silty clay is poor. It receives the run-off or seepage from surrounding types. The drainage outlets of the depressions are more elevated than the type, and in some of the depressions drainage outlets have never developed. When the country was first settled these depressions were usually filled with water, but cultivation of surrounding land has so diminished the run-off that most of the type is now water-logged only from seepage water and moisture from melting snows. Some marshy spots are found, but most of the type is simply saturated to within a few inches of the surface.

Conditions on the Rogers silty clay have favored the accumulation of alkali, the presence of which is shown by white surface deposits and barren spots and by the vegetation. The percentage of alkali is large enough to injure crops even if thorough drainage were established, and drainage is usually not practical on account of the unjustifiable expense of providing outlets for the small, isolated areas in which the type is developed. An area about 1½ square miles in extent, 4 miles northwest of Nortonville, in which the alkali accumulation is unusually large, is indicated on the map with alkali symbol.

The Rogers silty clay is derived from accumulated material laid down in low areas by the run-off from other soils. Some of the material was deposited in small lakes inclosed by steep slopes, while much of it was deposited in places of poor drainage. The fine texture indicates that deposition occurred in bodies of standing water.

Little of the type is farmed. Some small areas in shallow depressions are cultivated with the surrounding prairie type in order to preserve the regularity of the fields. Flax and barley are often grown in such places. The yields are small. Heavy manuring would be beneficial. The greater part of the type is devoted to pasture, for which use it is best suited. Some of the best land is cut over for hay. The greater part of the type is not suited to crop production, and the cost of improvement would in most cases be prohibitive. Salt grass (*Distichlis spicata*) is the principal growth. This grass is not much relished by live stock.

The average value of land of the Rogers silty clay type is about $15 an acre.

Mechanical analyses of samples of soil, subsoil, and lower subsoil of the Rogers silty clay gave the following results:

Mechanical analyses of Rogers silty clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
351370.....	Soil.....	0.2	1.0	1.2	8.4	19.0	41.5	28.8
351371.....	Subsoil.....	.1	.4	.6	4.6	17.5	43.8	32.8
351372.....	Lower subsoil...	.1	.3	.6	4.5	20.0	41.9	32.7

The following samples contained more than one-half of 1 per cent calcium carbonate ($CaCO_3$): No. 351370, 12.79 per cent; No. 351371, 13.22 per cent; No. 351372, 13.43 per cent.

MAPLE CLAY LOAM.

The surface soil of the Maple clay loam consists of a grayish-brown, rather smooth, heavy silt loam, clay loam or silty clay loam. It is sticky and plastic when wet and has a puddled, intractable structure, largely due to poor drainage and the excessive accumulation of alkali. It usually effervesces in acid. Its fairly high organic-matter content, with its naturally wet condition, gives the soil a dark appearance. Gravel is usually not encountered in the surface soil, but large numbers of glacial bowlders are found in places on the type.

The subsoil begins on the average at about 14 inches, the depth varying considerably. It ranges in color from light grayish brown to ashen gray or drab and is always highly calcareous. The texture is similar to that of the soil. Over most of the type the subsoil is soft, slushy, and poorly granulated, and it usually carries considerable quantities of intermingled coarse sand and waterworn gravel. In exceptional instances the subsoil is free from gravel to a depth of 60 inches, and in other places it shows only a gravelly or sandy tendency within this depth. Distinct beds of gravel, sand, and coarse alluvium are nearly everywhere encountered at 24 to 36 inches from the surface, usually at about 30 inches, and constitute the deep subsoil. The subsoil is naturally porous and unretentive of moisture, but is wet on account of the topographic position.

The Maple clay loam is of small extent in this county. The greater part of the type occurs in the northeastern part of the county, where it is most typically developed. It is found in narrow, elongated areas occupying flat-bottomed swales or the lowest part of the bottom land in minor valleys. It naturally occurs where the gradient is very low, and lies at almost the level of the bottom land occupied by the Lamoure loam. A shallow, indistinct stream course generally winds through the type. Some of these streams are now dry, except in the spring of the year and after exceptionally heavy rains, when

considerable water may drain into them. Before the breaking of the surrounding prairie land much greater quantities of water flowed over this type.

The boundaries of this type are generally well defined and are marked by steep banks. It is often bordered by the Bearden or Sioux types, which occur in closely related topographic positions on low terraces, and the transition to these types is usually marked by a gentle, well-defined rise in the topography. In places where the gradient of the stream course becomes steeper the Maple clay loam merges imperceptibly with the Lamoure loam.

Drainage is very poor, the soil being normally water-logged almost to the surface, except in the driest seasons. Water from the surrounding land seeks the low level of this type and keeps the porous subsoil saturated with water containing a high percentage of soluble material. Subsequent evaporation from the surface causes an accumulation of alkali sufficient to make the soil unsuited to crop production.

The Maple clay loam is of alluvial origin. It occurs in the bottoms of depressions eroded by glacial streams. The gravel subsoil was deposited by glacial torrents, while the finer soil material was laid down by the present sluggish streams.

The Maple clay loam is not cultivated. Owing to its poor drainage, high alkali content, large number of bowlders, gravelly subsoil, and the irregular outline of the areas, the type is suited to use only as pasture and hay land. A fairly heavy carpet of grass grows except on the areas most affected by alkali, where only a fair growth of salt grass (*Distichlis spicata*) occurs. This grass is common on all areas of the type. The wettest land is the most valuable, as it supports a heavy growth of marsh grass, which makes a rather good yield of hay.

A few of the Maple clay loam areas are valued almost as highly as the Barnes silt loam. The type is priced in general at about $14 an acre.

Below are given the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Maple clay loam:

Mechanical analyses of Maple clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
351367	Soil	1.0	3.0	2.0	9.2	7.2	56.6	21.2
351368	Subsoil	1.0	4.0	2.1	8.2	7.6	42.9	34.0
351369	Lower subsoil	2.4	5.7	3.2	8.3	6.6	34.5	39.3

The following samples contained more than one-half of 1 per cent calcium carbonate ($CaCO_3$): No. 351367, 43.04 per cent; No. 351368, 55.11 per cent; No. 351369, 51.54 per cent.

VALENTINE FINE SAND.

The Valentine fine sand consists of a dark-gray to dark-brown fine sand, remaining about uniform in texture from the surface to the underlying substratum of blue clay. The material is also quite uniform over the area of this type. The soil is in places a little more silty and heavier at a depth of about 3 feet, which seems to mark the point at which the wind has had little influence in recent years. The maximum depth of sand, about 30 feet, occurs in the center of the area, where the texture is also the lightest. The soil becomes slightly heavier and the depth of sand gradually decreases toward the margin of the area and to the southeast. The material is remarkably free from coarse particles, even coarse sand, and stones are altogether lacking.

A heavy variation of the type occurs in a few small, slight depressions, where deposition has taken place, covering the fine sand with about 24 inches of still finer material, consisting mostly of silt.

Only one area of Valentine fine sand is mapped in the county. This occurs southeast of Lamoure. The type lies a little higher than the other upland soils of the vicinity. There is no noticeable difference between its topography and that of the Barnes types that surround it, except for the effect of wind action. This effect is especially conspicuous in the central part of the development, where there are many "blow-outs" or "sandpits" excavated by the wind. Here the soil is light and incoherent, much like dune sand. Two of the larger and more conspicuous areas of this dune-sand development are outlined and indicated on the map with the conventional dune-sand symbol.

The boundary of the type is distinct, although the material has been deposited directly over elevations and depressions without regard to the topography. It is an interesting fact that the area of this soil is of almost exactly the same width as the James River Valley, where it heads. It borders the Sioux sandy loam and continues over the slope of the valley. The type differs from the Sioux sandy loam in having a more uniform fine sand texture, a lower organic-matter content, and a lighter color, as well as in its origin. Indications are that it is entirely of eolian origin and consists of material blown from sand deposits of the James River. The soil is without stratification, and its irregularly and slightly streaked appearance show plainly the effect of wind action.

The drainage of the type is mostly through the subsoil and is usually excessive. Ground water stands close to the surface, however, over parts of the area in the spring of the year. The water-holding capacity of the soil is very low, and crops are easily affected by drought. The type is not considered of high natural productive-

ness. Crop failures come oftener than on the heavier types, and yields are lower in good years. Trees seem to thrive, and if a large part of the type were planted to trees the destructive blowing of the soil now going on would be largely prevented.

Corn does well. The type is better suited to cultivated crops than to the small grains. Exclusive grain farming is not profitable on this type.

The land included in the Valentine fine sand is valued at about $22 an acre.

VALENTINE FINE SANDY LOAM.

The Valentine fine sandy loam consists of a dark-brown fine sandy loam or fine sand to a depth of about 12 inches. The subsoil varies in color from yellowish gray to yellowish brown with distinct dark-brown iron stains, and in texture ranges from a fine sand to a loamy sand. Heavier till underlies it at varying depths, at about 24 inches in the higher situations and at the margin of some of the areas, but at a probable depth of 10 feet or more in places. Neither soil nor subsoil usually effervesces in acid. The type is somewhat lower in organic-matter and lime content than the Barnes silt loam. The structure of the surface soil is somewhat loose, but the subsoil is fairly compact.

The type is practically free from stones or gravel. It is of good tilth and is easily prepared for crops. Careful precautions are necessary, however, to protect against the wind, so as to prevent drifting after seeding and before the young crop can hold the soil.

The Valentine fine sandy loam is not extensively developed in Lamoure County. Isolated areas occur in a belt extending southeast of Nortonville to beyond the Lamoure-Dickey County line. The largest and best developed area occurs southeast of Medberry. The topography is undulating to level. The type is well drained through its porous subsoil.

The effect of wind action is not very noticeable in the landscape where this soil is developed. The type is probably derived from glacial till greatly modified by water or wind action.

The use of this type for the crops to which it is best suited has not yet received much attention. Practically the same crops are grown as on the Barnes silt loam, and with the same relative acreage. Owing to the leachy nature of the subsoil the type is not as productive as the Barnes silt loam. The average approximate yields per acre are as follows: Wheat 9 bushels, barley 15 bushels, oats 22 bushels, rye 14 bushels, corn 20 bushels, potatoes 80 bushels, millet 1⅓ tons of hay, and native grass one-half ton. Corn and other intertilled crops do well, and alfalfa would apparently be successful.

The utilization of this type to best advantage depends largely upon following crop systems and tillage practices that will prevent soil

drifting and incorporate organic matter in the soil. The supply of organic matter can also be readily increased by the use of manure.

The average value of land of the Valentine fine sandy loam is about $25 an acre.

LAMOURE SILT LOAM.

The Lamoure silt loam is similar to the Lamoure silty clay except in texture. It is usually black in color and a heavy silt loam to a depth of 16 to 24 inches. It is subject to some variation in texture, ranging from a silty clay in depressed areas and where it borders the Lamoure silty clay to a fine sandy loam in small areas along bends of the river. The subsoil is usually a dark-brown silty clay loam to silty clay in texture, but it often contains thin layers of fine sandy material that is more reddish in color. The surface soil has a high organic-matter content, is free from stone and gravel, and is smooth and friable and fairly easy to till. In places it is as mellow as the Barnes silt loam. Both soil and subsoil usually effervesce freely in acid.

The type is underlain by coarse alluvium. This usually occurs at a considerable depth, but in places it approaches the surface. Where layers of coarse material occur within 3 feet of the surface the soil is separated as the closely related Sioux silt loam of the James River bottoms.

The Lamoure silt loam is developed in the flat first bottoms of the James River. Below Grand Rapids it occurs in narrow, tapering strips and patches in close connection with the Lamoure silty clay. Above Grand Rapids it occupies almost the entire first bottom, except for small areas in the oxbow loops occupied by the Lamoure loam. The type lies on a flat surface, with a very gentle slope, and is fairly well drained, except in the abandoned oxbow bends. Only the latter places, which are rather marshy, need artificial drainage, and these are of small extent. The type is of alluvial origin, the material having been deposited by the James River.

Most of the type originally supported a heavy growth of native grasses, and it was partly forested. The growth was principally elm, ash, and box elder, with plum and berry trees. The type is now practically all cultivated. The soil is very productive, ranking close to the Lamoure silty clay in this respect, and many farmers prefer it to that type because of its greater ease of tillage. Certain crops, including corn, potatoes, and garden truck, give better results than others on this type, but all crops do well. Wheat yields average about 15 bushels per acre. A more diversified system of farming prevails on the Lamoure silt loam than on most of the types of the county. The dissection of the fields by the meandering course of the river is the most objectional feature of the type.

LAMOURE LOAM.

The Lamoure loam is an extremely variable type. The surface soil to a depth of 8 to 24 inches is usually a dark-brown to black loam, but varies from a light loam to a heavy silt loam. The organic-matter content is high, giving the soil its dark color and smooth texture. It does not bake or crack on drying, but is sticky in the more poorly drained areas when wet. A small quantity of gravel is usually encountered in the soil, and there are large numbers of bowlders on some areas in the eastern part of the county near the Ransom County line. Elsewhere the type is practically free from stones.

The subsoil ranges in color from dark brown or brownish yellow in the better drained localities to gray or drab in the poorly drained places, while even in the better drained areas the high content of lime carbonate gives the material a spotted gray appearance. To a depth of 40 inches the subsoil is on the average similar to the soil in texture, or slightly coarser. It consists largely of layers of material varying from clay loam to fine sand. A heavier layer is commonly found at about 16 inches, and seams of fine sand or gravelly clay loam usually having a reddish color frequently occur below this depth. Below 36 or 40 inches the texture is generally coarser, and gravelly or sandy beds commonly occur. The subsoil is retentive of moisture, but is less compact in structure than that of the Barnes silt loam.

In the eastern part of the county much of the Lamoure loam closely resembles the Sioux loam, and the types are separated on the basis of the depth to gravel. Where gravel occurs within 36 inches the soil is mapped as Sioux loam, and where the depth is greater, as Lamoure. The Lamoure loam is more generally confined to localities having poor drainage, where deposition has taken place in more recent periods of time.

The Lamoure loam is well distributed over the county, but its total area is relatively small. As mapped in this county it is confined to the first bottoms of streams or abandoned stream channels. It occurs in narrow developments in level, terracelike situations, and in meanders of the James River in the northern part of the county. Some of the areas, especially in the vicinity of Edgeley, are dissected by meandering stream channels. Usually there is a fairly distinct rise in elevation at the boundary of the type where it borders the drift soils, but in the eastern part of the county the type often merges imperceptibly with the more uneven Barnes soils.

In general the type is fairly well drained and free from alkali. Much of it is subject to flooding after heavy rains and during spring thaws. This disadvantage lowers the value of the type considerably. In the eastern part of Litchville and Black Loam Townships and in

the northern part of Norden Township much of the land is poorly drained and has suffered from excessive accumulation of alkali. The areas occurring in the James River bottom are especially well drained.

The type is of alluvial origin. It consists of drift material reassorted and redeposited by water. Its formation occurred partly during the glacial period and partly in more recent times.

The Lamoure loam is covered with a heavy growth of native grass. Most of the type in the James River Valley was originally forested with such trees as elm, ash, box elder, plum, and buffalo-berry. Much of the type is situated near natural water holes, so that it is particularly desirable for pastures. The soil is naturally productive and with the exception of poorly drained areas, it is a valuable agricultural type. The greater part of it is cultivated. The common crops of the region are grown and the yields approximate those obtained on the Barnes loam. In the James River Valley the type is adapted to all kinds of trucking and cultivated crops. Here the yields compare favorably with the yields obtained on the Lamoure silt loam.

Below are given the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Lamoure loam:

Mechanical analyses of Lamoure loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
351349.....	Soil.....	1.2	3.6	2.4	10.9	14.8	44.9	22.2
351350.....	Subsoil.....	2.2	4.2	2.2	9.7	12.6	41.2	27.6
351351.....	Lower subsoil...	1.6	3.2	2.0	12.0	13.0	38.8	29.4

The following samples contained more than one-half of 1 per cent calcium carbonate ($CaCO_3$): No. 351350, 9.81 per cent; No. 351351, 15.56 per cent.

LAMOURE SILTY CLAY LOAM.

The Lamoure silty clay loam resembles the Lamoure loam closely, except in texture. The surface soil is black to dark brown in color and a silty clay loam in texture, though small areas of clay loam are scattered through the type. The subsoil is similar in texture to the surface soil, though possibly somewhat heavier, and is of practically the same color as the subsoil of the Lamoure loam. The soil is quite free from gravel. It is fairly high in organic matter and has a smooth, well-granulated structure, but lacks the soft, fluffy feel of the Barnes silt loam. It is inclined to be sticky when wet and cracks slightly on drying.

The type is of small extent in this county. It is confined to stream bottoms, and is mainly developed where the gradient is low and

channels have not been distinctly developed. It often occurs in bottoms near the heads of streams where the gradient is slight, and merges gradually with the loam type farther down the stream, where the gradient is steeper. The silty clay loam commonly occupies level swales or bottoms having a gentle slope. The drainage is fair. The material consists of glacial drift redeposited by water.

The type is for the most part cultivated. Its natural productiveness is high and it is covered with a heavy sod of native grass. The best drained areas give yields slightly higher than those obtained on the Lamoure or Barnes loams.

The following table gives the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Lamoure silty clay loam:

Mechanical analyses of Lamoure silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
351343	Soil	0.3	1.3	1.3	7.7	15.9	49.5	24.3
351344	Subsoil	.2	1.4	1.6	13.7	16.8	41.0	25.3
351345	Lower subsoil	.6	3.7	3.4	17.4	12.8	31.7	30.4

The following samples contained more than one-half of 1 per cent calcium carbonate ($CaCO_3$): No. 351344, 8.13 per cent; No. 351345, 13.43 per cent.

LAMOURE SILTY CLAY.

The Lamoure silty clay consists of a dark-brown to black silty clay to a depth ranging from 20 inches to 3 feet or more. The subsoil is of a lighter color, owing to its smaller content of organic matter, and is more plastic and compact. The color changes gradually to brown and then to brownish or yellowish gray. White calcareous mottlings are quite common in the lower section of the subsoil, and both soil and subsoil usually effervesce freely in acid. Coarse alluvium of swift-water deposition is encountered at a depth of 12 feet or more.

The surface soil is free from bowlders and gravel and has a fairly high content of organic matter. It has a well-granulated, rather friable structure and cracks very slightly on drying, although it is quite sticky when wet. For a soil of its fine texture it is not hard to cultivate.

The Lamoure silty clay is confined to the flat James River bottoms. It occurs as narrow, tapering belts along the river from the southern boundary of the county to a point a short distance above Grand Rapids. The most typical development occurs southeast of Lamoure, where the type occupies the entire first bottom of the river. The soils of the James River bottoms gradually become coarser upstream

and toward the stream channel, so that there are often intervening developments closely approaching silt loam between the silty clay areas and the river, and the silt loam of the series finally entirely displaces this type in the northern part of the county.

The surface of the type is level except for old oxbow remnants of abandoned channels. The river meanders by sharp curves through this flat belt. The type usually lies 10 to 20 feet above the bed of the stream. The river flood stages are not so high as formerly, owing to decrease in the regional run-off, and overflow is confined to the lowest bends and oxbow depressions, and occurs only in early spring after a winter of heavy snowfall. The type was last flooded during the extremely high water stage of the spring of 1897.

The Lamoure silty clay is an alluvial product of the James River, and the sluggishness of the current accounts for the absence of coarse material. Most of the soil material has been transported long distances and thoroughly intermingled, so that the texture is uniform. Except for a few abandoned meadows, the type is fairly well drained and free from injurious accumulations of alkali.

The Lamoure silty clay was never forested. It originally supported a heavy growth of native grasses, but it is now all cultivated. All the common crops of the region do well on this type. It is naturally a productive soil, being considered the most productive in the county. Owing to the retentive nature of the soil and subsoil crops do not usually suffer from drought. The yields of all the crops are probably higher than on any other soil in the county. Wheat averages 16 bushels or more to the acre. Barley seems to do especially well. Its more exclusive use for certain crops to which it is best suited has not received much recognition. The excellent showing made by alfalfa on this type indicates that this legume is particularly well suited to it.

The Lamoure silty clay requires more careful handling than the prairie types, but is more dependable when crops are planted under even moderately favorable conditions. Its productiveness can be materially increased by manuring and by growing intertilled crops, so that the structure can be lightened by tillage. The most undesirable feature of the type is its occurrence in irregular, patchy developments on account of the tortuous course of the river.

Land of the Lamoure silty clay is valued at about $50 an acre.

LAMOURE CLAY.

The surface soil of the typical Lamoure clay is a dark grayish brown, sticky, heavy, tenacious clay of a gumbo nature and having a fairly high content of organic matter. It cracks on drying and is rather difficult to cultivate. The material becomes lighter colored

and more compact at about 24 inches; otherwise the subsoil is similar to the soil. The one area of typical Lamoure clay occurs in a slightly depressed, small flat in the James River bottoms, immediately south of Lamoure. The drainage is fair and the alkali content is not high. The land is under cultivation at the present time. The value is probably about $45 an acre.

Over the greater part of the type mapped in this county the soil varies from the typical and may be considered a poorly drained variation. The surface soil, to an average depth of 18 inches, ranges from bluish-gray to brown or dark-brown clay. In places the soil is black for several inches, owing to a large accumulation of organic matter, and in a few places it consists largely of plant remains. Except for the surface layer, the organic-matter content of the soil is not high. Coarse material is lacking. The subsoil is a plastic, heavy, tenacious clay of a dark bluish gray color, becoming lighter in the lower subsoil. In rare cases the clay contains considerable embedded gravel at about 36 inches in depth, but in general it is free from coarse material.

The soil is very poorly granulated. It has a sticky, slippery feel and bakes and cracks badly on drying, so that it is difficult to cultivate. The subsoil, although normally in a water-logged condition, is firm and compact. It is very similar to the subsoil of the Maple clay loam, but has a much finer texture and somewhat firmer structure.

White streaks of alkali are often encountered in the upper part of the soil section, and the content of lime carbonate is high, both soil and subsoil effervescing freely in acid. Surface evaporation has caused a large accumulation of alkali, and there are many barren spots covered with an efflorescence of white alkali during dry seasons. The alkali symbol is used on the map to denote an area covering about 3 square miles, immediately west of Lamoure, where there is an injurious accumulation of alkali.

The poorly drained areas of the Lamoure clay occupy broad, flat, gently sloping swales in the first bottoms of the James River below Grand Rapids, the principal area lying to the south of Lamoure. These swales usually lie a considerable distance from the present stream channel. The total area is small.

The soil is of alluvial origin, having been formed by the deposition of material derived from glacial till.

Much of the land is periodically under water, and the soil is too wet to cultivate, being practically always in a soggy condition. The moisture seems to come largely by seepage from gravelly terraces and the more elevated prairie land. Much of the variation can probably be drained by ditching into the James River, and for many areas the cost of drainage would be comparatively low. Many farmers

do not care to provide drainage, considering the land equally as valuable for the native hay it produces as it would be for farming. The growth of grass is variable. In places there is only a scattered growth of salt grass, while in some of the wettest situations there is a luxuriant growth of meadow grass. Part of the land is pastured, but most of it, where drainage permits, is cut over for hay.

Owing to the poor drainage, high alkali content, and the consequent large percentage of waste land, the value of land of the poorly drained variation is rather low.

ROUGH BROKEN LAND.

Rough broken land comprises areas that are too rough to be cultivated profitably.

It is largely confined to the precipitous slopes or bluffs masking the deeply eroded slopes from the prairie land to the James River bottoms. Here it occurs in two narrow strips of an average width of about one-eighth mile, bordering the bottom land. The margin of these two strips nearest the valley is quite regular, forming the fairly even border of the valley soils. The boundary along the higher side of the strips is more irregular, since the Rough broken land projects back into the prairie in places along tributaries and coulées. Even here the outline is not conspicuously irregular, on account of the small number of the tributaries. Along the James River the range in elevation from the lower to the upper side of the strips is about 100 feet. Rough broken land also includes a few small areas covering precipitous slopes along the edge of the Missouri Plateau and inextensive morainic areas in the western part of the county. Remnants of nonagricultural, old gravelly terraces are also included.

The soil of the areas of Rough broken land consists for the most part of unassorted glacial till considerably modified by erosion, though it is now not subject to severe erosion. Much of the finer material has been washed out, leaving a large number of bowlders and much other coarse-textured residue on the surface. There are small strips or pockets of alluvial material along some of the coulées. The soil in the lower lying parts of the areas contains varying quantities of intermingled colluvial material and merges with the colluvial types usually found at the foot of the slope.

Practically none of the Rough broken land is cultivated at present. Much of it could be tilled in an intensive system of farming, but with the present development of agriculture it is best used for pasture. It is much in demand for that use, owing to the good growth of grass. Hay is cut on some of the more even slopes. A scrubby growth of trees exists in protected positions in some of the coulées where moisture and soil conditions are favorable. The trees are mostly buffalo-berry and wild-plum

The areas included in the Rough broken land have an average value of about $15 an acre.

SUMMARY.

Lamoure County is located in southeastern North Dakota. It is approximately 48 miles long and 24 miles wide, rectangular in outline, and comprises an area of 1,140 square miles, or 729,600 acres. The eastern and central parts are mostly undulating prairie, broken by the valley of the James River. The western part is gently rolling to hilly and is more elevated. The county lies in the James River basin. Surface drainage is not well established, but is in most places sufficient where assisted by percolation into the subsoil.

The population of the county increased from 3,187 in 1890 to 10,724 in 1910. Lamoure, the county seat, with a population of 929, is the largest town. About three-fourths of the population is native, the remainder being largely of German or Scandinavian birth.

Four railroads furnish good transportation facilities, and farm products can be readily marketed in all parts of the county. Practically all the farms are within 8 miles of a shipping point. The roads are naturally good and are gradually being improved. Much of the water supply comes from artesian wells. The school system of the county is good.

The climate is subhumid, with comparatively long winters and short summers. The mean annual temperature is 39° F. The average date of the last killing frost in the spring is June 2 and that of the first in the fall September 12, allowing an average growing period of 102 days. Low temperatures occur in the winter, and even in summer the nights are cool. The annual precipitation averages 18 or 20 inches.

Agriculture was carried on first in the eastern part of the county in the early eighties and was gradually developed westward as railways were built. The one-crop system of farming, with spring wheat as the main crop, was followed until about 1910. Since then farmers have grown more corn and have begun to practice more diversified farming. Stock raising, a form of agriculture that should be very remunerative in this territory, is receiving increased attention. After wheat, oats, barley, corn, flax, and rye rank in importance in the order named. Land values range from $20 to $60 an acre for tillable land.

The soils of the county fall into four general groups—glacial, glacial-lake and river-terrace, river flood-plains, and eolian soils. Including Rough broken land, 25 types are mapped.

The Barnes, Williams, and Edgeley series are of glacial origin.

The Barnes series comprises dark-colored surface soils with high organic-matter content and grayish or greenish-yellow or yellowish-brown subsoils containing a large quantity of lime concretions. The soils are productive, retentive of moisture, and well suited to general farming. The Barnes silt loam is the most extensive and one of the most desirable soils in the county. It occupies the more level parts of the prairies.

The Williams series comprises dark-gray to dark-brown surface soils and lighter colored subsoils with reddish-brown shades. The subsoils contain a high percentage of calcium carbonate. The topography is rather rough and the soils are stony.

The Edgeley loam is a brown soil, characterized by a subsoil high in shale fragments. The type is comparatively low in productiveness.

The glacial-lake and river-terrace group comprises the Sioux, Bearden, Fargo, Rogers, and Maple series.

The Sioux series is characterized by its gravelly, droughty subsoils. The Sioux silt loam and loam are good agricultural soils. The sandy loam is droughty and not naturally productive. The fine sandy loam is fairly productive. The gravelly loam and its rolling phase are valuable chiefly for pasture.

The Bearden silt loam is a valuable soil for all classes of farming, and is similar to the Barnes silt loam in economic value.

The Fargo silty clay and Fargo loam are dark-colored soils, poorly drained and consequently having light-colored or mottled subsoils. They are valuable as hay and pasture land, and when drained make productive farming soils.

The Rogers silty clay is unproductive, being poorly drained and containing injurious accumulations of alkali.

The Maple clay loam is an inextensive, poorly drained soil occupying old stream channels.

The eolian soils include the Valentine fine sand and fine sandy loam. These are inextensive types, best suited to intertilled crops.

The Lamoure series comprises the river flood-plains or alluvial soils. The Lamoure silty clay and silt loam are especially productive and desirable types, practically all under cultivation. The loam and silty clay loam are also good farming soils. The clay type is for the most part too poorly drained for farming, but is in places cultivated and gives good yields.

Rough broken land comprises all areas too rough to cultivate with improved farming machinery.

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[PUBLIC RESOLUTION—No. 9.]

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

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

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

Approved, March 14. 1904.

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

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