Number ~~27~~ 23 Series 1924

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY AND SOILS
In cooperation with the University of Minnesota Agricultural Experiment Station

SOIL SURVEY
OF
LAC QUI PARLE COUNTY, MINNESOTA

BY
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COUNTY SURVEYED

Lac qui Parle County is in the western tier of counties in Minnesota and borders South Dakota. On the north and east Minnesota River forms the boundary. The county roughly forms a right-angled triangle, with a base and altitude each about 34 miles long. The county comprises 776 square miles or 496,640 acres.

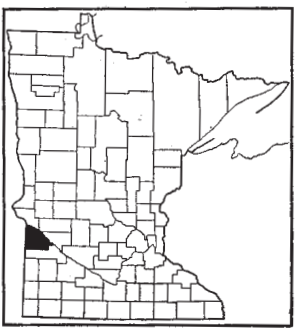

FIGURE 1.—Sketch map showing location of Lac qui Parle County, Minn.

The county as a whole has an undulating or moderately rolling surface, with local relief varying from 10 to 30 feet. The slope is to the northeast. Nearly flat areas are small, as also are rolling or sharply rolling areas. The largest rolling areas are in the western part of the county. With their highest hills rising to an elevation of as much as 100 feet, they constitute a prominent variation from the general land surfaces about them. The valley of Minnesota River is the only other prominent physiographic feature. This valley, lying from 100 to 150 feet below the uplands, has a flood plain of one-fourth mile to 1½ miles wide on the Lac qui Parle County side of the river. This flood plain is bordered by a series of benchlike terraces lying about 75 feet above the river and about 50 feet below the upland levels. Along this valley are most of the flatter areas of the county.

The larger areas of flat lands in the uplands occur in well-defined depressed strips paralleling the Minnesota River Valley. An added physiographic feature of the Minnesota River Valley is the isolated clusters of granite knobs, rising as high as 50 feet above the river in northern Yellow Bank and Agassiz Townships.

The county has a mean elevation of 1,220 feet above sea level. The highest elevation, about 1,400 feet above sea level, is in the southwestern corner of the county. From this elevation there is a gradual descent northeastward of about 250 feet in 25 miles. The lowest elevation in the county is 913 feet above sea level at the east county boundary.[1]

[1] UPHAM, WARREN. THE GEOLOGY OF BIG STONE AND LAC QUI PARLE COUNTIES, MINNESOTA. From The Geology of Minnesota, vol. 1 of the final report, Minn. Geol. and Nat. Hist. Sur., pp. 613–631, 1884.

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The main drainage courses have tributary development only sufficient to adequately drain the lands from 1 to 3 miles distant. In a considerable area local surface drainage is good by virtue of the moderately rolling relief, but the surface waters collect in numerous constructional depressions with sluggish-flowing outlets or scarcely any outlets at all. Only a comparatively small proportion of these depressions are permanently swampy or even intermittent ponds. In recent times only two such depressions held permanent bodies of water large enough to be named as lakes. Many of these areas are provided good outlets by open ditches or large underground tile drainage improvements. Between 225 and 250 miles of such artificial drains were in operation in 1924. The best estimate possible would place the area of land surface having inadequate natural drainage in the county between 175 and 200 square miles. Of this land only about 20 or 25 square miles are in ordinary seasons of rainfall too wet for cultivation.

Lac qui Parle County was organized in 1871. It is supposed the body of water known as Lac qui Parle was first explored in 1816 by John Lockwood. Between that time and the Civil War there was some traffic on Minnesota River between the Selkirk colony, in the Red River Valley of Canada, and St. Paul. The village of Lac qui Parle was the first trading post in the county. A few settlers came after the establishment of a mission there in 1835, but permanent settlement was delayed until 1868, largely because of Indian troubles. In 1868 and 1869 a large party of Norwegians came from northeastern Iowa. This began a steady influx of settlers, largely of Scandinavian and German extraction, from States to the south and east. Unofficial enumerations give the county's population in 1870 as 145 and in 1875 as 1,428.[2] In 1880 a population of 4,891 is reported by the United States census; the number for 1890 was 10,382; for 1900 was 14,289; and for 1910 was 15,435. In 1920 the population was 15,554, all classed as rural. The density was 19.7 persons to the square mile. Most of the inhabitants are American born. The 1920 census gives the number of native farmers as 1,356 and of foreign born as 652. Norwegians, Germans, and Swedes lead among the foreign born.

There are seven incorporated towns in the county. Their population, according to the 1920 census, was as follows: Madison, the county seat, 1,838; Dawson, 1,511; Boyd, 549; Marietta, 413; Bellingham, 405; Nassau, 168; and Louisburg, 99. Lac qui Parle, Providence, and Rosen are inland trading centers.

Two railroads enter the county. The Minneapolis & St. Louis Railroad runs from the southeast corner to the west-central part of the county. The Great Northern Railway serves the northern part of the county. A main line of the Chicago, Milwaukee & St. Paul Railway closely parallels the north side of Minnesota River outside the county and serves adjacent territory within the county. Similarly the southwest corner of the county is accessible to a line of the Chicago & North Western Railway.

Well-maintained dirt roads serve all parts of the county. Improved gravel roads, four running east and west and four north and

[2] MOYER, L. R., and DALE, O. G., HISTORY OF CHIPPEWA AND LAC QUI PARLE COUNTIES, MINNESOTA: THEIR PEOPLE, INDUSTRIES, AND INSTITUTIONS. 2 v., illus. Indianapolis. 1916.

south, reach all sections of the county. In 1924 there were 213 miles of gravel roads, 71 miles of which were State trunk highways. Rural telephone and mail service reach all parts of the county. Three consolidated public schools, three semiconsolidated schools, and 96 independent schools constitute the rural educational facilities.

CLIMATE

The climate of Lac qui Parle County is characterized by warm summers and cold winters. Temperatures in spring and fall are more changeable than in summer and winter, as is shown by the seasonal absolute maximum and minimum temperatures.

The average frost-free season, from the average date of killing frosts in spring and fall, extends from May 8 to September 29, a period of 144 days. The latest recorded killing frost was on June 9 and the earliest on September 12.

The temperatures during the growing season are characteristically moderate. Moist conditions favor spring plantings, and warmer, drier summer weather favors good plant growth, which is seldom severely arrested by protracted dry, hot weather. The moderate temperatures and well-distributed rainfall usually continue through the month of September, and crops usually mature before the damaging frosts. The fall plowing and seeding of grains is favored by the same weather conditions. The months of October and November are characterized by comparatively dry weather, with frosty nights and moderately warm days. The monthly snowfall averages about 6 inches during the winter.

The seasonal variations from normal which decrease crop yields are late spring and early fall frosts, unusually wet weather during or immediately following spring plantings, and protracted dry and hot periods during late summer and early fall. Seldom if ever does the growing season continually feature these unfavorable conditions, and usually unfavorable weather is compensated by associated conditions favoring rapid crop growth. The rainfall is most unevenly distributed in May and June, but seldom are crop replantings necessitated by excessive rain and standing water. Unusually heavy rains during the late summer sometimes are responsible for poorly matured corn, especially if they are preceded by unusually cool summer weather. Protracted dry spells during the summer are seldom damaging. Open cold winters occasion poor stands of fall-seeded grains and hay meadows. Prevailing winds are from the west and northwest.

Wind and hail storms occur, but only in spots is the damage severe.

Table 1, compiled from records of the Weather Bureau station at Montevideo, Chippewa County, gives data representative of conditions in Lac qui Parle County.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Montevideo, Chippewa County*

[Elevation, 950 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1895)	Total amount for the wettest year (1908)	Snow, average depth
	° *F.*	° *F.*	° *F.*	*Inches*	*Inches*	*Inches*	*Inches*
December	18.2	64	−33	0.74	0.02	0.90	5.8
January	10.5	57	−38	.75	.50	.29	7.5
February	13.2	64	−38	.70	.67	.90	6.6
Winter	14.0	64	−38	2.19	1.19	2.09	19.9
March	28.0	88	−25	1.28	.54	1.41	8.2
April	45.7	92	5	2.48	1.13	2.89	2.6
May	56.7	97	16	3.32	2.55	7.69	.2
Spring	43.5	97	−25	7.08	4.22	11.99	11.0
June	66.3	102	31	4.11	2.50	6.53	0
July	70.8	106	40	2.91	1.41	2.00	0
August	69.0	102	34	2.79	2.26	1.75	0
Summer	68.7	106	31	9.81	6.17	10.28	0
September	60.8	101	14	2.26	2.79	3.02	Trace.
October	48.0	98	4	1.83	Trace.	2.34	.8
November	31.9	82	−23	.87	1.25	2.68	3.6
Fall	46.9	101	−23	4.96	4.04	8.04	4.4
Year	43.3	106	−38	24.04	15.62	32.40	35.3

AGRICULTURE

Before settlement Lac qui Parle County was a broad prairie with trees fringing the valleys. Slender wheatgrass, bluestem, and meadow rue were the common prairie grasses. The elm, green ash, box elder, cottonwood, basswood, slippery elm, silver maple, ironwood, willow, hackberry, and bur oak are trees native to the valley lands. The bur oak also encroached on the prairie in places. At the present time some trees are still present on the bluffs and narrow bottom lands. The prairies now present a solid expanse of cultivated fields dotted with planted tree groves about the farmsteads.

In 1870 there were reported in Lac qui Parle County 23 farms of 11.7 acres each. Two hundred and forty-one head of livestock were enumerated, as follows: 19 hogs, 25 sheep, 21 horses, 176 cattle. Lac qui Parle village remained the center of activity until the construction of the present railroads through the county in 1884 and 1887. During the period from 1870 to 1885 the land in the eastern part of the county was taken up, and the population jumped from 145 to 7,842. Lands were obtained from the United States Government by preemption, by homesteading, or by tree claims. Preemption involved only a cash payment of $1.25 an acre. Homesteading involved five years' residence and certain improvements. Tree claims involved the planting of 10 acres of trees as proof to title of 160 acres of land.

By 1870 open range for livestock was no longer available. The greatest expansion of crop acreage took place between 1890 and 1910. Wheat was the main crop. Grasshopper plagues between 1875 and 1880 and low market prices between 1880 and 1885 brought about a trend toward diversification from the one-crop method of farming. Flax was the most extensive new crop. Cultivated hay crops and corn were adopted more gradually and associated with their steady increase was a corresponding growth of livestock industries on the farms. Wheat, however, remained the leading crop until after 1920, when corn and oats each occupied a larger acreage.

The trend of agriculture is reflected somewhat in the census figures from 1880 to 1925, inclusive, given in Table 2:

TABLE 2.—*Number and size of farms and acreages*[1] *of principal crops in stated years*

Census year	Farms	Size of farms	Wheat	Oats	Hay crops	Corn	Barley	Flax
	Number	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
1880	1,180	176	22,937	3,765	9,643	2,233	470	
1890	1,550	206	106,889	20,498	36,020	9,485	1,101	576
1900	1,951	233.1	218,420	29,179	39,116	30,565	6,260	9,678
1910	1,863	249.1	104,421	61,052	42,095	45,833	43,895	12,578
1920	2,008	231.5	108,046	53,511	41,347	53,127	9,411	2,905
1925	2,056	225.5	55,691	90,010	43,915	84,455	13,985	27,406

[1] All crop acreages are for the year preceding the census year.

The accompanying growth of livestock industries is shown in Table 3:

TABLE 3.—*Number of livestock reported by the census from 1880 to 1925, inclusive*

Census year	Hogs	Sheep and goats	Horses	Total cattle	Dairy cows
1880	1,550	944	2,189	5,771	2,282
1890	6,452	5,280	7,656	18,750	7,251
1900	22,138	2,771	12,982	21,264	8,646
1910	29,896	3,581	13,998	25,870	10,985
1920	49,583	[1] 2,063	15,545	35,436	19,887
1925	61,883	[1] 2,926	13,416	37,115	12,131

[1] Sheep only.

The marked decrease in wheat acreage after 1890 took place in all parts of the county except the northwestern quarter. Decreasing yields and lower market prices combined to cause this reduction. The farmers attribute the decrease in yields mainly either to diseases or to a run-down condition of the soil. Corn, oats, flax, barley, rye, alfalfa, and sweet clover increased in acreage from 1910 to 1925. Sweet clover, once considered a roadside weed, has been cultivated for only a few years. Alfalfa was scarcely known in 1910, the census of that year reporting only 19 acres in the county. Indifferent results attended the first attempts with alfalfa growing, but the crop soon established itself as the highest yielding, most nutritious cultivated hay in the county and won general recognition as a soil im-

prover. Flax acreages after 1920 were greatly increased, owing to the high market prices of flaxseed and to its adoption as a nurse crop for alfalfa and as a substitute or companion cash crop for wheat. The more staple crops, such as corn, oats, barley, and rye, are largely fed on the farm, the smaller surpluses being sold. The increased production of these crops has thus been associated with increased numbers of livestock. The decreased income from wheat was offset in a large measure by the increased income from livestock products as well as from substitute cash crops. Pork and beef production brought increasing returns, but perhaps the steadiest and greatest increase came from dairy products. Although no comparisons for the county as a whole are available, the annual reports of the Minnesota State Dairy and Food Department show that the income to patrons of the three creameries operating in the county increased from $35,974 in 1919 to $262,753 in 1924. These reports also show an increased production per cow, a fact also indicated by the decrease in the number of dairy cows kept. The numbers of horses and sheep decreased, with a corresponding decrease in the production of work animals and of wool. Pork and beef production brought increased returns, and an increase in numbers of beef cattle and swine is shown. Poultry products net good returns.

A slight increase in the number of farms and a decrease of 6 acres in the average size of farms occurred between 1920 and 1925. A slight increase in tenancy accompanied this change.

The 1925 census shows 79.2 per cent of the farm acreage in crops and 13.7 per cent in pasture.[3] Of the acreage in crops, oats occupy 24.5 per cent; corn, 23 per cent; wheat, 15 per cent; hay and forage crops, 12.7 per cent; flax, 7.4 per cent; and barley, 3.8 per cent. These are the leading crops raised at present. Wheat and flax are the cash crops raised almost solely for market. Corn, oats, barley, and rye are produced both for feed and for market, more than half the corn, less than half the oats, about five-eighths of the barley, and three-fifths of the rye produced being marketed. The bulk of the grain crops marketed is handled by local cooperative and independent elevators and is shipped to the Minneapolis market.

According to the 1925 census the average number of livestock kept on a farm was 31 hogs, 10 beef cattle, 8 dairy cattle, 6 horses, and 1 sheep. Poultry flocks averaged about 110 fowls. Poultry products are largely cooperatively marketed or are sold through local independent stations. Thus, in this county oats, corn, wheat, hay, and forage crops are the most important crops, and the raising and fattening of hogs and cattle are the most important livestock enterprises, dairying, poultry production, and wool production being side-line activities.

In 1924 the yield of oats totaled 4,255,825 bushels, an average of 46.2 bushels to the acre. Oats have a place on practically every farm of the county. Producing oats for market is not considered very profitable, yet a little less than half the crop is sold. The large acreage is grown for feed and as a follow crop for corn in rotation. Oats are planted between April 15 and April 25, in the average season. Home-grown seed of mixed varieties is generally used.

[3] Minnesota State census of 1925.

Medium-maturing varieties, such as Green Russian, New Victory, and Swedish Select, are the most popular, but the early yellow oats varieties are increasingly grown. The medium oats are harvested between July 8 and July 17 and the early oats between July 5 and July 15.

The average market price of corn makes it a more profitable cash crop than oats, and consequently a little greater part of the crop is marketed. A little less than half the crop is fed on the farms. Formerly, Lac qui Parle County was considered too far north for successful corn growing, but the crop soon became acclimated and dependable. Mixed home-grown seed is used most commonly. The most popular varieties are the yellow dent Early Murdock, Golden Jewel, Minnesota 13, and Ideal, and the white dent Silver King and Rustler White Dent. Most of the corn is planted between May 10 and May 20. Plantings after June 1 are apt not to mature properly. Harvesting begins the last of October and generally is finished during the first part of December.

In addition to the corn grown for grain, a considerable acreage is planted for fodder and silage. In 1924, 23,590 acres were cut for silage and fodder, and in 1919 there were reported 15,753 acres grown for fodder and 4,625 acres of silage crops (mostly corn, but including minor acreages of sorghum and soy beans). The reported production was 32,635 tons of fodder, an average of 2.1 tons to the acre, and 29,528 tons of silage, an average of 6.4 tons to the acre.

In 1924 wheat yielded 1,198,811 bushels, an average of 21.5 bushels to the acre. Practically the entire crop, except such as is needed for seed, is marketed. Small flour mills in Madison and Dawson buy locally, but the bulk of the crop is shipped out of the county. Marquis spring wheat is the most popular variety, but some Mindum is grown. The latter is recognized as a little more rustproof and yields more heavily than the former. The local elevators usually have to discriminate against it, even when market quotations are equal to the milling wheats, because of the added expense of separate handling of the smaller quantities of this macaroni wheat. Only a very small acreage of winter wheat is grown. The Minturki is the most common variety. Winter wheat is usually sown between September 1 and September 10 and harvested between July 4 and July 10. The spring wheats are sown between April 5 and April 15 and are harvested between July 10 and July 20.

Hay and forage crops occupied 12.7 per cent of the crop acreage in 1924, according to the 1925 agricultural census. Excluding forage crops, the hay crop acreage for that year was reported by the Minnesota State farm census as 40,773 acres, of which 23,956 acres were wild hay and 16,817 acres tame hay. The largest acreages of wild hay were in Hantho, Walter, Freeland, Camp Release, and Agassiz Townships, where it occupies from 7.8 per cent to 12.6 per cent of the farm land. The flood plains of the rivers and creeks and the numerous slough areas of the uplands yield the bulk of the wild hay cut. Census reports indicate an average yield of 1½ tons to the acre. Considerable acreages of well-drained wild prairie meadows are now used almost entirely for cultivated grasses. Timothy and red or mammoth clover mixed and timothy grown alone occupy the greatest acreages. Little red or mammoth clover is grown sepa-

rately. Alfalfa in 1924 was well distributed over the county, covering 5,071 acres, according to the Minnesota State farm census. Sweet clover occupied 1,989 acres. Millet is a minor crop, occupying perhaps 1,000 acres. Average yields of 2½ tons of alfalfa to the acre, 1½ tons of timothy or timothy and clover mixed, 1¾ tons of clover, and 2 tons of millet are indicated by the census reports. A small proportion of the hay produced is marketed outside of the county. The bulk of the crop is fed on the farm or is sold locally for feed.

Only a very small acreage of tame hay is harvested for seed. Seed production is rather uncertain and can be depended upon only in favorable seasons. Sweet clover is the most dependable seed producer. The Minnesota State farm census reports only 38 acres of timothy and 501 acres of clover harvested for seed in 1924. Alfalfa is the least dependable of the tame hays in seed production. Seed is almost entirely purchased from outside markets. Medium red is the most popular variety of clover, and practically all of it is seeded with timothy. Mammoth and alsike clover are sometimes substituted for medium red. Of the sweet clovers, the white biennial is most commonly grown. The alfalfa seeded is mostly of the Grimm variety.

The 1920 census reports that the forage crops occupied an acreage of 15,831 acres in 1919 and produced 32,854 tons, or an average of a little more than 2 tons to the acre. Corn occupied the great bulk of this acreage. Sorghum, soy beans, rape, rye, and the root crops, such as mangels, rutabagas, and beets are also used to a small extent for forage. The hay crops furnish considerable forage in addition to the hay cut but are not included in the acreage enumerated above.

In 1924 the census reported a flax acreage of about 7.4 per cent of the cultivated land and a production of 333,845 bushels, an average of 12.2 bushels to the acre. This is a far greater acreage than that reported in any previous year. Formerly flax was rarely seeded except as a sod crop, but it is now seeded on the regularly cropped farm fields as well. The acreage is well distributed throughout the county. The entire crop is handled as a market seed crop. Little or no local market exists for the flax straw. Home-grown seed of wilt-resistant strains is used. Of these North Dakota Resistant No. 114 is the most popular variety.

Barley in 1924 occupied about 3.8 per cent of the cultivated land and produced 463,656 bushels, an average of 33.1 bushels to the acre. From one-half to three-fourths of the crop is sold, and the remainder is fed on the farms. Home-grown seed of mixed varieties is generally used. To a very small extent an improved Manchuria strain called Minnesota 184 is seeded. With satisfactory yields barley returns a better profit on the average than oats.

The Minnesota State farm census reported small acreages of rye in six townships. About three-fifths of the rye produced is sold for grain. High prices were largely responsible for the increased acreages in 1922 and 1923. With the decline in prices, the acreage has declined. Rye is the hardiest of fall-seeded crops in this county. Its adaptability as fall forage, grain, or green hay gives it a greater variety of utilization than the other small grains. The census indicates average yields varying from 9 to 20 bushels to the acre.

Minor crops worthy of brief mention here are potatoes, buckwheat, emmer and spelt, and mixed grain crops. Potatoes are very gen-

erally produced for home use. Early or medium maturing varieties are the most popular. In 1924 the Minnesota State farm census recorded 687 acres in potatoes. Yields are from 100 to 125 bushels to the acre.

In 1919 buckwheat was grown on only 130 acres in the entire county. Emmer and spelt are not separately recorded but no doubt occupy a small total acreage.

A considerable acreage is devoted to mixed grain crops. The most popular and practically the only mixtures grown are wheat and flax for grain, wheat and oats for grain, and oats and barley for feed. According to the 1925 census pasture lands in 1924 occupied 63,501 acres, of which 29,411 acres were plowable and 4,481 acres were farm woodlands. The common pasture grasses, such as Kentucky bluegrass, Canadian bluegrass, redtop, timothy, and red, white, sweet, and alsike clovers, have largely supplanted the native prairie pasture grasses such as slender wheat, bluestem, and meadow rue grasses. Only a comparatively small percentage of this pasture acreage is rotated to cultivated crops. The grazing season extends generally from the last of April to the middle of October.

Orcharding receives little attention. Apples are the principal fruit, and some plums and cherries are produced. Small fruits, such as grapes, strawberries, raspberries, and blackberries, are scarcely worthy of mention. No attempts are made to produce orchard or small fruits commercially.

According to the 1920 census, the value of livestock on the farms was 5.8 per cent of the total farm value, or $4,169,892. Financial returns from the marketing of fat livestock in the aggregate exceeded the steadier-yielding returns of dairy and poultry produce. The census estimated the revenues during 1919 from all classes of livestock marketed as $954,905, from dairy products $311,101, and from poultry $241,157. The raising and fattening of hogs is the most important livestock industry. The 1910 census enumerated 24,340 hogs marketed (or slaughtered) as compared with 1,662 calves, 4,828 other cattle, 652 horses, and 619 sheep, and gave their combined value as $555,605. The local livestock-shipping associations handled the bulk of this stock, consigning practically all of it for shipment to the South St. Paul market. In 1924, according to the census, there were in the county 61,883 hogs, of which 15,493 were brood sows. The majority of the herds are of mixed breeds. The most popular pure-bred stock is of the Duroc-Jersey, big-type Poland China, Hampshire, and Chester White breeds. Few farmers are able to place at a single time a whole carload of hogs on the market. The bulk of the stock is handled by the local county cooperative livestock-shipping associations. With ordinary care pig production is not curtailed seriously by diseases.

Beef production is mainly from native farm-raised stock supplemented now and then by feeder stock purchased generally from South St. Paul or directly from South Dakota ranches. Native young stock is given a fattening period of seven or eight months before marketing and the older feeder stock about four months. In 1924 the number of beef cattle in the county was 21,214, an average of 10.3 to the farm. A little more than half of this number were calves and yearlings. Most of the beef cattle are grade animals.

However, interest in purebred stock seems to be increasing. In 1922 the Minnesota State farm census reported the presence of 662 purebred Shorthorn, 152 Hereford, 151 Angus, and 32 Red Poll cattle. In 1924, 11 farmers were breeding Hereford, 13 Angus, 32 Shorthorn, and 1 Red Poll. The numbers of calves (1,662) and of other cattle (4,828) marketed during 1919 indicate about one-fourth of the cattle are marketed as veal. The marketing is almost entirely through the local county livestock-shipping associations.

Dairying is carried on as a side line on the average farm of the county. In 1924 there were reported 12,131 dairy cows, an average to the farm of 5.9 head. Calves and yearlings made up about two-thirds of this number. The 1924 report of the three local creameries listed 759 farm patrons milking an average of 5.2 cows each. The majority of the dairy cattle are grade animals. Of the purebreds, the Holstein is most popular. A few head of other breeds, such as Guernsey, Ayreshire, Brown Swiss, and Jersey, are kept. The Minnesota State Farm Census of 1922 reported 319 purebred Holstein, 106 Ayrshire, 54 Brown Swiss, 24 Guernsey, and 1 Jersey. Dairy products are marketed with the three cooperative creameries within the county and at adjacent markets in Canby, Appleton, Montevideo, Ortonville, and Clarkfield. Practically all the produce is marketed as cream, the skim milk being fed on the farm.

An exceptionally good type of draft horses is kept as work animals on the farms. In the past, when wheat farming was important, the work animals were a more important factor in the farm operations. During that time a foundation for the present high-grade horses was laid. In 1924 there were reported in the county 13,416 horses and 220 mules, a total number of 13,636 head or an average of 6.6 head to the farm. Of this number about one-twentieth are colts and yearlings. Breeding is largely from high-grade mares and purebred sires, although some purebreds are raised. The Percheron, Belgian, and Shire are the popular breeds. Production supplies local demands, and a small surplus is marketed outside the county.

Most of the wool produced in the county is marketed through the cooperative State wool pool at Wabasha, Minn. From one-sixth to one-eighth of the sheep are sold or slaughtered. Few or no feeder sheep are bought for fattening. The Shropshire is the most popular breed.

There is scarcely a farmer who does not keep poultry sufficient to supply home demands and afford a surplus for marketing. The 1920 census reported the number of poultry as 203,578, an average of about 100 to the farm. Chickens comprised all but 3.7 per cent of this number. About a third of the poultry is marketed annually. Egg production was estimated at 816,510 dozen for 1919 and the total received from poultry produce as $241,157. Local produce stations handle practically all the poultry products.

One-crop farming is now followed on only a few farms. In its stead continuous growing of corn and small grains is the prevailing practice. On some of the farms of the county corn and oats are grown almost exclusively. These two crops are more commonly grown in rotation in Manfred, Mehurin, and Freeland Townships. Elsewhere in the county wheat, barley, rye, and flax are occasionally grown, though corn and oats are generally the main crops in point

of acreage. Cultivated hay grasses comprised only 5.2 per cent of the 1924 crop acreages. Crop rotations, including cultivated hay grasses, are generally recognized as the best for the maintenance of soil productiveness.

The practices followed in the growing of the various crops are briefly outlined. The small grains, oats, spring and winter wheat, barley, rye, and spelt do best after a cultivated crop, such as corn, but in many fields they are grown continuously as long as yields are satisfactory and the land is reasonably free from weeds. From small-grain stubble the seed bed is prepared by plowing, either in spring or fall, disking, and harrowing. Fall plowing usually allows early spring seeding. For late spring seeding, barley is the surest crop. Winter wheat and rye generally are seeded on land which was plowed early in the fall. Following corn, the land is usually double disked and harrowed for small grains.

The small grains are used as nurse crops for timothy and clover. The spring-seeded grains are used for this purpose more often than the fall-seeded grains. Wheat and barley are usually considered better nurse crops than oats.

Corn generally follows small grains, though occasionally it is grown after tame hay or on sod land. Sod land, meadows, and small-grain stubble are generally plowed in the fall.

Flax follows small grains or is grown on sod land. On sod land, cultivation is not so thorough as on small-grain land. Small-grain stubble is usually plowed before disking and harrowing for planting. Flax is grown for the seed and no use is made of the straw.

Timothy and clover, either mixed or alone, are seeded with a small-grain crop. Timothy is much the easier to grow and usually outgrows the clover in a mixed seeding. Clover is much more sensitive to lack of moisture at seeding time and for a time afterwards and to winterkilling. Where good stands are obtained light pasturing in the fall ordinarily will not damage the crop for the following year. Two cuttings of hay are harvested, one crop is cut for hay and a second left for seed, or one hay crop is cut and the land is then pastured. Timothy produces seed dependably, but little is harvested. Clover-seed production is uncertain. The first crop is generally more dependable for seed production than the second. After the hay or seed crop is harvested the field is usually left for a temporary pasture for three or four years. Bluegrass makes a good volunteer growth as a rule. Red clover is difficult to maintain, and reseedings are seldom made in a pasture. Timothy commonly lasts from three to five years. Other pasture grasses often sown with timothy and clover are redtop, Canadian bluegrass, alsike clover, and white clover.

Alfalfa is seeded both in the fall and spring, but spring seeding is most common. Fall seedings are made on a well-prepared seed bed about the 1st of August. No nurse crop is used. Spring seedings are commonly made with small grains or flax as nurse crops. Liming and inoculation are but little practiced. The first year's crop is light, but the second year there are ordinarily two heavy crops. Winterkilling is occasionally severe. The seed is not usually produced until the third season, and the yield is never very dependable. Alfalfa seldom maintains itself more than eight years, by which time bluegrass commonly crowds it out. During that period, however, it

can be counted on for good hay yields, light pasturage, and possibly one or two seed crops.

Sweet clover is sown in the same way as alfalfa, except that nurse crops are less commonly used. It produces a thriftier but coarser growth of hay and requires heavier pasturing. For that reason most farmers growing large acreages harvest it for seed. One cutting of hay and considerable pasturage are afforded the first year. Two cuttings of hay or one of hay and one seed crop are produced the second year. Seed is harvested from either the first or second crop, but commonly from the first.

Millet for hay is the most popular short-season catch crop. Smaller acreages of Sudan grass and fodder sorghums are grown. The sorghums require practically the same culture as corn, are less desirable for fodder and silage, and mature only slightly earlier.

Field peas and soy beans as hay and forage crops are grown to a very small extent, the peas usually with oats and the soy beans alone or with corn. Rape is grown for forage to a small extent, alone or with corn and small grains. Root forage crops such as mangels, rutabagas, and livestock carrots demand hand cultivation and so are not grown on the scale of a field crop.

No serious weed or insect pests or plant diseases commonly attack crops. The Canadian thistle and quack grass are the most difficult weeds to eradicate. Often the infested part of the crop must be sacrificed. Other weeds can usually be controlled by thorough cultivation or rotation to a cultivated crop without any total sacrifice of the infested crop. Weeds are the most damaging in late-maturing small grains and hay crops, often crowding out tame hay grasses in the meadow. The smuts and rusts are the most prevalent diseases of small grains. Except in an occasional wet, backward spring little damage is caused by them. Corn is practically free from diseases. Flax is sometimes subject to wilt.

Manure produced on the farm is the only fertilizer used and seldom is enough produced to adequately fertilize the fields. Green manuring is seldom practiced. Commercial fertilizers are used on very small acreages devoted to special garden crops. Phosphatic fertilizers are used in small quantities.

The buildings on the average farm in the county include the dwelling, a combined horse and cattle barn with a haymow, a hog house, grain crib, implement shed, and chicken house. Silos, sheep barns, separate cattle barns, and additional grain cribs are found on farms of more than average improvements. The 1923 Minnesota State farm census reported 322 silos in the county.

Most of the fields are fenced with barbed wire or woven and barbed wires. Windmills or engine pumps are in common use. Wells from 25 to 35 feet deep usually furnish good water. The 1925 Minnesota State Farm Census reported 467 tractors and 187 auto trucks in use in the county. Implements used cooperatively by groups of farmers are threshing machines and separators, corn pickers, silage cutters, and hay balers.

Most of the farm labor is done by the family, laborers being hired only during the rush seasons of small-grain harvest, haying, and corn picking. Help by the day was paid about $3.50 and corn pickers 6 or 7 cents a bushel during the 1924 season. Monthly wages were

about $40 for the summer and $20 or $25 for the winter. All labor is white. Where farm operations call for a small crew of laborers the practice of exchanging labor between a group of farmers is common. This is commonly done for threshing and silo filling. The 1920 census records an average labor expenditure of $406.22 for 82.4 per cent of the farmers reporting for the year 1919.

Farm tenancy has slowly and steadily increased. In 1925 the census reported 46.9 per cent of the farms operated by tenants. Under the tenant system smaller acreages are seeded to hay crops as a rule, and grain cropping is more continuous. Livestock is raised in smaller numbers. Terms of tenancy most prevalent are crop-share rents and cash rent for pasture. Corn and hay land are also sometimes rented for cash. A one-third share, with the tenant furnishing everything, is more common than the half share with the owner furnishing seed and a part of the implements and livestock. Cash rents for pasture in the 1924 season averaged about $4 an acre, for cornland $5 or $6 an acre, and for hay land $4 or $5 an acre.

SOILS

The one outstanding characteristic of all the soils of Lac qui Parle County is the dark color of the surface layers. In their virgin state the soils were treeless, except small areas adjacent to the streams. Prairie grasses grew abundantly on the great treeless expanses and even formed a considerable part of the undergrowth in the small forested tracts. It is to the organic matter formed by the decay of the grass roots and incorporated with the mineral constituents of the soil that the dark color is due. The decay of this grass vegetation has been thorough, and its remains are in the form of finely divided carbonaceous material thoroughly mixed with the soil. This and other characteristics of these soils less discernible at first glance have been imparted to them through the activity of the soil-forming agencies working under a prairie environment of optimum moisture and temperature.

The activity of the soil-forming agencies has varied in extent, depending on the relief and on surface and internal drainage, which control the moisture supply of the soil. The differences now to be found in the soils are in the largest measure due to the varying intensity of these soil-forming processes and in but minor extent to the differences in the parent soil materials on which they act. The moisture conditions prevailing in a soil affect the rate of weathering to the greatest extent. The larger area of the soils of this county occur on well-drained uplands and terraces under moisture conditions favorable to leaching and aeration. The resultant soil is one in which the incorporation of organic matter has given a dark surface layer varying in thickness from 10 to 14 inches and from which leaching has removed practically all the lime carbonate.

Below this black surface soil is dark-brown heavier soil of very fine or fine granular structure, also leached of the greatest part of its lime. This layer varies in thickness from 6 to 18 inches. Beneath this is more friable lighter-brown or yellowish-brown soil material only slightly leached and characteristically rich in lime. The lime of this unleached layer is commonly accumulated to a slight degree

within a layer, from a few inches to several inches thick, lying immediately below the leached layers. The moisture conditions of the soil are such that the lime leached from the surface has been concentrated in this layer as also has lime formed by the conversion of calcium compounds into calcium carbonate. This accumulation is so slight that in some places it is not discernible by the eye, but in most places a lighter shade of gray clearly distinguishes the material. Soils in which this layer of accumulated lime is commonly noticeable are Barnes loam and Barnes silt loam, Moody silt loam, and Moody very fine sandy loam. It is less common and less well developed in Moody fine sandy loam, Pierce fine sandy loam, Benoit loam, Bearden fine sandy loam, Barnes fine sandy loam, and Barnes sandy loam. In these lighter-textured soils the greater openness and porosity result in the lime being leached to a greater depth and diffused throughout the soil with little or no accumulation within any one layer. In some cases no appreciable quantities of lime occur above a depth of 4 or 5 feet, where limy soil showing little weathering and closely resembling the still deeper unweathered till is found.

The organic matter varies both in quantity and in the depth to which it extends, depending on the different moisture conditions under which its accumulation has taken place. Under conditions of excessive surface or internal drainage, poorer grass stands were maintained and the black surface soils are slightly lighter colored and range in thickness from 6 to 12 inches. This condition prevails in Pierce fine sandy loam and parts of the Moody fine sandy loam and Barnes sandy loam. Benoit loam, with its porous lower layers, occupies a low, level terrace with a moderately high water-table level and has a black surface soil about 12 or 14 inches thick.

Conversely, under conditions of poor drainage, the surface soil is darker in color and continues to a depth varying from 18 to 40 inches. Over the flatter and more depressed parts of the county the ground-water level was near the surface and the moisture was abundant. This favored a luxuriant growth of grasses and on the decay of the roots larger quantities of organic matter were furnished, resulting in a deep, black soil. Beneath this black soil the material was not much aerated and only slightly oxidized and leached, so that it has been little altered by weathering agencies. It is gray or mottled and highly calcareous. Whether the large quantities of lime present are more largely the result of accumulation or of parent lime in the unweathered till has not been determined. The soil above is only partly leached, and in many places appreciable quantities of lime occur even at the surface. In places, however, actual accumulations of lime are present. The soils of the Webster series have been formed under these conditions on the flatter uplands, the soils of the Fargo series on the poorer-drained terraces or in depressions, and the Lamoure soils on the first-bottom flood plains. The Lamoure soils are immature and have little or no lime accumulation or lighter-colored lower soil material.

Besides the general soil characteristics described there are a number of other differences in structure, in minor details of the soil profile, and in the character, origin, and manner of deposition of the parent material. A number of soil series have been established on the basis of similarities in one or more of their more important char-

acteristics. These soil series are further separated into soil types on the basis of different surface-soil textures. Soils subdivided on the basis of minor characteristics not of the soil itself, such as surface relief or the presence of stone on the surface, are called phases of the soil type.

Lac qui Parle County lies in the part of Minnesota covered by the Wisconsin glaciation, the most recent of the glacial advances. The parent material was originally a mixture of clay, sand, and gravel, yellowish brown or gray in color. The present exposures of calcareous material and the number of limestone pebbles and bowlders show that this glacial deposit had a high lime content. It is from this material, as deposited by the ice or as transported, resorted, and redeposited by waters of glacial origin, by present streams, or possibly to a small extent by the action of wind, that the soils of the county have been formed. The Barnes, Webster, and Pierce soils show little or no assortment of their parent materials. The Barnes and Pierce soils belong to the group of well-drained soils which show lime accumulation. The Barnes soils have heavy subsoils and the Pierce have loose gravelly subsoils. The Webster soils have deep, black surface soils characteristic of the soils formed under poor drainage conditions. The layer of lime accumulation is not commonly well developed. A part of this glacial till shows an assortment of particles now generally agreed to be the result of wind action, or the action of sheet waters from the melting ice, or of the sluggish flow of streams. The Moody soils of the well-drained uplands have well-developed accumulations of lime and are thought to have developed over such materials. The soils of a third group have been formed over the alluvium of glacial streams and present-day drainage ways. The Fargo, Bearden, and Benoit soils are formed from deposits laid down by glacial waters. In them layers of accumulated lime are developed to a greater or less extent. The Fargo soils were formed under poor drainage conditions and the Benoit under conditions of poor surface drainage and a moderately high water-table level, but with excessive internal drainage caused by the loose gravelly subsoil. The Bearden soils, formed under conditions of well-regulated drainage, bear a close resemblance to the Barnes soils of the uplands. The Fargo soils, developed on water-laid material, resemble the Webster soils developed over glacial material. This resemblance of soils formed from parent materials of different character shows the standardization which can be effected by the soil-forming agencies when they work under conditions of similar temperature and moisture. The Lamoure soils were formed from present stream or recent lake deposits and occupy flood plains. They are the best-assorted soils of the county and were formed under poor drainage conditions, with little leaching or accumulation of lime.

Brief descriptions of the various soil series, as standardized not only for this county but for the general regions of their occurrence, follow.

The soils of the Barnes series have very dark grayish-brown or black surface soils of loose, very fine granular structure, underlain by brown, moderately heavy upper subsoil layers and by light-brown or yellowish-brown, friable lower subsoil layers which are rich in lime and show an accumulation in a layer immediately beneath the

heavy brown soil layer. They developed under good drainage conditions from glacial drift materials. The silt loam, with a terrace phase, the loam, with a heavy-textured phase, a stony phase, and a terrace phase, fine sandy loam, and sandy loam members of the series were mapped in this county.

The soils of the Bearden series are very similar in their profile arrangement and general appearance to the Barnes soils, but by reason of their development from the better-assorted parent materials and their freedom from coarser drift materials they have been mapped separately. Bearden fine sandy loam was mapped in this county.

The soils of the Pierce series have dark grayish-brown, loose, very finely granular surface soils, underlain by a thin layer of heavier brown material. Below this is loose, porous calcareous gravel showing feeble accumulations of lime in the upper part. These soils have developed under conditions of good drainage from the coarser materials of glacial deposition. The fine sandy loam and gravelly loam members of this series were mapped.

The soils of the Benoit series have dark grayish-brown, loose, very finely granular surface layers overlying loose, porous, more or less stratified, highly calcareous sandy and gravelly layers. The groundwater levels are maintained at a depth of 4 and 5 feet below the surface, and because of the poor subsoil drainage very little lime has accumulated. These soils have weathered from gravelly drift materials deposited on low terraces where surface drainage is restricted. The parent gravel is better assorted than that in the Pierce soils. Benoit loam was mapped in this county.

The soils of the Webster series have almost black surface soils of finely granular structure. The subsoils are dark brown or yellowish brown, are highly mottled and calcareous, and are heavier textured than the surface soils. The next lower layer is heavy, grayish material more calcareous than that above. In some places the lime in this layer appears to have accumulated as did that in the Fargo soils, but in most places only the lime of the parent material is present. These soils are imperfectly weathered from the heavier, finer-textured drift deposits laid down under conditions of poor drainage. Webster silty clay loam, with a terrace phase, was mapped in this county.

The soils of the Fargo series are similar in general appearance to those of the Webster series. The grayish subsoil layers containing accumulations of lime are better developed as a rule than in the Webster soils. The Fargo soils also differ from the Webster in having developed from the better-assorted heavy-textured glacial deposits on terraces and in lake beds. Fargo silty clay loam, with a meadow phase, and Fargo silty clay were mapped.

The soils of the Moody series have very dark grayish-brown surface soils, mellow and of very finely granular, almost single-grained structure. Beneath this layer is a brown, slightly heavier soil layer which in places has developed some degree of compactness. This is underlain by loose, friable, yellowish-brown material which continues without change to the lower part of the silty deposit from which it was developed. The lime has been leached to a depth varying from 12 to 36 inches, both with and without the appearance of accumulations in the upper subsoil layer. These soils have developed

from uniform silty and fine sandy materials of single-grained structure, generally thought to be deposited and assorted by wind action. Moody silt loam, Moody very fine sandy loam, and Moody fine sandy loam were mapped.

The soils of the Lamoure series are almost black very finely granular soils which become only slightly heavier in texture, more coarsely granular in structure, and lighter colored or mottled with depth. Lime is present in considerable quantities in the subsoils and in places in the surface soils. These soils are imperfectly weathered alluvial deposits occupying flood plains and former lake-bed depressions where drainage is poor. Lamoure silty clay loam, Lamoure silt loam, Lamoure loam, and Lamoure fine sandy loam were mapped.

In the following pages the soils are described in detail and their agricultural importance is discussed; their distribution is shown on the accompanying soil map; and their acreage and proportionate extent are given in Table 4:

TABLE 4.—*Acreage and proportionate extent of soils mapped in Lac qui Parle County, Minn.*

Type of soil	Acres	Per cent	Type of soil	Acres	Per cent
Barnes loam	42,048		Fargo silty clay	2,944	0.6
Heavy-textured phase	229,504	57.4	Lamoure silty clay loam	14,080	2.8
Terrace phase	11,072		Lamoure silt loam	7,040	1.4
Stony phase	2,368		Lamoure loam	6,400	1.3
Barnes silt loam	12,992	3.9	Lamoure fine sandy loam	2,432	.5
Terrace phase	6,272		Benoit loam	1,984	.4
Barnes sandy loam	4,736	1.0	Bearden fine sandy loam	1,152	.2
Barnes fine sandy loam	4,224	.9	Pierce fine sandy loam	3,072	.6
Moody silt loam	16,064	3.2	Pierce gravelly loam	1,024	.2
Moody very fine sandy loam	7,104	1.4	Rock outcrop	320	.1
Moody fine sandy loam	7,872	1.6			
Webster silty clay loam	59,136	13.1	Total	496,640	
Terrace phase	6,080				
Fargo silty clay loam	31,744	9.4			
Meadow phase	14,976				

BARNES LOAM

Barnes loam has a surface soil of very dark grayish-brown loam, very friable and of very fine granular structure. This ranges in thickness from 8 to 14 inches. It retains moisture well, but not so well as Barnes silt loam or heavy-textured loam, and when moist is a little less plastic than those soils. It is underlain by dark grayish-brown or dark-brown heavy loam or clay loam which continues to an average depth of 18 inches. This layer is a little coarser than the surface soil though it still has a very fine granular structure, is retentive of moisture, and is moderately plastic when wet. Lime in appreciable quantities is not present in this layer or in the one above. The next lower layer is light grayish-yellow friable loam or fine sandy clay loam containing large quantities of lime. The amounts of lime are noticeably greater in the upper part of this layer. With depth, the subsoil becomes more yellowish than grayish, coarse sand and gravel are present in greater quantities, and soil particles are more mixed in size. In general, the subsoil of Barnes loam is coarser in texture and more friable than that of Barnes silt loam and the

heavy-textured phase of Barnes loam. Save for this, there is essentially no change with depth in the less-weathered parent soil material.

Variations from the profile described above are of common occurrence. In many places the dark-brown subsurface layer is thicker and deeper, continuing to a depth of 28 or 30 inches. In its lower part it is more brownish, more plastic when wet, slightly more compact when dry, and finely granular in structure. Another variation has a high lime content in the upper part of the subsoil and contains very fine sand or silt in sufficient quantities to give the material a loose, floury structure. Less common variations are associated with conditions of relief and drainage or are influenced by material from other soils. Thus, in association with fine sandy loam and sandy loam upland soils, Barnes loam has a lighter-textured surface soil or subsoil or both than is typical. Such is the character of much of the Barnes loam mapped in Freeland, Manfred, and southeastern Walter Townships. In southeastern Ten Mile Lake Township thin layers or pockets of loose sand and gravel occur in the subsoil. The same subsoil condition exists in north-central Manfred Township, where areas of this soil occur in association with Benoit loam. Areas in sections 13, 14, 22, and 23 of Riverside Township are of this character and the scarcity of bowlders and the more level surface are suggestive of the Bearden soils. In Baxter, southwestern Camp Release, and northeastern Ten Mile Lake Townships Barnes loam occurs in strips intermediate in position between Moody fine sandy loam and Barnes loam, heavy-textured phase. Here the surface soil is lighter textured but the subsoil is as heavy as that of Barnes loam, heavy-textured phase.

In western Perry Township and along Yellow Bank River in Yellow Bank and Agassiz Townships, Barnes loam occurs in distinctly more rolling country than typical. In these areas the surface soil is shallower, and its texture is more variable. Where erosion is very active, the dark-colored surface soil is very thin and in spots has been entirely removed, exposing the lighter-colored material beneath. Coarse drift sand and gravel occur in larger quantities than typical in the subsoil, and in some places gravel and bowlders are abundant in the surface soil. All of these areas, except a few on the steeper slopes, are tillable. The rapid run-off from this land decreases the quantity of water that enters the soil, so that crops suffer quickly in dry seasons. The greater part of this land is used for pasture and hay land. It is somewhat difficut to get a stand of alfalfa and tame-hay grasses, but in seasons of good rainfall very satisfactory yields of hay are obtained.

Areas of Barnes loam range from undulating to rolling. Natural drainage is well established, but the soil is not susceptible to rapid erosion.

Barnes loam occupies an area of 65.7 square miles. Corn and oats are the main crops, and wheat, barley, and rye are raised on much smaller acreages. Timothy is the most popular tame-hay grass, but alfalfa and sweet clover are increasing in acreage. Red clover does well when a stand has been established, but it is started with some difficulty. Crop yields are about the same as those obtained on the heavy-textured phase of the soil. In dry years the heavy-textured

soil produces heavier crops, but in wet years Barnes loam is commonly the better producer. Acre yields of corn average between 30 and 35 bushels but range from 25 to 75 bushels; oat yields average between 40 and 45 bushels but range from 25 to 55 bushels; wheat yields average between 15 and 18 bushels but range from 10 to 30 bushels; the yields of barley average between 25 and 30 bushels but range from 20 to 45 bushels; rye averages between 20 and 25 bushels, but yields range from 15 to 35 bushels; and flax averages between 10 and 12 bushels, with yields ranging from 5 to 15 bushels. The acre yields of timothy range from 1 to 2½ tons, averaging 1½ to 1¾ tons; of red clover from 1 to 3 tons, averaging 2 tons; of clover and timothy mixed from 1 to 2½ tons, averaging 1½ or 2 tons; of alfalfa from 1¾ to 3 tons, averaging 2½ tons; sweet clover yields are a little higher than of alfalfa; and wild prairie hay yields from three-fourths to 1¾ tons, averaging 1 or 1½ tons.

Barnes loam is more easily worked than the heavy-textured phase of the soil. It can be plowed under a little wider range of moisture conditions and requires less draft. Earlier planting is usually possible, and this insures more certain yields, especially of corn.

Crop rotations and practices of fertilizing advocated for Barnes loam, heavy-textured phase, apply equally well to this soil.

From recent transfers of farms consisting largely of this soil, a range in market value from $55 to $125 is indicated.

Barnes loam, heavy-textured phase.—The surface soil of Barnes loam, heavy-textured phase, is mellow very dark grayish-brown or black heavy loam which continues to a depth varying from 10 to 14 inches. When moist the soil is moderately plastic, and when dry it has a very fine granular structure. Between average depths of 10 and 20 inches is very dark or dark grayish-brown heavy loam or clay loam, less mellow, slightly more granular in structure, and a little more plastic when wet than the surface soil. Between average depths of 20 and 30 inches is grayish heavy loam or clay loam which has a larger content of sand than the layers above. This material differs markedly from layers above in containing large quantities of lime, greater even than in the parent soil material below. When wet the soil has a soft, doughy plasticity, and when dry it is of very fine or fine granular structure. Below a depth of about 30 inches is light yellowish-gray clay loam, splotched with grayish, white, yellow, and rust brown. It is friable and has a fine granular structure when dry. When moist it is moderately plastic. The lime content is high. With depth coarse sand and gravel increase in quantity and are intermixed with clay, and the deeper, less-weathered or unweathered parent soil material has a very heterogeneous composition.

In a variation occurring indiscriminately over the area of the soil but perhaps most frequently where the surface textures are lighter and the soil is better oxidized is a grayish-white subsoil abnormally rich in lime. In places it resembles a layer of accumulated lime thicker than typical and in other places the parent soil material with its originally high lime content.

Where this soil is associated with other upland soils it differs slightly in one or more respects. The surface soil typically contains a little less than 40 per cent silt, and the variable quantities of sand

and clay in places cause the texture to approach fine sandy loam or very fine sandy loam and in others to resemble clay loam or silty clay loam. The lighter-textured soil occurs mainly in northwestern Maxwell, Providence, and Freeland Townships, in southeastern Ten Mile Lake Township, and on the uplands immediately bordering the Minnesota River Valley. Along the Minnesota River bluffs the lighter-textured soil is chiefly associated with Moody very fine sandy loam.

The heavier-textured areas of this soil occur in association with the heavier upland soils of other series or on smoother land and show a slightly deeper surface soil of darker color and higher organic-matter content than typical. Such areas are mapped in southwestern Ten Mile Lake, northeastern Cerro Gordo and Perry Townships, and western Lake Shore Township. Also the areas in sections 13 and 14 and in the northern half of section 23 of Riverside Township show this variation. Here there is a scarcity of bowlders and a level surface suggestive of the Bearden soils.

About one-half of the area of the county is of this soil. It is the predominating upland soil in all parts of the county save in Freeland and Walter, the eastern part of Mehurin, the southwestern part of Garfield, the eastern and northern parts of Manfred, the southeastern part of Baxter, and the eastern part of Ten Mile Lake Townships. In Perry, Arena, Madison, Cerro Gordo, and Hamlin Townships it is practically the only upland soil.

Most areas of this soil are gently rolling or undulating. Surface drainage is good, seldom if ever erosional, but often sluggish in the smoother regions. The friability of the subsoil insures well-regulated internal drainage, except when abnormal quantities of water soak into the smoother areas in wet seasons. The soil is seldom if ever water-logged but holds sufficient moisture to retard planting and cultivation in a wet spring.

Barnes loam, heavy-textured phase, is practically all tillable and under cultivation. Corn and small grains are the leading crops, but the soil is suited to the production of practically all the crops common to the county. The farming practices are essentially the same as those mentioned in the description of agricultural methods of the county. Most of the soil is in cultivated crops, and the remainder in hay and pasture land. Tame-hay grasses occupy a considerable proportion of the hay lands. Farms on this soil are well stocked. Hogs are kept in the greatest numbers, cattle, horses, and sheep following in the order named.

Abnormally wet seasons cause greater decreases in crop yields than dry years, owing to the water-holding capacity of the soil. The soil does not bake or crack in dry years if ordinary cultivation is given it. Corn yields 30 or 40 bushels to the acre in a season of well-distributed rainfall. Dry years probably reduce that yield about 5 bushels to the acre and wet years about 10 bushels. During wet years the late plantings seldom produce well-matured ears before frost. Yields varying from 60 to 75 bushels to the acre are reported by many farmers. Such yields are not an average, but they indicate the soil's possibilities. Usual acre yields for the other staple crops are as follows: Wheat, 15 or 20 bushels; oats, 40 or 45 bushels; barley, 25 or 30 bushels; rye, 20 or 25 bushels; and flax, 10 or 12 bushels. The acre

yields of tame hay are: Timothy, 1½ or 2 tons; clover, 2 tons; clover and timothy, from 1¾ to 2 tons; alfalfa, 2½ tons; sweet clover, 2½ or 3 tons; and millet, 2 tons. Prairie hay yields about 1½ tons to the acre.

This soil can be worked under a fairly wide range of moisture conditions and ordinarily is maintained in good tilth without much difficulty. It is better adapted to general farming than any other soil in the county. Cropping to corn and small grains is usually continued for seven or eight years. Tame-hay meadows are maintained from two to five years.

Systematic crop rotations are only occasionally followed. Manure is applied about once in four years. On the narrow crests or knolls where the soil is shallower and lighter, manure is usually applied in greater quantities or more frequently. The only organic matter plowed under, as a rule, is the corn, small grain, and hay stubble. Green-manure crops are not grown to any extent.

Most farms on this soil are well improved. Their market price varies with the state of improvement and nearness to markets, as well as the productiveness. Thus a range from $50 to $125 an acre is indicated by land transfers during 1923 and 1924. During the World War increased activity in land transfers led to prices varying from $175 to $200 an acre.

Many of the existing farm practices which tend to deteriorate the fertility of the soil are inherent in the system of short-term tenancy and in the large size of many farms. Crop rotation and adequate manuring of soils usually call for a more permanent farm management than that practiced under these conditions. The keeping of more livestock will increase the production of manure.

Barnes loam, terrace phase.—The surface soil of Barnes loam, terrace phase, is very dark grayish-brown loam of very fine granular structure. At an average depth of 10 inches this grades into dark-brown coarser loam, slightly more plastic than the soil above when wet and compact and friable when dry. Considerable coarse sand and gravel are present in this layer. Lime does not occur in appreciable quantities above an average depth of about 28 or 30 inches, but below this depth is olive-gray clay loam rich in lime. In many places this layer contains more lime than the deeper material, indicating a normal accumulation of lime. There is little change in the soil with depth through this less-weathered layer to the unweathered soil material.

In areas mapped with this soil the surface soils range in texture from fine sandy loam to heavy loam, and unseparated small areas of fine sandy loam and sand are included. The sandy loam areas are looser in structure and more porous than the typical loam to a depth of 24 inches. Such areas occur along Yellow Bank River in west-central Walter Township.

Barnes loam, terrace phase, occurs along the Minnesota River Valley, on benches ranging from a few feet to 75 feet above the flood plain. The largest areas of the soil occur on the higher benches in Hantho, Lac qui Parle, Agassiz, and Yellow Bank Townships. The areas are flat, undulating, or very gently sloping. A series of slight ridge elevations running parallel to one another and giving the surface a wavelike appearance offers the only variation from an other-

wise flat surface. The terrace phase differs from typical Barnes loam essentially in topographic position and in its higher content of gravel and bowlders.

The surface drainage is not well developed in this soil, but the major drainage systems of the county give the smaller individual areas good drainage. Standing water after rains does not occur on any except the areas on the larger of the level benches or in slightly depressed areas in back-terrace positions. The internal drainage is commonly well regulated. A tendency to drought is not evident in the soil, except on the terrace slopes and the immediate crest of the bluffs.

Barnes loam, terrace phase, has a total area in the county of 17.3 square miles. It is not so easily cultivated as typical Barnes loam because of the greater quantity of bowlders present. Mapped with this soil are numerous areas in which the surface is too bowldery for any practical use save as pasture land. These areas have been indicated on the soil map by stone symbols.

This soil is not in a high state of cultivation. The pasture acreage is greater than the cropped acreage. All the staple crops of the county are grown. Corn, oats, and tame hays occupy smaller relative acreages than on the average farm of the county. Building improvements on these farms are also below the average.

Values for this soil can not be exactly stated. Two transfers in the spring of 1924, involving 40-acre and 80-acre tracts containing this and similar soils, were at $87.50 and $43.30 an acre, respectively.

Methods of cropping and cultivation in use and to be recommended for this soil are similar to those described for the upland Barnes loam.

Barnes loam, stony phase.—In areas of Barnes loam on steep slopes or narrow-crested, high, elevated knolls or ridges there are in many places on the surface and in the soil an abundance of bowlders. Areas in which bowlders are so numerous on the surface as to make cultivation a difficult and generally impractical task have been indicated on the soil map as the stony phase of the soil. Such areas comprise 3.7 square miles.

The soil of the stony phase of Barnes loam is similar to the typical soil, differing mainly in the more mixed texture of the soil layers and the greater quantities of coarse sand and gravel present. Occupying steeper slopes, the surface soil of the stony phase is more eroded, pebbly surfaces or lighter-colored brown subsoil layers being exposed in many places. As mapped, the stony phase contains areas, too small to map separately, of typical Barnes loam, Pierce fine sandy loam, and Pierce gravelly loam.

The steep slopes to the Minnesota River Valley, many of them bare of trees and supporting only a sparse stand of prairie grasses, are typical of this phase of soil. Areas occur also in Lac qui Parle Township on the bluffs of Lac qui Parle River, and in Yellow Bank and Agassiz Townships, along Yellow Bank River. Small individual areas occupying narrow-crested elevations are scattered over the more rolling sections of the western part of the county. The largest area is in section 19 of Garfield Township.

Pasturing is the only use to which the stony phase of Barnes loam is put. The steep areas will always be best utilized for this purpose. Small areas not too stony could well be cultivated and man-

aged similarly to typical Barnes loam or to Pierce fine sandy loam. Large areas of the stony phase on a farm detract greatly from its market value.

BARNES SILT LOAM

The surface soil of Barnes silt loam is mellow, very dark grayish-brown or black silt loam to an average depth of about 14 inches. It is friable and has a very fine granular structure, but when wet it assumes a moderate degree of plasticity. Below this layer, to a depth of about 22 inches, is dark grayish-brown heavy silt loam or clay loam which is a little more plastic when wet and less friable and more coarsely granular when dry than is the surface soil. Between depths of 22 and 30 inches is grayish heavy silt loam or clay loam, coarser in texture than the soil above and containing large quantities of lime in contrast to the material above, which is poor in lime. When dry, the structure is very finely or finely granular, and when wet the material is softly plastic. Below this layer is clay loam, light yellowish gray splotched with grayish white, yellow, and rust brown. When wet, this layer is moderately plastic. The lime content is high, but seemingly lime is not so concentrated as in the layer above. With depth, larger quantities of coarse sand and gravel are intermixed, and the material below the zone of surface weathering has, in general, a more heterogeneous composition.

In the southwestern part of Manfred Township, the soil contains coarser sand in the surface layer. The dark-colored soil is only 8 or 10 inches thick, and the layer beneath has a greater clay content and is more plastic when wet than the same layer in typical areas.

This soil covers 20.3 square miles in the county. It occupies more smoothly undulating areas than Barnes loam, heavy-textured phase, and is very similar in surface features to Moody silt loam, with which soil the most typical areas are associated. The layers above the layer of accumulated lime common to both of these soils are almost identical, the main difference being in the content of coarser materials at a greater depth.

The natural drainage of Barnes silt loam is a little poorer than that of Barnes loam, heavy-textured phase. Although standing water seldom causes damage, surface moisture does not allow working the fields under a wide range of moisture conditions.

This soil is practically all cultivated. It is cropped much as is Barnes loam, heavy-textured phase. Yields are about the same on the two soils and are limited by the same seasonal factors. Improvements in farming practice to be recommended for one soil are equally applicable to the other. Farms on this soil are well improved and are considered among the best in the county. Few land transfers have been made in the last few years, and any valuation at present would be only a rough estimate.

Barnes silt loam, terrace phase.—Barnes silt loam, terrace phase, has a 12-inch surface layer of very dark grayish-brown or black friable silt loam of very fine granular structure. The material is slightly plastic when wet. Between depths of 12 and 26 inches is light grayish-yellow heavy silt loam or silty clay loam, friable when dry but plastic when wet. Large quantities of lime are present, in marked contrast to the surface soil. Below a depth of 26 inches is

light grayish-yellow silty clay loam or silty clay, stained or mottled with gray, yellow, and rust brown and heavier in texture and slightly more plastic than the layer above. Below this layer no great changes occur, save for the greater variation in the proportions of sand and clay present in the deeper unweathered drift materials.

This soil closely resembles Barnes loam of the uplands but has a slightly more compact, finer-textured subsoil. There is also in Barnes silt loam, terrace phase, a larger quantity of bowlders on the surface and in the soil. Areas where bowlders are so abundant as to interfere with cultivation have been indicated on the soil map by stone symbols.

Barnes silt loam, terrace phase, occurs almost entirely on the benches adjacent to the Minnesota River Valley. Most of it is on the first benches above the bottom lands, on terraces lower than those occupied by the terrace phase of Barnes loam.

Owing to the flatness of the areas, surface drainage of this soil is rather slow in all save the small isolated terrace remnants of the flood plains. Internal drainage is not efficient enough to carry off the surface water after heavy rains, and water stands for moderately long periods. When rainfall is normal in amount and distribution, the moisture conditions in the soil remain good.

Barnes silt loam, terrace phase, occupies an area in the county of 9.8 square miles. The greater part of the soil is used for pasture and wild-hay land. This soil is more difficult to cultivate than Barnes loam, heavy-textured phase, and because of the poorer surface drainage the surface soil is too moist for cultivation for a longer period after rains. The greater number of bowlders make the soil difficult to bring under cultivation. Its utilization is very similar to that of Barnes loam, terrace phase. Compared to that soil, it produces later-maturing crops, and crop yields are subject to more damage in wet seasons. On the other hand, this soil withstands longer periods of dry weather than Barnes loam, and pastures remain in better condition. All the staple crops are grown. Yields in average years are the same as on Barnes loam, but in wet years they are a little lower. Methods of cropping in use and to be recommended for Barnes loam, heavy-textured phase, apply also to this soil.

BARNES SANDY LOAM

Barnes sandy loam is very dark grayish-brown or black sandy loam to an average depth of 12 inches. It is loose when dry and moderately adhesive when wet. Between depths of 12 and 26 inches is loose, loamy sand containing considerable coarse sand and gravel. When wet the particles adhere slightly. The layer contains small quantities of lime. The color varies from very dark brown in the silt and clay aggregates or earth-coated sand particles to grayish white in the lime-coated pebbles, giving the soil a pepper-and-salt appearance. Between average depths of 20 and 40 inches is light yellowish-gray loose loamy sand which adheres slightly when wet. It is rich in lime and commonly appears as a layer of accumulated lime, though in many places the lime appears to continue downward in about the same quantity. Below this layer the soil materials are lighter in color, are more stained, and are of more variable texture,

with no visible assortment of particles. A slight or moderate degree of adhesiveness is maintained. This is the less-weathered parent soil material. It consists of soil particles ranging from clay to coarse sand and gravel but predominantly is coarse in texture. The depth of leaching, as shown by the depth at which appreciable quantities of lime are present, is variable but is commonly 2 feet or less. Barnes sandy loam seems to be leached to a slighter depth than Barnes fine sandy loam, with which it is largely associated.

Areas of this soil occupying undulating or gently rolling land in association with Barnes fine sandy loam resemble the more deeply leached fine sandy loam. Such an area occurs in section 1 of Manfred Township. The more rolling areas of the soil are commonly associated with Pierce fine sandy loam. In such areas more gravel is present in the subsoil and the surface soil is a little shallower and finer in texture. Pockets of very loose gravel and of heavy silt and clay make the subsoil variable. However, it averages heavier in texture and is more retentive of moisture than that of Pierce fine sandy loam. Barnes sandy loam is mapped also on the gently rolling slopes from high promontories of Pierce gravelly loam to the undulating lands below. In sections 16 and 27 of Freeland Township are areas of this kind. The surface soil is subject to some slope wash, which serves to vary its texture from loamy sand to light loam.

The surface of Barnes sandy loam ranges from undulating to rolling. In association with Barnes fine sandy loam and Barnes loam this soil commonly occupies high, elevated, more rolling positions. In association with Pierce fine sandy loam and Pierce gravelly loam it generally occupies lower slopes or less rolling lands.

The surface drainage is not erosional but is usually too rapid to allow adequate moisture to sink into the soil. The internal drainage is so thorough that the soil water is not held in sufficiently large quantities to carry crops through dry periods. On the average, this soil is not considered so droughty as Pierce fine sandy loam, but it is less retentive of moisture than the heavier soils of the Barnes series.

Barnes sandy loam occurs almost entirely in the western part of the county, especially in the four townships of Manfred, Freeland, Mehurin, and Walter. In crop adaptation, crop yields, and methods of cropping it is similar to Barnes fine sandy loam. Its limiting factors in production are essentially the same: namely, a tendency to droughtiness and too low an organic-matter content to support continuous cropping. It is subject to drifting under cultivation if it is not thoroughly mulched and kept sufficiently moist. In well-manured and thoroughly cultivated fields no reduction of yield from drought occurs except in unusually long, dry periods. In wet years, yields are more satisfactory than on the heavier soils. Estimated normal acre yields for the various crops are: Corn, 30 bushels, with yields ranging from 20 to 50 bushels; wheat, 10 or 15 bushels, ranging from 8 to 25 bushels; oats, 30 or 35 bushels, ranging from 20 to 50 bushels; barley, 20 or 25 bushels, ranging from 15 to 40 bushels; rye, 20 bushels, ranging from 15 to 50 bushels; flax, from 5 to 9 bushels; clover and timothy from 1 to 1½ tons; prairie hay three-fourths ton; alfalfa, 2 tons, ranging from 1 to 2¾ tons; and sweet clover from 2 to 2½ tons.

Farms made up of this soil and other fine sandy loam soils are not so well improved as farms on the heavier soils. A fair valuation of the land is not easy, as scarcely a farm consists entirely of this soil. A 1924 transfer of one farm consisting of this and similar soils, located 10 miles from the nearest market, involved a consideration of $68 an acre.

BARNES FINE SANDY LOAM

The surface soil of Barnes fine sandy loam is very dark grayish-brown or black fine sandy loam, loose in structure when dry but mellow, soft, and moderately cohesive when wet. When dry the exposed surface soil is subject to drifting by the wind. This layer continues to a depth of about 10 or 12 inches and is underlain, to a depth of about 22 inches, by very dark grayish-brown fine sandy loam, somewhat looser in structure and less well supplied with organic matter than the surface soil. Between average depths of 22 and 38 inches is dark-brown or very dark-brown heavy fine sandy loam or light loam. When wet this layer is moderately plastic, but when dry it is practically as loose in structure as the layers above. No appreciable quantities of lime are present in this or in the layers above. Below a depth of 38 inches is loam or clay loam containing considerable coarse sand and gravel. When dry the material is friable and somewhat loose, but when wet it is a little more plastic than the soil above. Its color is brown or yellowish brown, stained with gray and rust-brown. Lime is present in considerable quantities, frequently in concretionary form or as a coating on the sand and gravel. There is a slight accumulation of lime in the upper part of the layer. With depth little change in the character of the soil material is noted, except for a greater variation in color and in the texture of the soil particles making up the body of the less-weathered parent material. In many places the lime-bearing layer does not occur above a depth of 40 or 50 inches below the surface.

Variations in the thickness of the soil layers just described as well as in the depth at which they occur account largely for the differences in the soil as it is mapped. Minor differences in texture and structure also occur. In central Walter Township the soil varies over considerable acreages and is perhaps the most spotted land of this type in the county.

Areas of Barnes fine sandy loam vary from undulating to rolling. The soil commonly occurs in small areas in association with other soils, principally Barnes loam, Barnes sandy loam, and Pierce fine sandy loam. It generally occupies lower lands or slopes below Barnes sandy loam and Pierce fine sandy loam and the same or slightly higher more rolling elevations in association with Barnes loam. In association with Barnes sandy loam and Pierce fine sandy loam it commonly has a lighter-textured subsoil than typical, and in association with Barnes loam and Barnes silt loam the subsoil may be heavier. In a few places the subsoil is fairly uniform in texture, containing only negligible quantities of gravel. In this respect it resembles the subsoil of Moody fine sandy loam. An area in section 21 in the extreme northern part of Yellow Bank Township is perhaps the only notable example of such a variation in the county.

Barnes fine sandy loam has good surface drainage and good or excessive internal drainage. The greater part of it is cultivated, and the remainder is in hay or pasture land. Occurring in small individual patches with a total area in the county of only 6.6 square miles, the soil is not important agriculturally. It is recognized as a drier, warmer, and earlier soil than the loam and silt loam members of the Barnes series and preferable to them because of the earlier maturing of crops. However, manuring is necessary if damage from drought is to be avoided and certain yields obtained. Also, thorough cultivation is required to maintain a surface mulch which will not be subject to drifting. The soil can be worked under a wide range of moisture conditions. In wet years it often yields better than the heavier soils.

This soil produces practically all the crops common to the county. Catches of red clover are more difficult to obtain than on the heavier soils, but alfalfa and sweet clover do as well as or better than on those soils. Although crop yields are often higher in a wet year than on Barnes silt loam and heavy-textured loam, the decreased yields in a dry year result in a little lower average crop yield on this soil. Under systematic crop rotation, adequate manuring, and proper cultivation Barnes fine sandy loam can be counted on as a productive soil. In no place does it comprise a whole farm and in few places a whole field. Hence the farm practices for this soil do not differ from those for other soils on the farm.

The market value of this soil can hardly be estimated, owing to its spotted occurrence. In only a few places does it occupy a large enough area on a farm to be a factor in appraisal.

MOODY SILT LOAM

The surface soil of Moody silt loam is very dark grayish-brown mellow silt loam or loamy silt approaching very fine sandy loam. It is very finely granular in structure, is firm, and is retentive of moisture. At a depth of about 12 or 14 inches the color changes to a lighter shade, the material becomes more granular and when wet more plastic, but the soil is still very dark grayish brown or very dark brown and of very fine granular structure. The texture is heavy silt loam or very fine sandy loam. Below a depth of about 22 inches is grayish-yellow heavy silt loam or very fine sandy loam containing large quantities of lime. The abundance of lime distinguishes this layer from the soil above and the less limy soil below and indicates an accumulation of lime. Below a depth of 32 inches is yellowish-brown heavy silt loam stained gray, yellow, and rust brown and containing increased quantities of clay and very fine sand particles. It is friable when dry but when wet is plastic. Save for increased quantities of very fine and fine sand little change occurs above a depth of 4 or 5 feet, where the heavy-textured glacial drift similar to that underlying the Barnes soils is found. It contains an admixture of sand and gravel. The absence of gravel and coarse sand particles in the soil, together with a more brownish surface soil, distinguishes the Moody soils from the Barnes. Boundaries between the two are more or less arbitrary, however, because of the gradual change from a thick to a thin mantle of this stone-free upper layer.

Moody silt loam occurs in the upland region bordering the Minnesota River Valley. The area, as mapped, includes soils varying from typical in two main respects, the absence of a layer of lime accumulation and the development of a compact subsurface layer. Soils showing a layer of lime accumulation do not generally have any marked compact layer. Where the compact layer occurred the soil was leached of lime to a depth of 4 to 5 feet. The occurrence of this compact soil layer is very spotted and is seemingly unrelated to moisture or relief conditions.

Moody silt loam occupies gently rolling or undulating land. An area in section 19 of Agassiz Township, associated with Barnes loam, is an example of the more rolling land. The smoothest area is that in sections 1 and 12 of Lake Shore Township and sections 7 and 18 of Lac qui Parle Township. Here the black soil is slightly darker colored, a little deeper, and of heavier texture, resembling silty clay loam. The drainage conditions are poorer than typical. In such areas the soil resembles Webster silty clay loam in its poorly oxidized subsoil and Barnes silt loam in its less uniform pebbly lower subsoil layer.

Moody silt loam in the county occurs principally in the uplands bordering the Minnesota River Valley. Over most of the soil the natural drainage is well regulated. Standing surface water seldom causes crop damage. Because of its friability and more or less open structure the soil can be worked under a reasonably wide range of moisture conditions.

The largest areas of this soil, and about half its total area, are in Lake Shore and Hantho Townships. All of the land is cultivated. The improvements in the earliest-settled parts of the county are better than on similarly productive soils elsewhere. In agricultural value this is rated among the best soils in the county. All the staple crops of the county are produced, and yields are similar to or perhaps a little higher than on Barnes loam, heavy-textured phase. Practices of soil management followed and recommended for heavy-textured Barnes loam apply also to this soil.

MOODY VERY FINE SANDY LOAM

The surface soil of Moody very fine sandy loam is very dark grayish-brown very fine sandy loam to a depth of 8 or 10 inches. It is very finely granular and loose structured when dry and is moderately adhesive when wet. Underlying this layer to an average depth of 16 inches is very dark-brown heavy very fine sandy loam, more granular than the surface soil and slightly plastic when wet. Between depths of 16 and 24 inches is heavy very fine sandy loam or very fine sandy clay, which is dark yellowish brown or olive and is very finely granular in structure. When wet it is slightly plastic. In these first three layers lime in appreciable quantities is not present, but between depths of 24 and 32 inches is looser-structured, floury, grayish very fine sandy loam containing large quantities of lime. When wet this layer is very slightly plastic but when dry it is slightly compact in place but floury when broken up. Below a depth of 32 inches is light grayish-yellow very fine sandy loam, more cloddy than the floury layer above and looser in structure. It

retains moisture well and contains considerable lime. This material continues to a depth of 4 or 5 feet without much change and is underlain by the more variable, heavier-textured pebbly substratum.

The depth to which leaching has been effective, as indicated by the depth at which lime occurs in appreciable quantities, varies widely. Above a depth of 2 feet lime is rarely present in any noticeable quantity; below a depth of 2 feet there may be the typical accumulation or the quantity of lime may gradually increase with little or no evidence of accumulation within any one layer. Again, in places, lime in appreciable quantities may not be found above a depth of 4 feet. Lime generally occurs at such a depth where the soil is sandier and looser in structure than typical, approaching, in character, Moody fine sandy loam.

As compared to Moody silt loam the subsoil of this soil generally has a high content of very fine and fine sand. In places, however, the subsoils are similar, and the sandier texture of the surface soil may be the only difference. The occurrence of a subsurface layer of compact fine sandy clay or clay loam in areas of this soil is as spotted as are areas of the silt loam and is similarly unrelated to relief or drainage conditions.

Moody very fine sandy loam occupies the well-elevated but gently rolling crests of the uplands bordering the Minnesota River Valley. In association with Moody fine sandy loam and Moody silt loam this soil commonly lies on gentle slopes below and in an intermediate position between the fine sandy loam and the silt loam. In association with Moody silt loam alone, Moody very fine sandy loam occupies the higher and more elevated and rolling areas.

The natural drainage of this soil is well regulated. Where the subsoils are more porous than typical the moisture during dry spells is insufficient to maintain the best crop growth. Damage from long dry spells is slight as a rule, however, and the soil is not considered droughty as are parts of the Moody fine sandy loam.

The largest areas of Moody very fine sandy loam are in the northern part of Lake Shore Township and Hantho and Lac qui Parle Townships. It occurs in the earlier-settled part of the county, and the farms are better improved than the average farm of the county. The cropping of this soil has been heavier than of Barnes silt loam, but productiveness has been maintained. It is recognized that this soil combines the fertility of Moody silt loam and the earlier crop-maturing power of the lighter-textured soils, as does no other soil in the county. It produces well under a wide range of seasonal rainfall and of length of the frost-free season. Only in dry years does Moody silt loam outyield it, and only in very wet years does Moody fine sandy loam produce better.

All the staple crops of the county are grown on this soil, and crop yields average a trifle more than those given for Barnes loam, heavy-textured phase. Cropping methods used and recommended are the same for these two soils. Farms consisting of this soil have a value similar to or a little higher than those made up of the silt loam of the series. In their present state of improvement and productiveness, these farms are considered among the most valuable in the county.

Results of mechanical analyses of samples of the surface soil and subsoil of Moody very fine sandy loam are given in Table 5:

TABLE 5.—*Mechanical analysis of Moody very fine sandy loam*

No.	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*
321829A	Surface soil, 0 to 10 inches	0.0	1.0	0.8	9.6	30.8	40.5	17.3
321830A	Subsoil, 10 to 26 inches	.0	.2	.0	2.4	26.4	54.4	16.9
321831A	Subsoil, 26 to 40 inches	.0	.0	.4	5.8	41.2	42.4	10.1

MOODY FINE SANDY LOAM

The surface soil of Moody fine sandy loam is very dark grayish-brown loose loamy fine sand or fine sandy loam. In structure it is single grained, or the loose material may contain soft, imperfectly formed granules. Below an average depth of 10 or 12 inches is olive-gray or grayish-brown loose single-grained fine sandy loam which contains more imperfect granules than the surface layer and which is also slightly finer in texture. The surface soil contains no appreciable quantities of lime, but it is slightly calcareous. An increase in the lime content with depth and a slightly denser structure bring about a change, at an average depth of 26 inches, to light grayish-yellow floury very fine sandy loam. This layer contains more lime than those above or below, and the material, in position, is slightly denser and less porous. This layer is commonly from 6 to 10 inches thick and is underlain by light grayish-yellow or olive-gray loamy very fine sand or loose very fine sandy loam containing considerable lime. This material continues without change to the underlying heavy calcareous drift materials occurring at a depth varying from 5 to 10 or more feet. The entire soil is free from gravel and consists of well-assorted fine sand or very fine sand with small quantities of silt. In this respect it differs from Pierce fine sandy loam, Barnes fine sandy loam, and Bearden fine sandy loam. Gravel and bowlders generally occur only in the heavy drift substratum.

Over the area of this soil, as mapped, minor variations occur in the color, thickness, and compactness of the heavier layers. In different areas the sand may range in texture from fine to very fine. The depth to which lime has been leached and the degree to which it has accumulated in any layer also varies considerably. In one extensive variation, the texture becomes lighter downward and between depths of 30 inches and several feet is very fine loose sand. This soil is porous and somewhat droughty. Lime occurs below a depth of 12 inches, but no accumulation can be seen in any layer. In another variation a rich-brown layer occurs below a depth of 12 inches. The structure is granular and the texture is heavier than typical. This layer grades downward into loose, olive-gray, structureless fine sandy loam. Lime occurs below a depth of 40 inches, but no accumulation at any depth could be detected.

A large part of the Moody fine sandy loam, as mapped, is the soil described as typical, but each of the variations is represented by considerable areas. In this county the typical soil is probably less extensive than the soil having a deeply leached subsoil and no compact layer. Moody fine sandy loam is distinguished from the Barnes soils by the more uniform, stone-free upper soil layers.

The surface of this soil ranges from gently rolling to rolling, and a few areas are undulating. Moody fine sandy loam occurs with the other Moody soils, solely on the uplands adjacent to the Minnesota River Valley. It occupies the higher elevations or crests of divides whose lower slopes are covered with heavy soils. The axes of ridges on which it occurs commonly run northwest-southeast, parallel to the course of Minnesota River.

The natural drainage combines both surface and internal drainage too well developed to retain in the soil sufficient moisture to protect crops from the longer dry spells. In ordinary seasons, crops are only slightly damaged by lack of moisture, except on the soils of more open, porous structure than typical. The soils with a heavy, compact layer withstand drought well if they are thoroughly cultivated and if manure is applied.

A large part of the Moody fine sandy loam is in cultivated crops. It is recognized as less fertile and more in need of regular applications of manure than the heavier soils, but it is also known to be a soil which warms up earlier in the spring, is more easily maintained in good tilth, and ordinarily matures crops earlier than the heavier soils. These advantages are most important in a season which is wet and backward, as in such a season the small grains on the heavier soils are more apt to be damaged by rust and to produce stalk at the expense of grain, and corn is more apt to be soft at the time of killing frosts. The pasture, forage, and hay yields on Moody fine sandy loam are decreased by dry periods in the growing season. Red clover is more affected by a lack of moisture than alfalfa and sweet clover. Bluegrass burns out badly in pastures during the longer dry spells and can not be too closely pastured.

The average yields of the various crops are about the same as those given for Barnes fine sandy loam and are a little less than those given for Barnes loam.

The farms on Moody fine sandy loam are fairly well improved. The soil has been farmed a little longer than the fine sandy loam soils in the western part of the county. The present farm practices followed and to be recommended are the same as those given for Barnes loam. The market value of the soil is the same or a little less than for Barnes loam.

WEBSTER SILTY CLAY LOAM

The surface soil of Webster silty clay loam is very dark grayish-brown or black friable silty clay loam, slightly plastic when wet and of very fine granular structure when dry. This grades, at a depth varying from 12 to 16 inches, into very dark grayish-brown silty clay loam which is moderately plastic when wet and is very fine or finely granular in structure when dry. Variable small quantities of sand and gravel are present. Below a depth of about 20 inches the soil is gray or olive-gray, plastic, moderately friable silty clay loam or silty clay. When dry the structure is very finely or finely granular. Sand and gravel are present in small quantities but are more abundant than in the layers above. Lime is present in very small quantities. This layer is underlain, at a depth of about 28 inches, by light-grayish finely granular plastic silty clay, mottled brown, yellow,

and rust gray. Larger quantities of lime occur in this layer than in the unweathered parent material, and an accumulation is indicated. Little change in the material occurs with depth, except that the mottling is more noticeable and small but increasing quantities of sand and gravel are present. Only a few bowlders occur on the surface and in the soil.

In the more rolling region in the northwestern and north-central parts of the county, Webster silty clay loam occupies small depressions restricted in drainage. In such areas the soil, in places, has a sandy, rather porous substratum which gives better internal drainage than typical and accounts for the fact that these areas are seldom if ever saturated for any length of time. Thus while both surface and internal drainage of this soil are poorly developed, they are regulated so that water stands on the surface for only very brief periods. The poorest-drained areas occur in association with the meadow phase of Fargo silty clay loam. The soil in such areas is black to a depth varying from 20 to 36 inches, and the subsoil is dark gray or black when wet. Drift sand and gravel are not present in appreciable quantities above an average depth of 40 inches. Areas in Lake Shore Township are good examples of this variation from the typical soil. The soils on the more rolling uplands adjacent to Webster silty clay loam are almost entirely heavy loam or clay loam.

A lighter-textured surface soil ranging from silty clay loam to heavy loam occurs where Barnes loam and Barnes fine sandy loam border the depressions. Perhaps one-third of this soil is of this character, the largest areas being in Freeland, Baxter, Manfred, and Walter Townships. In association with adjacent uplands of fine sandy loam or sandy loam, the subsoil is spotted in many places with thin layers of loose sand, of gray or bog-iron color. Such variations generally occur above a depth of 3 or 4 feet, but the material below is typical of Webster silty clay loam. Such is the character of a considerable portion of the soil mapped in Freeland and eastern Manfred Townships. On such areas are a few very small unproductive spots, locally known by the farmers as alkali spots. These spots were observed in greatest numbers in Freeland Township. They are of insignificant total area, but because of their unproductiveness they draw attention.

Webster silty clay loam occupies the flatter, more depressed uplands over the county. More than half the soil is in Ten Mile Lake, Freeland, Baxter, Maxwell, Augusta, Manfred, and Garfield Townships. There is little or no surface drainage. The soil most commonly occurs in narrow, sluggish upland drainage basins, but a few enlarged, depressed areas are around the heads of drainage basins or adjacent to stream courses. In the wider drainage basins in which the Fargo soils occur in the lower parts, Webster silty clay loam commonly occupies gentle slopes intermediate in position between the Fargo soils and the Barnes soils of the undulating or rolling uplands. In Freeland and Manfred Townships areas occupy the whole width of slightly depressed, fairly wide basins. A few areas occur on flattened parts of the upland, not depressed below the adjacent levels. Such an area is in section 9 of Maxwell Township.

Open ditch and tile drainage have improved a considerable area of the Webster silty clay loam. These improvements rectify the poor

drainage limiting crop yields in normal years, but in rainy years yields are still reduced. Owing to the moisture retained in this soil and the large quantity of organic matter in the surface soil, the crops are usually of ranker stalk and are later in maturing than crops on the better-drained lighter-textured upland soils. The soil can not be worked under so wide a range of moisture conditions as well-drained soils. Planting as early as possible is necessary for the most satisfactory crop yields, and hence fall plowing is recognized as the best practice.

Cropping depends on the improvement made in drainage. The poorer-drained areas are devoted to the production of pasturage and wild hay. Bluegrass pastures are usually better than on the lighter-textured soils. On the better-drained areas all the staple crops of the county are grown. This is a better soil for red clover than the Barnes soils, but sweet clover produces too rank a growth. Yields of other crops are more uncertain than on the Barnes soils. Small grains lodge occasionally, and rusts and smuts do more damage than on higher soils. Corn yields average about 30 bushels to the acre, ranging from 25 to 75 bushels; wheat between 10 and 15 bushels, ranging from 8 to 30 bushels; oats 40 bushels, ranging from 25 to 55 bushels; barley 25 bushels, ranging from 15 to 40 bushels; rye between 15 and 20 bushels, ranging from 8 to 30 bushels; flax 10 or 12 bushels, ranging from 5 to 18 bushels; clover between 2 and 2½ tons; timothy 1¾ tons; clover and timothy mixed between 1¾ and 2 tons; alfalfa between 2 and 2¼ tons; sweet clover between 2½ and 3 tons; and wild hay 1¾ tons.

Sod land is usually a little intractable during the first year of cultivation. Flax is a common crop on virgin sod plowed for the first time. Frequently moderate quantities of organic matter, such as manure, in addition to crop stubbles improve the physical condition of the seed bed. Manure is applied in less quantities and less frequently than on the lighter upland soils, and the soil is more continuously cropped to corn and small grains. When the unproductive "alkali spots" are large enough to justify improvement, tile drainage, heavy applications of manure, applications of superphosphate (acid phosphate) and deep plowing are measures which prove beneficial.

The market value of this soil, where drainage is adequate, is as high as or higher than that of Barnes silt loam. In the present average state of the drainage the value is lower, however.

Webster silty clay loam, terrace phase.—Occurring on bench positions adjacent to the Minnesota River Valley is a soil which differs slightly from typical Webster silty clay loam. It has a more plastic subsurface soil and subsoil and, in places, the surface soil is moderately plastic when wet. The surface layer and the calcareous subsoil are more coarsely granular than typical. Stone and rock fragments are intermixed with the subsoil in variable quantities. Bowlders occur in greater numbers than in the typical soil but are not sufficiently numerous to make cultivation difficult. Lime is present in moderate quantities in the surface and subsurface layers and in large quantities in the upper part of the subsoil, where it presents more marked evidence of accumulation. Some gypsum is present in places in the

subsoil. Below the heavy subsoil, at a depth varying from 3 to 5 feet, is a sandy or gravelly layer which may be porous but which is ordinarily clayey and retentive of moisture.

Included with this soil in mapping are areas occurring on the gentle slopes to the flood plains of Minnesota River and in the basins of constructional valleys bordered by higher terrace and upland soils. The largest area of this kind is in Lake Shore Township. Like the meadow phase of Fargo silty clay loam this soil is black to a depth of 40 or more inches. The lower layers, below an average depth of 30 inches, are dark gray when dry but black when wet. The entire soil is in most places rich in lime, which increases in quantity with depth, and gypsum is present in places. As a rule, coarse sand and gravel occur in negligible quantities above a depth of 30 inches and below that depth are not so abundant as in the subsoil of the typical soil. The drainage is poorer than typical, and the heavy surface soil is more intractable. Practically all of this variation is in wild hay and pasture land.

In small areas of the terrace phase of Webster silty clay loam, an abundance of bowlders is exposed on the surface. For that reason the areas are difficult to put under cultivation and are used only for pasture land. Such areas are indicated on the soil map by stone symbols.

This soil occurs on benches or terraces in association with the terrace phases of the Barnes soils. It occupies the poorer-drained, slightly depressed areas of the terrace, the largest area being in Agassiz Township. Half of it occurs on high benches and half in deeper constructional valley basins. About one-half of the areas occurring on the benches is in grain crops, principally corn. In value, utilization, and management this phase of soil is similar to the typical soil. It is unimportant agriculturally.

Results of mechanical analyses of samples of the surface soil, subsurface soil, and subsoil of typical Webster silty clay loam and of the surface soil and subsoil of Webster silty clay loam, terrace phase, are given in Table 6:

TABLE 6.—*Mechanical analysis of Webster silty clay loam*

No.	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*
321809	Surface soil, 0 to 6 inches	0.5	1.9	1.8	9.9	16.1	48.6	21.4
321810	Subsurface soil, 6 to 20 inches	.4	1.6	.8	8.4	15.9	47.6	24.1
321811	Subsoil, 20 to 28 inches	.4	2.0	1.6	9.2	24.2	40.3	22.6
321812	Subsoil, 28 to 40 inches	1.0	3.2	1.9	9.4	15.2	47.8	21.5

Mechanical analysis of Webster silty clay loam, terrace phase

No.	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*
321840	Surface soil, 0 to 12 inches	0.5	6.3	5.3	15.3	11.5	38.3	23.3
321841	Subsoil, 12 to 24 inches	.8	4.7	3.8	15.6	16.7	36.7	22.1
321842	Subsoil, 24 to 40 inches	1.4	5.3	2.1	8.4	11.8	43.1	28.2

FARGO SILTY CLAY LOAM

The surface soil of Fargo silty clay loam is black silty clay loam of very fine granular structure, friable when dry but slightly plastic when wet. At a depth of 8 or 10 inches this grades into black heavy silty clay loam of fine granular rather than very fine granular structure. This layer is plastic when wet. These two upper soil layers are rich in organic matter, and small but appreciable quantities of lime are present. Between average depths of 16 and 30 inches is olive-gray silty clay, mottled gray, yellow, and rust brown, and containing considerable lime. Between depths of 30 and 40 inches is light-gray silty clay, mottled yellow and rust brown, and containing high percentages of lime, some in concretionary form. In this layer and the one above are small quantities of coarse sand and gravel. These coarser materials are hardly noticeable in the two upper black soil layers, although small quantities are present. Below a depth of 40 inches the coarse sand and gravel increase in quantity and are embedded in plastic silty clay or clay. The color is grayish, but the layer is more mottled than the lime layer above. Lime is abundant but appears to be well distributed.

Between Florida and Canby Creeks are large areas of Fargo silty clay loam in which so-called "alkali spots" are common. The subsoils here are exceptionally rich in lime, and considerable gypsum is present. An area in Lake Shore Township is more deeply dissected than typical and is bordered by bluffs from 30 to 50 feet above it. Here drift bowlders are more frequently exposed and the drift still occurs in places at a slight depth. Fargo silty clay loam here closely resembles Webster silty clay loam, terrace phase, which adjoins it on the southeast in Hantho Township in this same valley. Large areas occupy former lake or marsh positions in Madison and Ten Mile Lake Townships. The surface soil of these areas varies in texture from clay loam to silty clay, in thickness from 1 to 3 feet, and in present drainage conditions from very poor to good. The better-drained areas are adjacent to the open artificial ditches which serve as drainage outlets. Small areas of soil similar to the meadow phase are included in these areas as mapped. A 2-inch or 3-inch surface layer of sandy loam occurs in the southern part of the former bed of Ten Mile Lake near its inlet.

The soil material from the surface downward is very retentive of moisture. This makes internal drainage poor, as the soil occurs in flat depressions where surface drainage is also poor. Standing water remains unabsorbed for a few days after rains, and in wet seasons the land is so frequently flooded as to make cropping uncertain or even impossible. A great deal of the Fargo silty clay loam has been reclaimed by artificial open-ditch drainage. The most marked drainage improvement in the county is the transformation of Ten Mile Lake in section 3 of Ten Mile Lake Township from a permanent lake to cultivatable land.

The greatest single areas of Fargo silty clay loam are in Freeland Township, where the soil occupies a part of the broad constructional flat which is continuous from the broad bottoms of Yellow Bank River in southwestern Walter Township to Yellow Medicine County. The soil also occurs in narrow constructional depressions through

Ten Mile Lake, Maxwell, Arena, Hamlin, and Lake Shore Townships. Fargo silty clay loam is free from gravel where it occurs adjacent to Lamoure silt loam and Lamoure silty clay loam along the stream channels. Boundaries between these soils are arbitrary. The Fargo soil differs from the Lamoure principally in the lighter color of its subsoil.

Only a small part of the area of Fargo silty clay loam is now adequately drained. In most places lateral tile drains are needed to supplement the open ditches or large main tile outlets to insure the soil adequately against the wet seasons. The areas now served by artificial drainage, however, are very productive in seasons of well-distributed rainfall. Areas not tapped by surface drainage outlets can not be cultivated during wet years, and satisfactory yields are certain only in dry seasons.

Fargo silty clay loam makes up a considerable part of the acreage on a large number of farms in the county. About two-thirds of its total area is in pasture and hay land, and the rest is cultivated to grain crops. Pasture and hay grass stands are usually well maintained on this soil during dry spells, and hay yields are excellent. Red clover does better than on the upland Barnes soils. Of the clovers, alsike is perhaps the best adapted to this soil. Sweet clover grows too rank, and the hay is coarser than that produced on the better-drained lands. Alfalfa does well where the drainage is not too poor. Of the grain crops flax produces the most satisfactory yields. However, it is commonly grown for only the first two years after new ground has been broken. Corn is considered better adapted to this soil than the small grains, because of the tendency of the small grains to produce straw at the expense of grain. Lodging frequently causes considerable additional loss. Although corn grows taller and is later in maturing than on the better-drained lighter-textured soils, yields are very good when drainage and season combine to facilitate reasonably early planting and unchecked growth. Cultivation during wet seasons is more or less of a problem. The soil remains too wet for cultivation for several days longer than the upland loam soils. A ranker growth of weeds must also be combated. A mulch surface is hard to maintain during the first year, as the soil is too sticky when wet and too hard when dry to cultivate it into a good mulch. With subsequent cultivation this intractable quality disappears largely, and only in wet seasons or on the poorer-drained areas is cultivation difficult.

Manure is applied to this soil more for the purpose of improving the physical condition than for a fertilizer, as fertility is considered high. Smaller and less frequent applications of manure are made than on the upland loam soils. The small spots of alkali call for special attention if they are to be made productive. Drainage is the first improvement to be made, and tillage must be thorough and moderately deep.

Crop yields vary widely on Fargo silty clay loam, being highest in dry years and lowest in wet years. Usual acre yields of corn are 25 or 30 bushels and range from 20 to 75 bushels. Wheat yields average between 10 and 15 bushels to the acre and range from 8 to 31 bushels; between 35 and 40 bushels is the average yield for oats, and the range is from 20 to 45 bushels. Barley yields an average between 20 and

25 bushels to the acre, but the range is from 15 to 40 bushels; rye averages between 15 and 20 bushels, ranging from 8 to 25 bushels; and flax averages 10 bushels, yields ranging from 5 to 15 bushels. Red clover yields average between 2 and 2½ tons to the acre; clover and timothy mixed between 1¾ and 2¼ tons; timothy between 1½ and 2 tons; alfalfa between 2 and 2½ tons; and sweet clover 2½ or 3 tons. Wild hay yields range from 1 to 2½ tons to the acre.

In its present poorly drained condition, Fargo silty clay loam has not so high a market value as Barnes loam, heavy-textured phase. Well-drained areas in a good state of cultivation command higher prices, as a rule. Prices ranged from $50 to $150 an acre during 1923 and 1924.

Fargo silty clay loam, meadow phase.—Soil similar to that described as typical Fargo silty clay loam but so poorly drained that cropping is not possible without additional drainage improvements, except in the driest seasons, has been separated as the meadow phase of the soil. The surface soil of these areas is black, moderately plastic silty clay loam rich in organic matter and commonly containing small quantities of lime. When dry the soil has a fine granular structure and is moderately friable. Below a depth of 6 or 8 inches is black, plastic silty clay containing greater quantities of lime, some of it in concretionary form, and small quantities of sand and small gravel. When dry this material is of finely granular structure but much less friable than the surface soil, and the granules are tougher and more resistant to breaking. This material continues to a depth of about 3 feet without noticeable changes except a slightly lighter color and increased quantity of lime. The material below a depth of 36 inches is grayish and of still higher lime content. Organic matter has been incorporated in small quantities, and the black color has disappeared. Below a depth of 3 feet the soil is almost permanently saturated.

Poorly drained soil similar to typical Fargo silty clay loam has been included with this soil in mapping. There is a close resemblance between the soils of this poorer-drained phase and similarly textured Lamoure soils. Both have the deep, uniformly fine-textured black surface soils, undoubtedly of alluvial deposition. This soil occurs in basins in former glacial lakes or broad glacial stream valleys, unmodified by any deposits of present streams, and the Lamoure soils occupy present stream flood plains which have received more or less recently deposited alluvium. The 2-inch or 3-inch surface layer is in many places slightly mucky or is a little browner in color when dry, but well-defined muck was not found anywhere in the county. In section 36 of Ten Mile Lake Township this mucky silty clay loam extends to a depth of 12 or 14 inches, with a 2-inch or 3-inch surface layer of very dark-brownish loose muck on the surface. In places, mostly in areas surrounded by light-textured uplands, the subsoil contains spotted thin layers of sand or sandy clay loam.

The meadow phase of Fargo silty clay loam occupies flat or saucerlike depressions, well distributed throughout the county. The natural drainage is at present so poor that at a depth of 3 feet the soil is water-logged even in the drier periods; in wet seasons it is water-logged to the surface. The more depressed areas have almost

no drainage outlet and in wet years are marshy practically the whole year.

Practically all of this soil is used for the production of pasturage and wild hay. A small area is marshy or covered with rank, unpalatable coarse rush grasses, cat-tails, and canebrake and is entirely waste land. The cropping of land is contingent on the drainage improvement. Under the present natural drainage a small part is cropped only during the drier seasons. Such occasional cropping is usually difficult and uncertain, owing to the intractable condition of the soil and its tendency to crack, bake, and curl into a crusty surface. Recognized as a very productive soil, it is sure of development as the need becomes more urgent for additional crop acreages. Where the pasture and hay grasses are not too coarse and unpalatable excellent forage and hay yields are now obtained.

FARGO SILTY CLAY

Fargo silty clay is in all respects similar to Fargo silty clay loam, except in the texture of the surface soil. The surface soil, to an average depth of 10 inches, is black silty clay. It is plastic when wet and when dry has a tendency to break up into small clods. The next lower layer is black, heavy, plastic clay. At a depth ranging from 18 to 24 inches, the black soil is underlain by olive-gray plastic clay, mottled with yellow and rust brown. The color becomes lighter with depth, and below a depth of about 30 inches the material is light-gray highly calcareous clay.

The greater part of this soil occurs in three principal areas, two in the west-central part of the county east of Marietta, and one near the southern boundary south of Dawson. The soil occupies depressions that were originally poorly drained. It was impossible to cultivate the greater part of this land until artificial drainage had been established. In the western part of the county, it was necessary to construct a drainage canal for a long distance in order to drain the soil. In depressions water stands on the surface for a week or more after rains, and in wet seasons it is impossible to grow cultivated crops. The areas south of Dawson are better drained and are in a high state of cultivation.

The crops grown on Fargo silty clay loam are also grown on this soil. The average yields are lighter on account of poorer natural drainage. The greater part of the soil is used for pasture and hay land. Good yields of wild hay are cut even in the dry years. Red and alsike clover do well on the better-drained areas. The small grains, as a rule, are not profitable, as they grow too rank and lodge. Corn does well in the drier years when it can be planted early and cultivated thoroughly.

The recommendations for the management and improvement of Fargo silty clay loam apply also to this soil.

LAMOURE SILTY CLAY LOAM

The surface soil of Lamoure silty clay loam is nearly black silty clay loam of very fine granular structure, moderately plastic when wet but rather mellow when dry. The lime content is variable but on

the average is slight. Below a depth varying from 8 to 12 inches is slightly browner silty clay. The material is a little more plastic when wet, and when dry it lacks the mellowness of the surface soil but is still moderately friable. It is finely granular rather than very finely granular in structure. Appreciable quantities of lime are present. Below a depth of about 18 inches the material is slightly grayish, is of more finely granular structure, and becomes plastic when wet and more resistant to breaking when dry. These changes progress with depth so slightly that there are no well-defined contrasts between the layers. Below a depth of about 30 inches, however, the material commonly is mouse-gray, sticky silty clay or clay containing large quantities of lime. This continues downward without much further change.

This soil, as mapped in the larger areas in back bottoms and in the more-depressed poorly drained small areas, commonly is heavier than typical. To a depth of 12 inches the material is nearly black silty clay, plastic when wet and of finely rather than very finely granular structure when dry. There is little change to a depth of 40 inches, except for slight progressive increases with depth in plasticity, in the size and number of small clods formed when dry, and in the content of lime. Below a depth of 40 inches is dark-gray or gray silty clay mottled gray, yellow, and rust brown. It is plastic when wet, but when dry it breaks into a greater number of very fine clods than does the soil above. It is markedly richer in lime and is scarcely affected by any incorporation of organic matter. About one-third of the Lamoure silty clay loam in the county is of this character.

Lamoure silty clay loam occupies the wider flood plains of the county. The largest areas are on the Minnesota River bottoms. Other wide areas are in southwestern Walter Township along South Fork Yellow Bank River and in Hamlin Township along West Branch Lac qui Parle River. Smaller areas occupy back bottom positions, with coarser-textured soils adjacent to the streams. Internal drainage is fair, but surface drainage is slow. It is partly compensated, however, by the nearness of the soil to stream channels. Moisture conditions for cropping are fair in seasons of well-distributed rainfall. The heavier silty clay areas, however, are less certain for cropping, even when rains are well distributed, and the occasional overflows do considerable damage by drowning out crops in the back bottom positions. On the broader valleys of Yellow Bank, Lac qui Parle, and Minnesota Rivers damaging overflows seldom occur. In wet seasons standing water or a too moist condition of most of the soil prevents successful cropping.

As a rule, only areas which can ordinarily be utilized for crops annually are cultivated. The areas which in wet or normal seasons can not be cropped are not easily maintained in a good state of cultivation when they are broken for an occasional crop. Perhaps a fourth of the soil is cropped, and the rest is used as pasture and hay land. It is recognized as one of the best soils in the county for hay and pasture grasses, because of its resistance to drought. It produces rank, late-maturing crops. Because of the tendency of small grains to lodge and produce straw at the expense of grain, corn is the preferred crop. Early planting and thorough cultivation are essential to the best-matured and largest crop yields.

Poor drainage after heavy rains and flooding are the factors limiting cropping on this soil. With those factors eliminated, this soil produces as heavily as any soil in the county. Diking to protect from floods is necessary in some places. Where the fall is sufficient to furnish a good outlet, tile drainage improves the soil. Small alkali spots present a special problem, but most of them are too small to justify any special remedial practices except draining, manuring, and thorough tillage.

The value of this soil varies greatly with drainage conditions, associated soils, improvements, and nearness to markets.

A large part of the Lamoure silty clay loam can best be utilized for pasture or hay land. When brought under cultivation, the soil should be managed much as is Fargo silty clay loam.

LAMOURE SILT LOAM

The surface soil of Lamoure silt loam, to a depth varying from 12 to 16 inches, is very dark grayish brown or black mellow silt loam, plastic when wet but mellow and friable when dry. It contains some lime. It is underlain by silt loam of similar color but of heavier texture, which continues to a depth of 30 inches. When dry, this layer is of more granular structure than the material above and is friable but does not work up so readily into a mellow silty condition. When wet it is more plastic than the surface soil. Lime is present in larger quantities. Below a depth of 32 inches and continuing to a depth of about 44 inches is mouse-gray silty clay, slightly mottled with light gray, yellow, and rust brown. It is plastic when wet but crumbly when dry and is of very fine cloddy structure. Lime is present in considerable quantities. Below a depth of 4 feet the material contains no black organic matter and is grayish and mottled. The soil layers are not sharply contrasted from one another, and changes are slight and progressive with depth.

The largest areas of Lamoure silt loam occur along the lower course of Lac qui Parle River in Lac qui Parle Township. Here the soil is more frequently flooded than are the smaller areas in the valleys farther upstream, and the areas are narrower in proportion to the volume and size of the channel. The overflow waters run off more rapidly than the upstream overflows and, in places, deposit layers of sand on the surface.

Internal drainage is fairly efficient, and overflow waters are rapidly removed. However, the floodings are too frequent to make cropping of the larger areas in Lac qui Parle Township certain each year. Most of the land has been left to support a fine growth of hardwoods and is utilized as woodland pastures. In seasons of normal rainfall areas along the smaller streams can be cropped, and yields are very satisfactory. Moisture conditions are good, except while water is standing after the heavier rains and floods.

Less of the Lamoure silt loam is cultivated than of the Lamoure silty clay loam. Under cultivation, however, it maintains more favorable moisture conditions for growing crops under a wider range of seasons, and for that reason is more certain in crop yields. Methods of management are the same for both soils. The most practical use

of the soil is for pasture or hay land if the farm has a sufficient acreage of other soils for cropping.

The value of Lamoure silt loam is about the same as of Lamoure silty clay loam.

LAMOURE LOAM

The surface soil of Lamoure loam is very dark grayish-brown or black mellow loam, moderately adhesive when wet but very friable and of very finely granular or single-grained structure when dry. With depth the color gradually changes to slightly lighter gray, usually indicating increasing quantities of lime and decreasing quantities of organic matter. The texture remains the same or becomes lighter, and the material is almost as friable when dry and only slightly more adhesive when wet than the surface soil. At a depth varying from about 30 to 36 inches, the organic matter is lacking, and the lime occurs in still greater quantities. The material is gray heavy loam, slightly mottled with yellow and rust brown. It is moderately plastic when wet but is friable when dry.

The areas occurring in the more depressed, poorly drained back bottoms are invariably of heavier texture. The texture of the surface soil varies from fine sandy loam to silt loam and of the subsoil from porous fine sandy loam to heavy silt loam.

Lamoure loam occurs on first-bottom lands of Lac qui Parle and Yellow Bank Rivers and their main tributaries. In association with the heavier-textured bottom-land soils it occupies higher land, usually adjacent to the stream, and in association with Lamoure fine sandy loam it has a slightly lower position. The internal drainage is adequate or excessive. Flooding seldom damages crops, because of the rather rapid penetration of the water into the soil.

About half of this soil in Lac qui Parle County is in the bottom lands of Yellow Bank River in Augusta and Yellow Bank Townships and on the bottom lands of Lac qui Parle River in Providence, Riverside, and Lac qui Parle Townships. The soil here occupies the entire width of the bottoms, which are from one-fourth to one-half mile wide. Elsewhere the areas are small and occur in narrow bottoms in association with the back bottom areas of heavier-textured soils.

Only the larger areas of Lamoure loam are cropped to any extent, about two-thirds of the soil being in pasture or hay land. The land furnishes good pasturage and fair yields of native hay. Under cultivation it is more easily worked under a wider range of moisture conditions than the heavier soils of the series. A little earlier planting and earlier maturity of crops are possible. The run-off of flood waters is so rapid that it often causes damage by washing out plantings or covering them with sandy deposits. Pastures are well maintained, but the seeding of more palatable grasses to improve the natural pasturage is recommended. The tame-hay grasses also would improve the value and increase the quantity of hay produced. Red clover and timothy do very well on the soil. Alfalfa, a crop which is uncertain on Lamoure silty clay loam and a little less so on Lamoure silt loam does well on this soil. Corn is the leading cultivated crop. Small grains yield better on this than on the heavier Lamoure soils but are grown to about the same extent.

Cultivated areas of Lamoure loam usually command a little higher price than Lamoure silty clay loam and a little lower than Lamoure silt loam.

LAMOURE FINE SANDY LOAM

The surface soil of Lamoure fine sandy loam is very dark grayish-brown or black fine sandy loam, moderately adhesive when wet and of very finely granular or single-grained structure when dry. It is loose and very friable. Little or no lime occurs at a depth of 10 inches. Changes from the surface soil with depth are very slight. The color becomes lighter and slightly grayer but is still, at a depth of 3 feet, dark grayish brown. The texture remains practically the same to the 3-foot depth but by reason of a slightly less content of organic matter than in the surface soil the structure is a little more porous and open. The quantity of lime is not so great in this soil as in Lamoure silty clay loam or Lamoure silt loam. The black soil does not commonly continue below a depth of 3 or 4 feet. The materials below are variable, ranging in texture from loose loamy sand to silty clay loam.

Lamoure fine sandy loam is a minor soil, occupying only a small total area in the county. Two-thirds or more of it occurs in Mehurin, Manfred, Freeland, and Garfield Townships, on the narrow bottoms of West Branch Lac qui Parle River and Florida Creek where they dissect a region of sandy-textured uplands. Elsewhere it occupies small, slightly elevated natural levee positions between the channels and the heavier soils in the bottom.

The overflows on this soil are more like freshets which wash out numerous channels, leaving deposits of fine sandy loam on the slight ridges between the meandering channels and overflow courses. Although periods of overflow are of brief duration, their frequency and force make cropping uncertain. During dry spells the soil has a slight tendency to droughtiness, and bluegrass pastures are not so well maintained as on the heavier soils. The soil is used chiefly for pasture and hay land, but cultivated crops are grown occasionally during seasons of less frequent overflow. For small grains and alfalfa, Lamoure fine sandy loam is perhaps a better soil than the silt loam and silty clay loam of the series, but yields of corn and tame hay and pasture grasses are not usually so good.

Lamoure fine sandy loam is unimportant agriculturally. It is considered of lower value than Lamoure loam.

BENOIT LOAM

The surface soil of Benoit loam is very dark grayish-brown or black loam of very finely granular or single-grained structure, loose when dry but moderately adhesive when wet. At a depth of about 12 inches this grades into very dark grayish-brown heavy loam or clay loam of more granular structure than the surface soil but still very finely granular. When wet it is moderately compact and retentive of moisture. This grades, at a depth of about 18 inches, into dark-brown or slightly reddish sandy loam or clayey sand. This layer is loose in structure but is slightly adhesive when wet. Coarse sand and gravel are present in much larger quantities than in the layer above, and

the quantity increases with depth until, below an average of 24 inches, the material is very loose, porous, light grayish-brown gravelly sand showing more or less stratification. This gravelly sand is rich in lime, whereas the soil above contains no appreciable amounts. No marked accumulations of lime were observed in any one layer of the subsoil, but lime is, no doubt, present in places.

Benoit loam occupies flat or very gently undulating areas on slightly elevated bench forms adjacent to either shallow dissecting streams, shallow ponds, or former lake beds. It occurs in Manfred, Freeland, Garfield, and Walter Townships in the regions of poor natural drainage. The ground-water level of these low terraces is maintained at a depth ranging from 5 to 16 feet during the greater part of the season. Above this ground-water level internal drainage is excessive but is not so rapid as in Pierce fine sandy loam or Bearden fine sandy loam. Surface drainage is poor. The surface soil above the gravelly subsoil absorbs a large percentage of the rainfall, and sufficient water is retained to supply the needs of crops except during long dry spells.

In distinctly poorly drained areas of Benoit loam the soil is heavier in texture and is deeper than typical above the gravelly subsoil. Elsewhere over the soil as mapped the variation in the texture of the surface soil is more toward fine sandy loam than toward a texture heavier than loam.

Benoit loam is of small total area in the county. Except for areas in sections 16 and 35 of Manfred Township the individual areas are small, few of them covering a 40-acre field. The soil occurs in a region where the farms are less improved than the average farm in the county.

About half this soil is cultivated, and the remainder is used for pasture and prairie-hay land. Pastures are maintained better on Benoit loam than on Pierce fine sandy loam and Bearden fine sandy loam, but they suffer during dry spells, except on the poorer-drained areas. Hay yields average about the same as on Barnes fine sandy loam. Stands of clover and timothy are more easily obtained on this soil than on Pierce fine sandy loam and Barnes fine sandy loam, but the crops seem just about as subject to damage during dry spells and about as difficult to maintain. All the staple grain crops are raised, and crop yields average about the same as on Barnes fine sandy loam. On the heavier-textured, more poorly drained areas of Benoit loam, crop yields are lower in wet years but are better in dry years than on the typical soil.

Cropping practices followed on Benoit loam are similar to those followed on the fine sandy loam members of the Barnes and Pierce series.

The market value of Benoit loam is considered about the same as of Pierce fine sandy loam and Barnes fine sandy loam.

BEARDEN FINE SANDY LOAM

The surface soil of Bearden fine sandy loam is very dark grayish-brown loose fine sandy loam of slight or moderate coherence when wet and of single-grained and very finely granular structure when dry. This grades into lighter-colored material at a depth of 8 or 10 inches.

Below a depth varying from 16 to 20 inches is very dark-brown sandy loam or light loam, loose and open in structure and rather porous. It is underlain by dark-brown loam more compact and less porous than the layers above. This grades, at a depth of about 30 inches, into olive-gray heavy loam or clay loam containing considerable lime. Above this layer lime in appreciable quantities is not present, and in the material beneath it seems to be present in slightly smaller quantities. This material is moderately plastic when wet but is friable when dry. Below a depth of about 36 or 38 inches the material is coarser-textured loam or clay loam, containing considerable gravel.

In places the loose-structured surface soil is shallower than typical, and the heavier-textured, more compact layer is thicker above the layer of accumulated lime. A greater moisture-holding capacity results. Such is the character of most of the areas in sections 15 and 21 of Riverside Township. These areas, along the bluffs adjacent to the stream bottoms, have a stratified sandy and gravelly subsoil. These beds are in many cases utilized for road gravel. Their area is too small to indicate on the soil map. In still another variation the soil is coarser textured, looser structured, and sandier than typical to a depth of 4 or 5 feet. Such areas are poor in lime throughout the sandy material and are more distinctly porous and droughty. An area in section 24 of Mehurin Township is of this kind.

The large area in Walter Township, along the Grant County line, includes two kinds of soils, neither of which is typical. That part of the area in section 17 is of the sandier variation just described, although the lower part of the subsoil contains more clay and silt intermixed, giving a better water-holding capacity to the soil. Lime is also present in this slightly heavier lower subsoil layer, and the area as a whole seems not so deeply leached. This area occupies a gentle slope rising toward the west, and the level terrace extending into Grant County can not be defined until the top of the slope is reached. The elevation at this point appears about the same as of the surrounding uplands to the east. The part of this same area in section 8 is a distinctly lower flat, more poorly drained than typical. This condition is reflected in a darker-colored heavy-textured and deeper surface soil, covering a subsoil more poorly oxidized but loose and gravelly.

Bearden fine sandy loam in most respects resembles Barnes loam. The Bearden soil, however, is free from bowlders on the surface and in the soil and, although it commonly contains more sand than the Barnes soils, the soil layers show a better assortment of the particles. Bearden fine sandy loam occupies well-drained terraces along the main streams, whereas the typical Barnes soils occur in the uplands.

The areas mentioned comprise the bulk of the soil occurring in the county. The terrace benches it occupies are individually of small area and lie from 10 to 25 feet above the stream bottoms. The natural drainage varies from fairly well regulated in the typical areas to excessive in the sandier areas.

Most of this soil is cultivated. Crop yields on the typical soil are similar to those obtained on Barnes fine sandy loam. The lighter lands produce yields about equal to those obtained on Pierce fine sandy loam. Methods of cultivation and cropping practices are similar to those followed on the lighter-textured upland soils.

PIERCE FINE SANDY LOAM

Pierce fine sandy loam has a surface soil 10 or 12 inches thick consisting of very dark grayish-brown or black fine sandy loam, loose and friable, of very finely granular structure but moderately adhesive when wet. Small, variable quantities of coarse sand and gravel are present in the surface layer. Underlying it is a layer of very dark-brown coarse sandy loam or stony clay loam, varying in thickness from 4 to 6 inches. It is slightly compact and friable and is of finely granular structure. Below this is grayish-brown, loose, gravelly sand, which is very porous and which adheres slightly when wet. Considerable lime is present. This, in the more maturely weathered areas, is accumulated slightly immediately below the leached soil. This accumulation of lime is not so well developed and apparent as in the Barnes soils. The calcareous gravelly sand continues downward to the zone of less-weathered materials and becomes a part of the parent-drift substratum.

Small pockets containing more clay and silt than typical and more retentive of moisture occur in places in the subsoil and substratum. Where the soil is associated with Barnes sandy loam and Barnes fine sandy loam, boundaries between the two are more or less arbitrary, areas of each soil, as mapped, containing small areas of the other soils. The Barnes soils, as mapped, have subsoils which are moderately retentive of moisture, and Pierce fine sandy loam has a distinctly open, looser, porous, and gravelly subsoil.

Most of the more undulating areas of Pierce fine sandy loam are adjacent to well-marked, poorly drained depressions on undulating surfaces little above the prevailing upland levels and only slightly ridged. The surface soil is commonly deeper in these areas, and the loose, porous gravel is not seen above a depth of 2 or 3 feet. The texture of the surface soil ranges from loamy fine sand to light loam. The largest areas of Pierce fine sandy loam, such as those in sections 4, 15, and 22 of Augusta Township, occupy highly elevated, gently rolling or rolling lands. Here the surface soil is deeper on the foot slopes than typical, by reason of the addition of sediment washed from above.

Pierce fine sandy loam occupies undulating or rolling areas but occurs most typically on small, elevated ridges similar to those occupied by Pierce gravelly loam. The more undulating areas are in the regions of light-textured soil in Freeland and eastern Manfred Townships. In this county it occurs almost exclusively in the two western tiers of townships. Four-fifths of its total area is in Manfred, Freeland, Walter, and Augusta Townships.

The more rolling areas of the Pierce fine sandy loam are kept in pasture, but most of the remainder of the soil is cropped. All the staple crops are raised. Yields average a little less than on Barnes sandy loam.

This is recognized as a droughty soil, and crops escape damage only in wet seasons. Manuring and thorough cultivation improve yields, but these practices do not often insure against decreased yields during dry spells in an ordinary season, as they do on the Barnes and Moody light-textured soils.

A demand for road-surfacing gravel has created a profitable income from numerous areas of this soil. However, only small, spotted excavations are made for the removal of gravel.

PIERCE GRAVELLY LOAM

The surface soil of Pierce gravelly loam is dark grayish brown, somewhat lighter than the Barnes soils. The extreme range in texture may be from loamy fine sand to clay loam. Some gravel is present. The surface layer is thinner than that of the Barnes soils, ranging in thickness from a mere film to 6 inches. The subsoil is brown loam or clay loam which contains some gravel. This overlies gravelly stony loam, which continues to a depth of many feet. Beds of loose gravel or sand and gravel mixed occur on some of the steeper knolls, and pockets of clay or clayey gravel are found in many places. These extreme variations are too small to indicate on the soil map.

Pierce gravelly loam occurs on ridges and knolls which stand in sharp relief from the surrounding lands. It is a noticeable fact that these sharper ridges are commonly of a trend from northwest to southeast, parallel to Minnesota River. The areas in western Perry Township clearly show this direction. These knolls, in rolling, elevated regions, are from 10 to 40 feet above the surrounding lands, but where the surrounding region is lower and undulating the knolls rise to a height of 150 or more feet above the general level. Such conspicuous areas occur in sections 16 and 27 of Freeland Township. Bowlders are exposed here on the surface and are present in the soil in great numbers. A large proportion of the soil is stony. A ridge in northeastern Mehurin Township is of this same bowldery character. Cultivation would be difficult on account of the bowlders and the rolling surface.

Although widely distributed over the county, the only sizable areas of this soil occur in the two western tiers of townships. Very little of the soil is in cultivated crops. Dry spells cause crop damage, and pasture and hay grasses are stunted in growth. The amount of water which runs off the surface is much greater than that taken up by the soil. The use of hardy, more drought-resistant pasture grasses to supplement timothy, clover, and bluegrass would undoubtedly improve the pastures during the drier periods. In cultivated areas, thorough mulching is required to prevent serious washing or drifting of the soil. Contour plowing is a good practice. Heavier or more frequent manuring than on the heavier soils is required for equal production.

The market value of a farm is lowered by the presence of any considerable acreage of Pierce gravelly loam.

ROCK OUTCROP

On the slopes of Minnesota Valley in the northwestern part of the county the mantle of drift has been removed by the cutting of the stream, and areas of the bedrock are exposed. The largest of these exposures have been indicated on the soil map. The rock is reddish, coarse-grained granite. Some of these rocky ledges are

flat, and others are rounded or pitted. These bare areas have no agricultural value.

SUMMARY

Lac qui Parle County is in the southwestern part of Minnesota, bordering South Dakota. Its area is 776 square miles.

A slight decrease in elevations takes place from the southwest corner of the county to the northeastern border. The upland surface has, in general, an undulating or gently rolling surface. The upland elevations range from 1,050 to 1,400 feet above sea level.

The drainage waters of the county issue into Minnesota River, largely through its two tributaries, Yellow Bank and Lac qui Parle Rivers. Although continuous tributary upland drainage ways do not serve all parts of the county, the gently rolling relief gives good surface drainage to all but about 175 square miles of the county's area. Of this total, only about 25 square miles are too poorly drained for cultivation in normal seasons. More than 200 miles of ditches have improved the drainage of a large part of the depressed areas, but improvement is needed on the remainder.

Lac qui Parle County was organized in 1871. Agriculture has always been the main industry of the county. About two-thirds of the population are native-born Americans. Norwegians, Germans, and Swedes predominate among the foreign-born inhabitants.

The county has seven incorporated towns, Madison, the county seat, being the largest. The Minneapolis & St. Louis Railroad and the Great Northern Railway run through the county.

The average frost-free season in the county is 144 days. The mean annual precipitation of 24.04 inches is normally well distributed during the growing season.

The farms of Lac qui Parle County average 255.5 acres in size. General farming, with diversity of crops and increased activity in livestock raising, is becoming established. Oats, corn, wheat, flax, barley, and rye are the staple grain crops, ranking in acreage in the order named. A little more than half of the hay acreage is in wild prairie grasses and the remainder is in the tame-hay grasses, timothy and red clover, alone or mixed, alfalfa, sweet clover, and alsike clover ranking in acreage in the order named. The livestock industries, named in the order of their importance, are hog raising, beef-cattle raising, dairying, horse production, sheep raising, largely for wool, and poultry production.

Except for stable manure, the only fertilizer used for field crops is superphosphate, and the use of this material is only in the experimental stage.

A little less than half of the farms are operated by tenants. The labor supply is high class and adequate, except during harvest periods.

The soils of Lac qui Parle County have friable, very fine granular black surface soils.

Most of the soils have well-regulated natural drainage, which maintains good moisture conditions for growing crops.

Barnes silt loam and Barnes loam of the uplands and terraces and Moody very fine sandy loam and Moody silt loam of the uplands have developed under conditions of well-regulated drainage. About 65 per cent of the county is occupied by soils of this character. About

6 per cent of the soils have porous sandy or gravelly subsoils and are somewhat droughty during the longer dry spells. During seasons of normal rainfall only a very small acreage of soils is actually droughty. Moody fine sandy loam, Barnes sandy loam, Barnes fine sandy loam, Pierce fine sandy loam, Pierce gravelly loam, of the uplands, and Bearden fine sandy loam and Benoit loam, of the terraces, are of this character. The remaining 29 per cent of the soils developed under naturally poor drainage, and crops suffer to a greater or less extent from too much water during wet seasons. Artificial drainage has corrected this condition on a considerable acreage, and it is safe to say that only about one-tenth of the area of this group of soils is now too poorly drained for cropping in seasons of normal rainfall. To this group of soils belong all the Webster and Fargo soils and Lamoure silty clay loam, Lamoure silt loam, and Lamoure loam.

Rock outcrop is a miscellaneous classification of nonagricultural soils.

[PUBLIC RESOLUTION—No. 9]

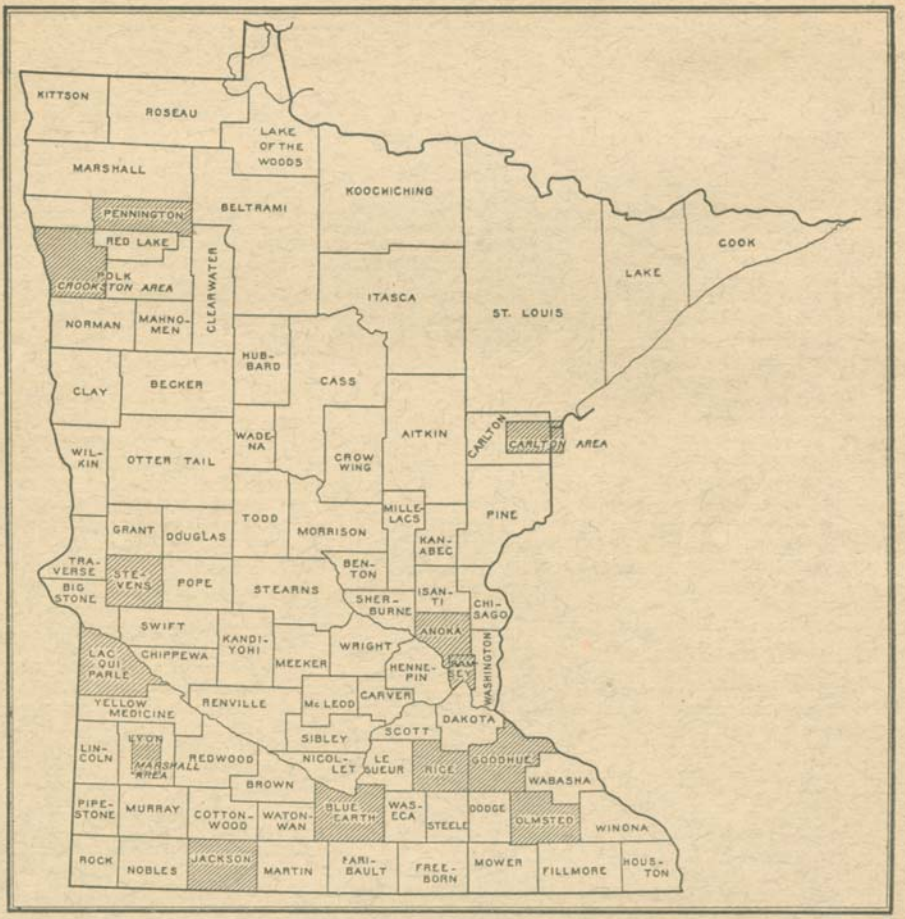
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture"

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

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

Approved, March 14, 1904.

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



Areas surveyed in Minnesota, shown by shading

U. S. GOVERNMENT PRINTING OFFICE: 1929

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