

Issued June 17, 1911.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS—MILTON WHITNEY, Chief.

SOIL SURVEY OF RICE COUNTY, MINNESOTA.

BY

R. T. AVON BURKE AND LAWRENCE A. KOLBE.

[Advance Sheets—Field Operations of the Bureau of Soils, 1909.]



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1911.

[PUBLIC RESOLUTION—No. 9.]

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

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

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

Approved March 14, 1904.

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

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., December 21, 1910.

SIR: In the extension of the soil survey in the State of Minnesota during the field season of 1909 work was undertaken in Rice County. The survey of this county was requested by its citizens, and the selection bore the indorsement of Hon. C. R. Davis, within whose district the area lies.

I have the honor to transmit herewith the manuscript report and map covering this work and to request their publication as advance sheets of Field Operations of the Bureau of Soils for 1909, as authorized by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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Soil map, Rice County sheet, Minnesota.

SOIL SURVEY OF RICE COUNTY, MINNESOTA.

By R. T. AVON BURKE and LAWRENCE A. KOLBE.

DESCRIPTION OF THE AREA.

Rice County is situated in the southeastern part of Minnesota. Its southeast corner is within 110 miles of the southeast corner of the State; its south line is 48 miles from Iowa, and St. Paul and Minneapolis lie within 40 miles northward. The meridian 93° west from Greenwich lies less than a mile beyond the east county line, and parallel $44^{\circ} 30'$ north passes through Wheatland and Webster townships. The area is a square of 24 miles to the side, with a strip 5 miles from north to south and 12 miles from east to west removed from its northeast corner. The county contains about 500 square miles divided into fourteen townships, all of standard size, except Bridgewater and Northfield, which contain 40 and 44 square miles, respectively. Scott and Dakota counties bound it on the north, Dakota and Goodhue on the east, Steele and Waseca on the south, and Le Sueur on the west.

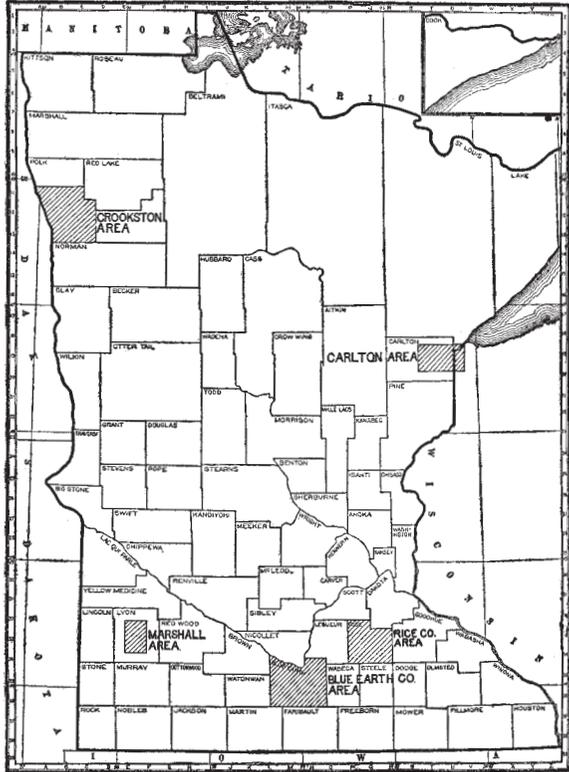


FIG. 1.—Sketch map showing location of the Rice County area, Minnesota.

There is considerable variation in the character of the topography. In the southeastern section of the county, particularly in Wheeling

and Richland townships, the country is generally smoothly rolling, with long, gentle slopes, and characterized by comparatively sluggish stream drainage. This part of the county is mainly occupied by the older, or Kansan drift. In the western and northwestern portions of the county the later Wisconsin drift is represented, the topography is more sharply rolling and hilly, the drainage is not so well established, the streams are more crooked, and there are many lakes. The boundary line between these two drift sheets is characterized by a belt of hilly country, known as the terminal moraine of the Little Wisconsin ice sheet. The Cannon River cuts through this moraine near Faribault. Farther west an older and rougher moraine belonging to the same drift sheet is present, and is particularly well marked in Morristown and Webster townships. Outside of this rougher morainic belt the central and western parts of the county is rolling to undulating. Terraces of gravelly glacial débris have been formed along Cannon and Straight rivers, and upon one of them the city of Faribault is principally built. Near the upper end of Cannon Lake one of these terraces has been built up to a height of 60 feet above the present lake level.

In the northeastern portion of the county the bottoms of Prairie Creek are broad and level and are bordered by sharply outlined and often precipitous valley walls of soft, easily eroded St. Peters sandstone, protected at the top by a thin capping of Galena limestone. These rugged valley bluffs, together with a number of detached flat-topped mesas of the same geological formation, form a conspicuous feature of the landscape, and are in quite marked contrast to the more rolling and deeply drift-covered country which prevails in the western and southern portions of the area. These escarpments are usually characterized by the occurrence of a marked talus slope of loose sandy material at their bases, formed from the disintegration of the St. Peters sandstone.

The general drainage of the area is toward the east and northeast through Cannon and Straight rivers and their tributaries, and through Prairie Creek and the north branch of the Zumbro River.

Rice County was created by an act of the Territorial legislature in 1853, its present limits being defined somewhat later. Its organization as a political unit was completed in 1855 by the election of its first corps of county officials, more than two years before Minnesota became a State.

A fur-trading post established by Alexander Faribault in 1826 on Cannon Lake, and later removed to the site of the city which bears his name, became the center of the first permanent agricultural settlement in the area in 1853. A strong tide of immigration followed, for by 1860 the county had 7,543 inhabitants. Natives of the older States were the earliest pioneers; but soon Germans, Norwegians, Irish,

Swedes, and other north Europeans, many of whom had first stopped in other States, came in considerable numbers. Some Bohemians also have located in Rice County, particularly in Wheatland and Webster townships, in some instances taking the place of Norwegians and others who have left to locate on cheaper lands in Canada. In 1880 over 30 per cent, and in 1900 less than 23 per cent of the inhabitants were foreign born. Canada has also furnished many immigrants.

The whole area is now comparatively thickly settled. The population in 1900 was 26,080, of which over one-half lived on farms. In most parts a high degree of prosperity prevails. Comfortable houses and commodious, gambrel-roofed bank barns, equipped with track for unloading hay, are seen on most farms. The buildings are almost always painted and in good repair. In the prairie region are attractive groves of poplar, willow, or maple, which usually are placed to protect the houses against the prevailing winter winds. Driven wells 100 to 250 feet deep, furnishing ample supplies of excellent water, are common. Windmills or gasoline engines are used on most farms to run pumps and other stationary machinery.

Besides an excellent system of public schools, there are a number of private institutions of learning in different parts of the county. Rural free delivery routes reach all parts of the area. In few country communities is the telephone more generally installed or put to wider service than in Rice County. Over some at least of the party lines the local market prices are announced as soon as fixed each morning; if a scarcity occurs in any product a general call is sent out over the country phones. Closing quotations at St. Paul and Minneapolis are announced each evening. Weather forecasts are given out regularly.

The area discharges its drainage waters from three sides. The Cannon River, the main stream, rises slightly west of the center of the county in Shields Lake and drains several other lakes on its circuitous course to the point where it leaves the county, 9 or 10 miles from the southwest corner. Reentering the county, about 7 miles to the south, it takes a general northeast direction, leaving the county about 5 miles west of the northeast corner. Between its source in Shields Lake, at an elevation of approximately 1,090 feet above sea level, and its final exit from the county there occurs a fall of about 200 feet. Straight River, the chief tributary of the Cannon, enters the county a little east of the middle of the southern boundary, and, flowing in a general north to northwesterly direction, joins the Cannon at Faribault. From the entrance of the Straight to its junction with the Cannon there is a fall of about 100 feet, equal to the fall in the Cannon in fully three times that distance. The Cannon, nearly doubled in volume by the addition of the waters of the Straight, receives other tributaries in its lower course, those from the west being somewhat larger than those from the east.

All the territory between the Straight and Cannon rivers is drained by this system. Above its confluence with the Straight, four expansions occur in the Cannon River. The largest of these is Cannon Lake, with an area of 1,475 acres. The territory lying between this portion of the stream and its headwaters and extending northward contains numerous lakes, the most of which are drained by Cannon River. With the assistance of Prairie Creek, Little Cannon River, and the drainage ways of northeastern Webster Township, this system drains fully three-fourths of the entire county. In the northwestern part several small streams lead to tributaries of the Minnesota, and in the southeast the north branch of the Zumbro drains about one township eastward.

Small portions of the western half of the county have no well-defined drainage, their waters being retained in lakes that overflow, if at all, only in times of extremely heavy rainfall. The lakes of the county have an aggregated area of more than 10,000 acres. All the drainage of the county ultimately reaches the Mississippi River.

A good system of public highways exists, a road lying on nearly every section line. Through local and State effort combined the more important roads are being greatly improved by eliminating grades and shaping up and resurfacing the roadbed. There are excellent railway facilities. The Chicago, Milwaukee and St. Paul Railway enters the county near the middle of its southern line and extends northwesterly to Faribault, passing through Dundas and Northfield. One branch extends from Faribault eastward through the southern townships to the line which follows the Mississippi; the Wells-Mankato-Farmington branch crosses the northwestern corner of the county; the Chicago, Rock Island and Pacific Railway follows a course from the south through two townships parallel with the Milwaukee and uses the latter's tracks from Comus northward; the main line of the Chicago Great Western makes a loop over the eastern boundary of the county, passing through Nerstrand; the Mankato branch of this system, leaving the main line at Randolph, in Dakota County, follows the general course of the Cannon River through the area. All northward-bearing lines go to St. Paul and Minneapolis, less than two and one-half hours distant, and furnish excellent facilities for shipping dairy and other products to those cities. An electric line to these cities is under construction. The railroads named afford good communication with Chicago and the other great cities of the south and east. No part of the county is 12 miles from a railroad.

The Cannon River affords perhaps a dozen power sites along its course below the junction with the Straight and several others above. A number of these are utilized, particularly to drive grist mills, auxiliary stream power being now provided at many of them.

Faribault, the county seat and chief city, situated at the junction of Straight and Cannon rivers, has over 8,000 inhabitants. It is a place of considerable business enterprise and has important manufacturing interests. The first flour sent from Minnesota to New York is said to have been milled at Faribault. The State institutions for the deaf and dumb, feeble-minded, and blind are located here, as are also several excellent secondary schools. This city affords a good local market for farm products of the central and southern portions of the area, while Northfield is the center of an extensive rural trade in the northern part. The latter city is also the site of two colleges, Carleton and St. Olaf, which together enroll about 1,000 students. Dundas, Morristown, Warsaw, Nerstrand, Dennison, Lonsdale, Wheatland, and Webster are other shipping points. Grain elevators are located in most of the places mentioned and at some points on railroads in the open country.

CLIMATE.

The climate of the area is cool temperate, the annual mean being about 44°. The extreme range at Faribault during the years 1906 to 1908 was from -33° to 94°. The average temperatures for June, July, and August are 65°, 70°, and 69°, respectively. September, with an average temperature of 61.5°, sometimes has the warmest day of the year. The means for December, January, February, and March are below freezing, in January and February sometimes being under 15° F. A low relative humidity considerably mitigates the bodily effect of temperature extremes.

Between December 1 and 15 permanent winter sets in and continues until March 10 or 20. Ice 18 to 20 inches thick is common, and a thickness of 32 inches has been attained. There is seldom any surface thawing during winter, and on bare spots the ground sometimes freezes 4 to 5 feet deep.

Plowing is sometimes continued into early December and frequently resumed the latter part of March, a time which often affords good seeding conditions also.

Killing frosts have occurred as late in spring as May 26 and as early as September 13 in the fall; the average dates are May 12 and October 4, respectively. On the lowland frost is apt to injure corn in autumn, but the other staple crops are seldom injured.

The average annual precipitation at Faribault is about 28 inches. Over 75 per cent of this amount falls during the period from April to September, inclusive, furnishing sufficient moisture for crops during the growing season in normal years. Except on seepy, low-lying ground, crops are, however, more often damaged by drought than by excess of moisture. Possibly one year in four long-continued

spring rains delay corn planting seriously on heavy soils and undrained lowlands, but rarely if ever is the planting of the small grains delayed.

The average precipitation for the four months of December, January, February, and March is less than 3 inches. The total snowfall recorded at Faribault during 1907 and 1908 was 37 and 29 inches, respectively. Four weeks of continuous sleighing is very common and a period of 140 days has been known.

The data in the following tables, compiled from the records of the Weather Bureau station at Faribault, and showing the average monthly and annual temperature and precipitation and dates of last and first killing frosts, represent fairly well the climatic conditions of the whole area:

Normal monthly and annual temperature and precipitation at Faribault.

| Month. | Temperature. | Precipitation. | Month. | Temperature. | Precipitation. |
|---------------|--------------|----------------|----------------|--------------|----------------|
| | ° F. | In. | | ° F. | In. |
| January..... | 14.7 | 0.41 | August..... | 69.0 | 3.88 |
| February..... | 15.4 | .60 | September..... | 61.5 | 4.03 |
| March..... | 30.5 | 1.15 | October..... | 49.9 | 2.83 |
| April..... | 45.0 | 1.58 | November..... | 34.1 | .88 |
| May..... | 57.4 | 3.50 | December..... | 18.8 | .58 |
| June..... | 65.3 | 4.63 | | | |
| July..... | 70.4 | 4.55 | Year..... | 44.3 | 28.72 |

Dates of first and last killing frosts at Faribault.

| Year. | Last in spring. | First in fall. | Year. | Last in spring. | First in fall. |
|-----------|-----------------|----------------|--------------|-----------------|----------------|
| 1901..... | May 25 | Oct. 2 | 1906..... | May 7 | Sept. 29 |
| 1902..... | Apr. 24 | Sept. 13 | 1907..... | May 20 | Sept. 25 |
| 1903..... | May 3 | Oct. 26 | 1908..... | May 4 | Sept. 29 |
| 1904..... | May 26 | Oct. 6 | Average..... | May 13 | Oct. 22 |
| 1905..... | May 25 | Oct. 10 | | | |

AGRICULTURE.

When Alexander Faribault penetrated what is now Rice County in the year of 1826 part of it was heavily wooded and part in open prairie. The greater proportion lying west of Cannon and Straight rivers and extending west to the county line and beyond was in timber or brush, but with the exception of a timber belt about 3 miles wide on the east side of Straight River and small bands along the slopes of the more important upland streams, the rest of the county was an open country or prairie.

Faribault moved to what is now the city of Faribault during the year 1844 and subsequently induced other pioneers to make it their home also. These early settlers were more often hunters and trappers than farmers, and came primarily to trade with the Indians, though they grew small crops of garden truck, corn, wheat, rye, and flax. Little real development took place until after the treaty in 1853, by which the Indians were induced to vacate their lands for settlement. Farms were then taken up in the river bottoms and along the large upland streams.

Rice County was organized in 1855, at which time the population was nearly 2,000. The development from this date was quite rapid, more than 5,000 people settling in the county within the next five years. Clearings were made in the "Big Woods," roads and drainage ditches were constructed in the prairies, and agriculture began in earnest. The panic of 1857 was not felt here until 1858, when many hardships were endured. Some of the settlers returned east, but the general progress was not hindered.

The nearest railroad station was at Rochester, but the Minnesota Railway Company completed their line from Minneapolis to Faribault in 1865. This company was eventually absorbed by the Chicago, Milwaukee and St. Paul Railway. The opening up of this railroad did a great deal toward developing the county and has contributed largely to its present prosperous condition.

The production of grains, particularly wheat, was the dominant interest at this time. Between the years 1860 and 1865, 325,000 bushels were grown; in 1872, 548,000 bushels; and in 1875 production had reached nearly 700,000 bushels. The acreage of corn and oats rapidly increased and of wheat decreased during the next few years. In the year 1879 the Census Bureau reported the acreage of oats at 12,726 acres; corn, 11,524; barley, 890, and wheat, 74,873 acres; in 1889, oats, 30,876 acres; corn, 23,437; barley, 1,603, and wheat 30,609 acres; in 1899, oats, 4,063 acres; corn, 24,366; barley, 4,768, and wheat, 62,036 acres. It would appear from these figures that barley, oats, and corn continued to increase, but the report of 1889 shows a falling off of over 50 per cent in the acreage of wheat. This is attributed to the ravages of the chinch bug some time between 1885 and 1889.

The discouragement attending the production of grain brought about a greater diversity of interests on the farms. Stock raising and dairying were resorted to with success, but as the lands increased in value the grazing of stock was discontinued and cattle were shipped in and fattened for market. This has gradually given way to the raising of dairy stock and the marketing of dairy products. The first creameries were operated by independent capital, but these have been superseded by farmers' cooperative creameries. Dairying now constitutes an important feature of the agriculture of Rice County and

promises to become the dominant interest, especially if the present high prices for dairy products continue. There are a few typical dairy farms scattered over the county, and nearly all farms have a few head of dairy stock which yield some income. The number varies from three or four to a hundred or more on the different farms. The cattle consist of common stock, Holstein grades, and mixtures resulting from the crossing of Shorthorn and Durham with Holstein blood. Some Jersey and Jersey grades are seen, but the Holstein strain appears to predominate.

A number of creameries are located throughout the county, some of which operate skimming stations within their territory. Some of the farmers haul their milk to skimming stations or cream to creameries, but most of them share in the expense of driver and wagon. The greater number of them have hand separators and the cream is collected each day during the week in summer, and every other day, with the exception of Sunday, in winter. Farmers living near a railroad station sometimes ship cream to the central stations in the city, which usually offer slightly better prices than the farmers' cooperative creameries, but this practice is growing less and less common. With the improved facilities of this day and time, markets are readily found and shipments of dairy products promptly made. It is not uncommon for the total output of creameries to be sold months ahead.

The principal crops of the area are wheat, oats, barley, corn, mixed and wild hay, and those of minor importance are potatoes, sugar beets, buckwheat, flax, garden truck, and fruit. The bulk of the wheat sown is spring wheat. This is sometimes seeded alone, but more often with oats. This mixture is known as "succotash." Comparatively little winter wheat is grown and this is confined to the land originally timbered, where the protection afforded by snow is said to be better. The best grades of wheat are secured from the more rolling land, but the yield of straw is not quite so heavy. On the more level areas the yield of straw and grain is generally heavier, but the quality of grain is said to be not so good. This, however, is not conclusive, as character of season has much to do with it and probably some deterioration in grade can be attributed to the practice in places of thrashing directly from the shock rather than the stack. This difference in method may depend upon the availability of machinery, labor, or weather conditions during harvest.

Probably more oats are grown alone than wheat, but the greater proportion is grown with wheat. Oats appear to be more hardy than wheat and adapted to a wider range of soils and soil conditions. The amount of precipitation has a marked effect on grain, which is generally plumper in dry seasons and more inclined to be chaffy in wet seasons.

The production of mixed crops of wheat and oats constitutes an important feature of the agriculture of this section. The history of this product, as reported by various farmers throughout the county, is that it was first used to combat the chinch bug about twenty-two years ago. They say that it was then noted that when clover was sown with the grain these bugs did not do so much damage, and this led to the sowing of a mixture of wheat and oats so as to have thicker covering. A different reason, however, is assigned for the continuation of the practice. It is said that the yield of wheat is not impaired and the oat crop is a surplus. It is true that the two grains do not ripen at exactly the same time, but it is doubtful if there is enough difference to affect the quality. The amount of each grain grown varies almost with the individual. "Succotash" is usually thrashed and sacked and sold to the mills, where a small toll is exacted for separation. Some farmers, however, have machines and separate their own grain.

The production of barley is on the increase. It is used largely for feed, only a small proportion being adapted to malting purposes. For malting it must be uniform in ripeness and size and have the ability to germinate rapidly and completely.

Rye is almost exclusively fall sown and is largely confined to lands originally timbered. Sometimes it is pastured during early spring, but the cattle are taken off in time for it to mature grain. Little or none of it is used as a green manuring crop.

The acreage of corn is also increasing. The greater proportion of this crop is produced on the gently rolling to rolling lands. Although north of the so-called corn belt, this crop seems to do well. It is probable, however, that more or less resistant varieties adapted to local conditions have been developed. Flint corns are grown to some extent, but most of the varieties are of the dent type. The proportion of the acreage of corn for grain to other crops is about 1 to 8, but where farmers have silos the ratio is much greater. The methods of planting vary more with the topography than anything else. On level to gently rolling land the check-row system is the common practice, but where the country is more rolling the seed is usually planted in rows. The crop is given frequent but shallow cultivation. Pumpkins are usually planted in the fields. Most of the crop is harvested with corn harvesters; some of it by hand, more particularly in the western part of the county. Most of the grain is fed on the farms. The recent high price of pork has made it very profitable to use corn for fattening hogs, and a considerable part of the crop is disposed of in this way.

Most of the sloughs, the sods of which are almost permanent, produce good crops of wild hay. The yields vary from one-half ton to 2 tons to the acre, and redtop is sown to maintain the yields upon

areas showing decline. It is believed that under existing conditions these sloughs are a hindrance to the proper utilization of the land. Their poorly drained condition interferes with the adoption of a systematic crop rotation. It is recognized here that timothy in conjunction with clover will not only yield more hay, but that the quality is better than that of the slough-grass hay. Where timothy and clover are in rotation with other crops the condition of the soil is improved and better yields of the grain crops may be secured. The production of timothy and clover hay is increasing; they are usually grown on all farms, but more particularly on those that have no natural mowing land. Clover is sometimes sown alone to improve soil conditions or for seed, and a small acreage of timothy is also sown for seed.

Of the minor crops buckwheat and flax are the most important. They are usually sown much later than most of the major crops, and frequently on land that is too wet in early spring for other crops. Flax is generally grown for its seed, but during the last few years more of the straw has been baled and shipped out of the county, much of it going to Minneapolis. Some of it is pulled by hand, but more is cut with a self-binder, shocked, and stacked. Flax is generally a profitable crop, but the fact that it can only be grown on the same land at intervals of six to eight years restricts the acreage considerably. It is a common practice to use for this crop virgin land or land that has been pastured for a number of years. In the latter case it is said to put the soil in splendid physical condition for subsequent cultivation.

The production of buckwheat is less than of flax. The crop is often used as a catch crop, where the stand of some cultivated crop like corn or potatoes is not good and the season is too far advanced for replanting. In Rice County it is more often sown on the lands bordering the sloughs.

Potatoes are not grown as a commercial crop, but are seen in small patches on most of the farms. This is largely true also of garden truck, with the exception of a few places in the vicinity of Faribault and Northfield. The production of sugar beets is confined largely to the western part of the county. They are considered a profitable crop, but, owing to the absence of local beet-sugar factories and the scarcity of labor, the acreage is limited to the area that can be cultivated by the farmer and his immediate family. The beets produced are hauled to Montgomery and shipped to the factory at Chaska, Minn. A number of small nurseries are situated in the county. These make a specialty of ornamentals and trees for windbrakes.

Of fruits, apples, plums, and grapes do well. The Wealthy, Duchess, Peerless, Longfield, and Northwestern are the favorite

varieties of apples, while the Concord, Worden, and Brighton are favorites among grapes. Raspberries, gooseberries, and strawberries thrive under the general conditions here.

The continuous production of small grain on the same land is a common practice, and the only variation that occurs is the length of the period in which the land is used for this purpose, which will vary from four to twelve years. It is largely due to such practice that the yields have decreased and that quack-grass and other pernicious weeds have attained such a general distribution. When the yields diminish to the point where the crops are no longer profitable recourse is made to timothy and clover and subsequent pasturage to increase the productiveness of the land. Corn is sometimes grown for three or four years in succession, so as to eradicate quack-grass and other weed pests. A rotation that is used to some extent and one growing in favor is corn, oats, and wheat two years, then barley with which timothy and clover are sown. The following year the grass is cut for hay and then pastured until the land is prepared for corn again. Where oats and wheat are grown alone the oats follow corn two years, then wheat one year, followed by barley, hay, and pasturage. Barley is sometimes eliminated and wheat used as a nurse crop for timothy and clover. The last two systems are better than the first, but a more definite one as to length of time to be used as pasturage might be advisable under some conditions. The question of market value of farm products will always be the controlling factor in the general arrangement or rotation of crops.

The methods of preparing seed beds for the different crops vary considerably. The corn land is usually plowed in the spring and then dragged. It is generally admitted that fall plowing and spring disking is the better method of preparing corn land, but this is rarely practiced. Corn stubble is usually disked for oats or wheat and oats, and for the next crop the land is plowed. Should successive crops of small grain be produced the stubble of every alternate crop is plowed and the other disked.

Little or no commercial fertilizer is used. Productiveness is maintained by applying manure, by turning under grain stubble and pasture sod, and by the use of clover in the crop systems. When land for corn is manured it is usually done in the winter; for small grain the manure is usually applied in the fall.

The prevailing methods of farming are open to one serious criticism. After thrashing the grain fire is set to many of the straw piles, thus destroying a great deal of organic matter which should be returned to the land. The nitrogen is dissipated in the air and the ash constituents are fused, rendering them less available; the phosphoric acid and potash drawn from perhaps 20 acres is too rich an

application for less than that number of square rods, and frequently causes the succeeding crop to lodge if the ashes are plowed under without spreading. Where the straw heap stood on a slope a heavy rain before plowing may do the spreading, but the portion which reaches running water can at best be deposited only on a lower flood plain—perhaps in another State—and may be carried to the sea. At all events, this portion is usually lost to the farmer who burns his straw. The loss which the area thus sustains in fertilizer values is in itself a serious one. According to the United States census there were produced in 1899 in Rice County 1,071,330 bushels of wheat. Assuming that the ratio of grain to straw in the harvested crop was as 2 to 3 there were produced 96,419,700 pounds of straw. Average wheat straw, according to Professor Henry, contains 0.5 per cent of nitrogen, 0.12 per cent of phosphoric acid, and 0.51 per cent of potash. Assuming that only 10 per cent of the straw, a low estimate, was burned, this means that 56,887 pounds of nitrogen, worth in its cheapest form about 15 cents per pound, or more than \$8,530, were entirely lost through the improper disposition of the straw of that wheat crop. Combining these figures with like data for the other grain crops of 1899 we obtain the following table:

Amount of wheat, barley, and oat straw estimated to have been burned in Rice County, Minn., in 1899, with nitrogen, phosphoric acid, and potash contained.

| Crop. | Grain produced in Rice County, Minn., 1899. | Ratio of grain to straw. | Total quantity of straw produced. | Estimated quantity of straw burned (10 per cent). | Contained in straw burned. | | | | | | Value of straw contents. | | |
|-------------|---|--------------------------|-----------------------------------|---|----------------------------|--------|------------------|--------|---------|--------|--------------------------|----------------------------|-------------------|
| | | | | | Nitrogen | | Phosphoric acid. | | Potash. | | Nitrogen (15 cents). | Phosphoric acid (2 cents). | Potash (4 cents). |
| | Bu. | | Lbs. | Lbs. | Pc. | Lbs. | Pc. | Lbs. | Pc. | Lbs. | | | |
| Wheat..... | 1,071,330 | 2.3 | 96,419,700 | 9,641,970 | 0.5 | 56,887 | 0.12 | 11,570 | 0.51 | 49,374 | \$8,533 | \$43 | \$390 |
| Barley..... | 141,360 | 1.1 | 6,785,280 | 678,528 | 1.31 | 8,888 | 0.30 | 2,035 | 2.09 | 14,081 | 1,333 | 40 | 602 |
| Oats..... | 1,465,130 | 2.3 | 70,326,240 | 7,032,624 | .62 | 43,602 | 0.20 | 14,065 | 1.24 | 87,204 | 6,540 | 281 | 3,706 |
| Total..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 16,406 | 364 | 4,698 |

While perhaps less oat than wheat straw is thus destroyed the proportion of barley straw is much higher; with the conservative estimate of proportion burned and lowest trade values of constituents taken, it is believed the figures are within the truth. If so, they show that from the straw of one year's grain crops the invigorating air of Rice County was enriched by over \$16,000 worth of nitrogen, while over \$5,000 worth of mineral constituents was injured by fusion. No account is here taken of feeding values that might have been realized.

Grain growing for distant consumption necessarily divests the producing region of considerable soil wealth. Says Professor Henry:

In this depletion of the soil of the Northwest by almost exclusive wheat growing and in transferring the fertility taken up by this crop to other regions in the by-products of milling we are experiencing one of the greatest economic changes ever witnessed in American agriculture.

The soil depletion referred to by Professor Henry is an unavoidable incident of grain growing and for it there is some compensation. But the losses incident to burning straw are needless; the material contained in that portion of the plant might be retained to produce the straw of future crops; for its loss there is no return, except the use of the straw-pile site for several years.

Nor are the losses mentioned the only ones chargeable to straw burning, but beneficial physical effects are also lost. On soils carrying an ample margin of humus produced by the decay of organic matter a better seed bed can be prepared than on those deficient in humus; plowing, harrowing, and cultivating are rendered easier; their water-holding capacity is materially increased, and the rate of evaporation lowered, a matter of no little importance in a dry year. At the same time, such soils retain heat better, giving an advantage in starting the crop in spring and, in the case of corn at least, in prolonging the growth in fall. Aeration is also assisted (for the higher water content due to the humus does not mean a water-logged soil) and the needs of beneficial soil organisms subserved, the humus itself affording those organisms food. Indeed, the sum of these latter benefits, which can not be directly computed, may exceed the merely chemical values of humus.

The reasons given for this wasteful practice are that it rids the ground of an encumbrance, that the straw refuses to rot, that in many cases it is full of weed seeds which should be destroyed, and that the soil does not need the straw returned. A 25-ton pile of such straw contains over \$41 worth of nitrogen alone and occupies less than one-fourth acre. Charging \$6 rent per acre annually for the straw-pile site and allowing four years for rotting leaves over \$25 saved on the nitrogen, assuming a loss of 25 per cent by fermentation. Besides, there is over \$11 worth of phosphoric acid and potash in a more serviceable form than when in ashes. In many instances straw may be placed where it interferes in no way with tillage or harvesting operations.

The unbroken winter doubtless retards rotting; nevertheless in three or, at most, four years an ordinary straw pile is changed to good manure.

Not all weeds are spread chiefly by seed. There is evidence that quack-grass, for example, is spread through roots carried by tillage implements. Moreover, there is little cause to fear the germination

of seeds that have been subjected to the conditions under which a pile of straw has thoroughly rotted. Besides, weed seeds are especially rich, and for that reason should be rotted instead of burned, so that their constituents may be offered to crops.

The proposition that the land does not need the straw returned or some substitute can not be maintained. Every ton of manure taken from barnyard to field is testimony that the land does need such return. While some especially favored spots may not now show the need of manure, they will eventually show such need. Even if that day lies in the distant future present occupants are not justified in bringing it about by wanton waste. Says Shaler:

They [the people of the future] will date the end of barbarism from the time when the generations began to feel that they had no more than a life estate in this sphere, with no right to squander the inheritance of their kind.

The change to dairy farming, involving a reduced grain acreage and a need for more litter, has already reduced the amount of straw burned and promises to lessen it still more. Incident to the production of ensilage for dairy stock the harvester secures many surviving weeds with the corn and the fermentation in the silos sterilizes their seeds. For a long time, however, there will be some surplus straw, much of which will be bought by dealers. One dollar per ton for wheat and \$2.30 per ton for barley straw amply pays for the ash constituents which farmers elsewhere buy as commercial fertilizers. Sale in local cities with the return of manure to the farm is a good arrangement. Straw for which there is neither use nor sale should be converted into manure as early as possible. It is believed that shaping the straw pile so that it will retain instead of shed rain would materially hasten the process. A little manipulation of the "hood" of the blow tube will make the surface more nearly level or even depress its center.

Rice County is one of the most prosperous counties in the State of Minnesota from an agricultural point of view. The farmers enjoy the convenience of rural free delivery, local and long-distance telephone communication, and fair highways. There is comparatively little waste land within the limits of the county. The value of farm lands and improvements, except buildings, as given by the census of 1900, was \$9,976,390, and of farm buildings \$2,307,820. In general the best conditions are seen in the eastern, northern, and southern parts of the county. Most of the farms have goods substantial dwellings of one or two stories and these are usually surrounded by the necessary farm buildings, including large, commodious barns conveniently arranged for the storing of hay and other foodstuffs and the sheltering and feeding of work stock and cattle. Silos are not an uncommon adjunct of the barns in the eastern and northern parts

of the county. The average size of farms, as given by the census of 1900, was 114.3 acres, while probably there are more of 80 acres than any other size. The farms are usually well equipped with improved machinery, including hay loaders, manure spreaders, rakes (including side delivery), self-binders, corn harvesters, sulky and walking gang plows, cultivators, harrows, drags, etc. Clover hullers, shredders, huskers, and thrashing-machine outfits are quite common and are operated on a large number of farms. The value of farm implements and machinery in 1900 was \$475,000.

Most of the farms are well fenced, but more improvement in this respect could be made in the northwestern part of the county, where the stock is often grazed in the stubble fields under the care of children. About 77.4 per cent of the farms are operated by the owners, the rest being mostly rented for a share of the crops. Comparatively little land is rented on a cash basis, but where this is done the rate varies from \$2 to \$4 an acre. Where grass and grain are the chief interests the tenant furnishes labor, work stock, tools, etc., and the landlord gets one-half of all crops grown. Where the dairy or stock interests predominate and the landlord furnishes land, buildings, cattle, brood sows, or other breeding stock, the landlord and tenant each receives one-half the income from sale of cattle, from breeding stock, from milk, and also from grain, if any is sold.

The problem of securing efficient labor is becoming more and more difficult. The great activity in private, industrial, and public utility works has drawn heavily on the farming communities. The opening up of western and Canadian lands has also attracted many to these new fields. Labor employed by the month receives from \$25 to \$30, while transient labor during the harvest season is paid from \$2 to \$3.50 a day. It is becoming more and more common for farmers to cooperate in their work and exchange services, particularly during the thrashing period. The use of improved machinery, however, helps to solve the labor question, though the demand for labor at special seasons is quite acute, and the uncertainty of getting it is resulting in the larger holdings being divided into small farms, as the farmer can now only work as much land as can be taken care of by himself and his immediate family.

Under present conditions most of the soils of Rice County show but slight differences in their adaptation to the crops now grown. The Marshall loam, Carrington loam, and Sioux silt loam are recognized as types best suited to general farming. The Fargo clay loam, well-drained Fargo silt loam, Carrington clay loam, Carrington silt loam, and Carrington loam, erosion phase, are best adapted to the production of grass and grain. The Sioux gravelly loam, Carrington sandy loam, Boone sand, and rougher portions of the Carrington loam are more suitable for the production of orchard fruits, while

the Sioux fine sandy loam, Sioux sandy loam, and the more gently rolling areas of the Carrington sandy loam are best adapted to light farming or the production of truck.

SOILS.

The underlying rocks of Rice County are all of Lower Silurian age, and consist of the Shakopee limestone, St. Peter sandstone, and the Galena limestone. These formations occur in nearly horizontal strata in the order indicated, the Shakopee limestone being at the bottom and the Galena at the top. The latter formation occurs chiefly in the eastern part of the county, and in the townships of Warsaw and Morristown, in the western part. The different formations are successively exposed by the cutting of Straight and Cannon rivers in their courses through the county. These exposures are particularly prominent in the vicinity of Faribault and along Prairie Creek, where serviceable building stone is quarried from the Galena limestone. None of these formations of consolidated rock exert any very material influence upon the soils of the area. Small bodies of material derived from the limestone have been encountered, but of insufficient extent to warrant their appearance upon the map. The weathering of the St. Peter's sandstone has, however, yielded small areas of the Boone sand. The Galena limestone has been eroded from much of the eastern half of the county in preglacial times so that there the St. Peter's sandstone forms the substratum under the drift. It is also exposed in the bluffs along Straight and Cannon rivers and Prairie Creek, and in some parts of Cannon City and Bridgewater townships it is exposed for half a mile back from the stream, where it has had a slight, modifying influence upon the character of the soil. St. Peter's sandstone is so weakly cemented in all but its upper portion as to be easily disintegrated, yielding considerable loose, incoherent sand where exposed.

Immediately above the St. Peters sandstone in the north and northwestern part of the county is a thin layer of shale, which gives rise to a greenish-yellow clay. This clay is very heavy and impervious to water and is usually indicated by a growth of coarse grasses. The shales will rarely be found thicker than 20 feet and the clay does not affect the soils beyond a few rods on the steeper slopes and more on the gentle slopes. In general the exposures were considered too small to map.

The greater part of Rice County is covered with a mantle of soil material foreign to this country, varying in thickness from a few inches to about 300 feet. This material was brought to the country during the Glacial Epoch by the different ice invasions of continental proportions. These great ice fields passed over the northern part of the continent very slowly but with resistless force, carrying vast

quantities of boulders, sand, and clay, and modifying the original topography by grinding off obstructions and filling depressions. Part of this material was brought from across the Canadian boundary line, but most of it is of local origin, the country rock having contributed largely to it. There were three different invasions known as the Pre-Kansan, Kansan, and Wisconsin drifts, occurring in the order named. Evidence of the first is seen only in the deepest cuts as determined from well borings. The Kansan was laid down over this, and occupies the surface of the eastern part of the county. The Wisconsin is found in the western part overlying the Kansan. It is from the last two that most of the soils of the county are derived. These drifts consist of a heterogeneous mass of clay, sand, gravel, and boulders, and as seen on exposure are usually yellow in color, although this changes to dull blue at about 30 feet from the surface.

The Kansan drift has generally a darker color than the Wisconsin and numerous rocks are in a more advanced stage of decomposition. The limestone, from which much of this drift is derived, has long since given way to the agencies of weathering and only the more resistant rocks are left, whereas in the Wisconsin drift limestone and shales in addition to numerous cherty and crystalline rocks are very common. In places in the Wisconsin there is, however, considerable overlapping of the material of these two drifts, the Wisconsin having transported considerable material of the older drift, or Kansan.

Since the deposition of these drifts they have been greatly modified by the incorporation of organic matter and the formation of soil by residuary disintegration and decomposition. The modification of the surface 3 feet of the Carrington silt loam, Carrington loam, and Fargo clay loam is quite pronounced. Except for an occasional chertlike pebble these soils are comparatively free from rock fragments. Over the surface of both drifts or concentrated along the bases of the more eroded portions of the original plains there is a scattering of large boulders.

Associated with the drift occur deposits of sand and gravel. These, however, occupy only small areas and are of local importance. They usually occur in the form of pockets or narrow ridges. The ridges were developed by subglacial rivers and streams, while the pockets were formed by surface glacial streams of temporary activity. Both of these deposits were likely made by strong currents of water, which accounts for the deposition of only the coarser sand and gravel. When occurring in areas of sufficient size this material has been mapped as Sioux gravelly loam. The origin of the Carrington sandy loam may be attributed in part, at least, to similar conditions, but the most of it is probably due to feeble glaciation.

Erosion and transportation of the residuary boulder clay from the steeper slopes has resulted in the formation of ponds, depressions, and sloughs, and produced conditions favorable to the development of the Fargo clay loam, Meadow, and Peat beds.

A small proportion of the area surveyed is covered with loessial or wind-blown material. Leverett says the advance of the Wisconsin drift was preceded by a period of great aridity, and it was probably during this period that the material was deposited. The local occurrence of the loess on the slopes facing the east, south, and southeast he attributes to the prevalence of west-northwest winds. It is, however, found in other positions where probably caught and protected by grass or other vegetation.

In addition to the deposits already described are the alluvial, lacustrine, and organic. The alluvial represents material sorted by rain and stream action and deposited on what were then the floodplains of the water courses, the lacustrine the material deposited in ponds, lakes, and depressions, and the organic the material largely made up of the remains of water-loving plants, grasses, etc.

There are fourteen types of soils, including Peat and Meadow, mapped in the survey of Rice County. The following table gives the names and relative and actual extent of the several types:

Areas of different soils.

| Soils. | Acres. | Per cent. | Soils. | Acres. | Per cent. |
|----------------------------|--------|-----------|----------------------------|---------|-----------|
| Carrington loam..... | 84,096 | 38.6 | Sioux sandy loam..... | 10,752 | 3.4 |
| Erosion phase..... | 39,296 | | Sioux silt loam..... | 7,744 | 2.4 |
| Meadow..... | 40,832 | 12.8 | Marshall loam..... | 4,992 | 1.5 |
| Carrington silt loam..... | 38,144 | 11.9 | Sioux gravelly loam..... | 2,304 | .7 |
| Fargo clay loam..... | 24,832 | 7.8 | Boone sand..... | 2,240 | .7 |
| Fargo silt loam..... | 22,720 | 7.1 | Sioux fine sandy loam..... | 1,344 | .4 |
| Peat..... | 16,320 | 5.1 | | | |
| Carrington clay loam..... | 12,544 | 3.9 | Total..... | 320,000 | ..... |
| Carrington sandy loam..... | 11,840 | 3.7 | | | |

CARRINGTON LOAM.

The Carrington loam consists of a brownish-black or yellowish-brown silty loam, 12 to 24 inches deep, grading into a heavy yellow clay, which usually exceeds a depth of 15 feet. The texture of the surface soil is for the most part uniform, but the color and depth are variable. Areas of minimum depth apparently have resulted from erosion, those of maximum depth representing more probably the natural conditions. A depth of 15 inches is more typical than either of the extremes. There are few stone fragments in the material to a depth of 3 feet, though these increase in quantity with depth.

A phase of the Carrington loam, due to erosion, is shown in the map by means of ruling. The principal distinction between the soil here and in typical areas is the more mottled appearance of the surface, due to exposure of the clay subsoil or to admixture of this with the surface material. The phase also contains more rock fragments than the typical soil.

The Carrington loam occupies the rolling uplands and is generally well drained. The surface features of the typical areas are usually regular and the slopes are generally long and smooth. Of the phase they are more rolling and often hilly and broken. The type has the greatest extent of any of the soils encountered in Rice County and occurs in all parts of the county. It is typically developed in the vicinity of and north of the city of Northfield, and large areas are found throughout the townships east of Cannon River.

The important bodies in the western part of Richland Township are quite typical as regards texture, agricultural value, etc., though occupying lands which were originally open prairies. Many small and irregular bodies are scattered through Webster Township, but these areas are not quite typical, the soils being generally lighter in color and more shallow. The areas in the southern and eastern parts of Wells Township also are hardly typical, the subsoils being generally heavier and of a darker color and resembling in some respects the Fargo clay loam. Other variations occur in different parts of the county. In the large area west of Rice Lake the subsoil is slightly heavier than that of most of the type. Included with the type is a narrow but disconnected band along the eastern terminal of the Wisconsin drift (Leverett) or little Wisconsin (Weidman), which is not true to type, the soil being more heterogeneous, the topography more hummocky, and the drainage more obstructed. The greater part of the type north and west of the Cannon River is of the eroded phase.

The Carrington loam is derived through the disintegration and decomposition of the underlying drift. In the typical soil, with the exception of an occasional boulder upon the surface, the absence of rock fragments in the surface 3 feet is quite marked. Considerable time must have elapsed to have almost completely reduced the rocks and boulders which originally composed the surface drift. This feature, however, is not so marked in the type as in the Carrington silt loam, where decomposition has gone much farther and deeper.

With the exception already noted, the greater part of the Carrington loam was originally timbered. Most of the cleared land has had the forest removed within the last thirty years. The Carrington loam is one of the most important soils of the area. It is generally easy to work, is well drained, and matures crops from ten

days to two weeks earlier than the prairie types. It is generally used for the production of corn, oats, wheat, barley, and mixed hay and to a less extent for potatoes, sugar beets, flax, and rye, though on the eroded phase only a small acreage is given to the intertilled crops. The following are the reported yields: Corn, 40 to 60 bushels; wheat, 15 to 30 bushels; oats, 30 to 60 bushels; barley, 30 to 40 bushels; rye, 20 to 30 bushels; flax, 6 to 12 bushels; potatoes, 50 to 100 bushels; mixed hay from 1½ to 3 tons; and sugar beets, 8 to 10 tons to the acre.

The production of sugar beets is largely confined to this type and they are an important product only in the western part of the county. Little or no commercial fertilizer is used, and the productiveness of the soil is maintained by the incorporation of organic matter in the form of grain stubble turned under, by the application of manure, and by the use of clover in rotation.

The type is admirably adapted to general farming, and it is recommended that greater care be exercised in the preparation of seed beds, so as to prevent erosion as far as practicable, and that timothy and clover be used more frequently in crop rotation. At present the common practice is to follow corn with a mixture of wheat and oats, then barley, with which timothy and clover is sown. The following year the grass is cut for hay, and the fields then pastured. The crops of mixed wheat and oats generally number from 1 to 6 and the fields are pastured from one to three years.

The eroded phase has a value of \$25 to \$60 an acre, while the better areas bring from \$60 to \$125 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the typical soil.

Mechanical analyses of Carrington loam.

| Number. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|------------|--------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
|  |  | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | <i>Per cent.</i> |
| 21442..... | Soil..... | 0.7 | 4.0 | 5.1 | 13.8 | 9.9 | 49.0 | 17.3 |
| 21443..... | Subsoil..... | 1.1 | 6.4 | 6.7 | 16.8 | 14.4 | 36.5 | 17.6 |

CARRINGTON SANDY LOAM.

The Carrington sandy loam consists of a light loam or sandy loam surface soil, 10 to 15 inches deep, of a gray or brownish color and containing some gravel, grading into a sandy clay or sandy gravelly clay subsoil, which extends to a depth of 36 inches or more. A phase of this type, developed in a few small areas, consists of 12 to 24 inches of a brownish-black or yellowish-brown sandy loam, underlain by a

yellow sandy clay with a depth of 15 feet or more, the main difference being in the absence of gravel.

Most of this type is found in the western part of the county, where it appears in scattered areas of irregular outline. A comparatively large area occurs on the uplands north of the Cannon River and northwest of Faribault. The relative extent of the type is greatest in Webster Township. The more important area without gravel occurs in the south-central part of Walcott Township east of Straight River. Another area of this phase occurs in a sharp bend of the Cannon River, southeast of Faribault.

The Carrington sandy loam occupies upland divides and low rolling to hilly topography. In places the type is subjected to very serious erosion and the underlying sandy or gravelly clay is locally exposed.

In origin this type is largely glacial, as might be inferred from the heterogeneous character of the material, but the uniformity of some of it, as it occurs in the neighborhood of the lakes and rivers, would probably indicate that the material had been reworked by water. The greater part, however, is apparently the result of feeble glaciation.

The Carrington sandy loam is an early, well-drained, and easily worked soil. It is used for the production of corn, wheat, oats, barley, potatoes, and mixed hay (clover and timothy). The production of corn and potatoes is quite limited where the topography is rough and hilly.

The rotation commonly used on this type is corn followed by wheat and oats (mixed), then barley, with which timothy and clover is sown, the last being cut for hay one year and then utilized for pasturage. Variations are quite common in the number of times wheat and oats are planted in succession and in the length of time the lands are used for pasture. Where the land is rough and broken and not suitable for cultivated crops, corn is often eliminated and the mixture of wheat and oats used instead. The yield of corn will range from 25 to 40 bushels, wheat from 10 to 25 bushels, oats 30 to 36 bushels, barley 25 to 30 bushels, and mixed hay from 1 ton to 3 tons to the acre. Potatoes yield 75 bushels per acre. The rougher portions of the type should be used for permanent pasture or devoted to fruit growing. Apples do unusually well. The smoother areas are well adapted to trucking. Little or no commercial fertilizers are used. The productivity of the soil is maintained by applications of manure and the turning under of grain stubble and pasture sod. The more frequent use of clover, and the incorporation of more organic matter generally, would do much to increase the yields. This type is valued at \$30 to \$60 an acre.

The following table gives the average result of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Carrington sandy loam.

| Number. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|-------------------|--------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
|  |  | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | <i>Per cent.</i> |
| 22804, 22806..... | Soil..... | 3.8 | 11.3 | 12.8 | 26.3 | 14.6 | 19.2 | 9.8 |
| 22805, 22807..... | Subsoil..... | 3.6 | 10.4 | 12.8 | 25.7 | 15.9 | 20.9 | 10.9 |

CARRINGTON SILT LOAM.

The Carrington silt loam consists of a grayish-black or black heavy silty loam, with a depth of 15 inches, grading into a drab or brownish silty clay which at about 24 inches is underlain by dark-yellow clay. The soil is generally uniform in texture and has a high content of organic matter. It is friable and easy to work when dry, but very sticky when wet.

The Carrington silt loam is largely confined to the eastern part of the county, but large typical areas occur southwest of Faribault, and south of Cannon Lake in the southwestern part. The areas occupy uplands of the prairie region. It is the main type on the remnant of the old Kansan plain east of Cannon City. Here the surface is almost level. Streams and sloughs are quite common throughout the area, but the approach to these is usually gentle, except in the northern part of the area where the slopes are more abrupt. The detached areas in Walcott Township are not quite typical, the subsoil not being so heavy, although it has the proper color. This may be due to the fact that these areas were originally wooded, whereas the typical material is developed in the open prairies. In general the drainage of this type is well developed.

The Carrington silt loam is derived largely from the underlying Kansan drift. Occasional boulders are seen upon the surface, but the soil is unusually free from rock. The few rock fragments encountered are of cherty character and very resistant to weathering. The bulk of the drift was made up of limestone but the fragments of this rock have disintegrated and disappeared. The original growth on this type was prairie grass and to the continuous growth of this for centuries is attributed the dark color and high organic content of the soil. This type was not considered so valuable as the timber lands during the early settlement, but it was all taken up before the bulk of the timber lands.

The Carrington silt loam is one of the most productive soils in Rice County. It is used largely for the production of grass and grain. Corn yields from 50 to 70 bushels; wheat, 16 to 25 bushels; barley, 30 to 40 bushels; oats, 25 to 60 bushels; clover seed, 4 to 6

bushels, and hay from 1½ to 3 tons to the acre. The usual rotation consists of corn one year followed by a mixture of wheat and oats two years, and then by barley with which timothy and clover are sown. The grass is cut for hay the following year, and the fields then used as pasture for one to two years. Most of the dairy farms are located on this type, and in addition to the crops mentioned considerable fodder and ensilage corn are produced. Land of this type is valued at \$60 to \$100 an acre.

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

Mechanical analyses of Carrington silt loam.

| Number. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|-------------------|--------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
|  |  | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | <i>Per cent.</i> |
| 22785, 22787..... | Soil..... | 0.0 | 1.2 | 1.6 | 2.8 | 18.8 | 62.3 | 12.9 |
| 22786, 22788..... | Subsoil..... | .0 | 2.3 | 2.2 | 3.8 | 30.9 | 39.7 | 20.8 |

CARRINGTON CLAY LOAM.

The Carrington clay loam, to a depth of 10 to 15 inches, consists of a dark-brown or grayish-black heavy silty loam, grading into a dull drab-colored silty clay, which at about 24 inches becomes a dark-yellow clay. The soil is usually free from rock fragments, but boulders are often concentrated at the base of the steeper slopes.

The Carrington clay loam occupies low rolling topography or upland valley slopes. It is confined to the northwestern part of the county, and the greater part of the area occurs in the central part of Wheatland and northern Erin townships.

The drainage of this type is usually good, though sloughs are very common. These are usually very narrow and winding and the movement of the drainage through them is sluggish, water flowing freely only during periods of heavy rainfall.

Grass and grain are the leading crops. Small grain has been grown successfully longer on this type than on any other in the area, and it is only in recent years that clover has had any place in the cropping systems. The following are reported yields: Corn, 30 to 50 bushels; wheat, 15 to 20 bushels; oats, 30 to 50 bushels; barley, 20 to 30 bushels; and mixed clover and timothy hay, from 1 to 2 tons to the acre. Very little hay is grown, dependence being placed upon the wild hay cut from the sloughs. Maintenance of these as permanent meadows interferes considerably with the systematic rotation of crops. The common practice of cropping consists of corn followed by wheat and oats mixed. This usually is planted on the same field for a number of years. When the yields begin to decrease the land

is put in timothy and clover. After the removal of the hay the land is used as pasture for periods ranging from one to three years.

It is suggested that more care be taken to prevent erosion than is the case at present. Contour plowing and cultivation where inter-tilled crops occupy the ground would do much to protect the slopes from surface washing. An effort should also be made to drain the sloughs or at least to keep them open. The acreage of wild hay may well be reduced and the area given to timothy and clover increased. The production of hay should also be increased by using the clover-timothy step in the rotation at least every fifth year.

The greater proportion of this land is owned by Bohemians. Values range from \$50 to \$150 an acre, depending upon location with respect to the towns of Lonsdale and Veseli.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil:

Mechanical analyses of Carrington clay loam.

| Number. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|-------------------|--------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
|  |  | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | <i>Per cent.</i> |
| 22779, 22783..... | Soil..... | 0.8 | 3.9 | 4.5 | 13.5 | 9.9 | 45.7 | 21.7 |
| 22780, 22784..... | Subsoil..... | 1.3 | 3.5 | 4.8 | 13.6 | 16.4 | 42.5 | 17.8 |

SIoux FINE SANDY LOAM.

The Sioux fine sandy loam consists of 15 inches of dark-brown fine sandy loam, grading into a fine to medium loamy sand varying in depth from 24 to 36 inches, and underlain by a bed of sand and gravel.

This is a bottom-land type and is of alluvial origin, having been deposited in the flood plains of the rivers and smaller streams when they flowed at a much higher level than at present. Some of it, however, has been deposited during comparatively recent times. The surface is usually level or slopes gently to the stream courses.

This type has a very small extent. Detached areas occur on the south side of Heath Creek in Bridgewater Township and along the Cannon River in Northfield Township. The largest area is found along the Cannon River southwest of its junction with Straight River. A few isolated areas are scattered in other parts of the county.

Comparatively little of this type is farmed, but where under cultivation it is used for the production of grass and grain, particularly corn, wheat, oats, rye, barley, timothy, and clover. The yields are usually light. Rye seems to do better than either wheat, oats, or barley. On account of the underlying gravel bed, crops suffer con-

siderably on this soil during seasons of drought. Generous applications of manure would do much to make it more retentive of moisture and increase its yields. This type is better adapted to light farming or the production of early truck than to general farming.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Sioux fine sandy loam.

| Number. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|------------|--------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
|  |  | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | <i>Per cent.</i> |
| 22762..... | Soil..... | 0.7 | 8.3 | 13.4 | 39.6 | 10.8 | 16.1 | 10.8 |
| 22763..... | Subsoil..... | .8 | 7.5 | 15.2 | 48.0 | 12.5 | 8.3 | 7.3 |

SIoux SANDY LOAM.

The Sioux sandy loam consists of a dark-brown or yellowish-brown heavy sandy loam, with a depth of about 15 inches, grading into lighter colored material consisting of a gravelly loamy sand to sandy clay, which at an average depth of about 24 inches is underlain by a bed of sand and gravel. Variations occur in the depth of the gravel bed, which is sometimes found within 15 inches of the surface, but such occurrences are usually local. There is considerable variation in the soil and subsoil, the former being somewhat heavier where influenced by wash from the heavier upland soils. The organic matter content is high, as shown by the dark color of the surface soil.

Areas of this type occupy the greater part of the bottoms of Cannon and Straight rivers. It also borders some of the larger tributaries of these streams. Most of the type occurs in the southern part of the county.

With the exception of an area forming an old river terrace northeast of Morristown, which lies 40 to 60 feet above the present river bed, the Sioux sandy loam usually occupies the level river and stream bottoms or areas slightly inclined toward the watercourses. The surface of the terrace area is more rolling and the soil not so uniform, erosion having exposed the underlying gravel in some places. The type is alluvial in origin, but since its deposition the streams have deepened their channels and most of it is not now subject to overflow and is well drained. It is apt to be deficient in moisture.

Like other soils in Rice County this type is devoted to grass and grain. The yields, however, are usually light, except in seasons of abundant rainfall. The following yields were reported: Corn, 25 to 50 bushels; wheat, 12 to 20 bushels; oats, 20 to 30 bushels; barley, 15 to 20 bushels; rye, 18 to 20 bushels; and mixed hay from 1 to 3 tons to the acre. Where the type borders large streams and the gravel

stratum in the subsoil lies at some depth or is thin the yields of the general farm crops are larger. From one such farm 75 bushels of corn and 150 bushels of potatoes to the acre were secured during the present season. The type is much better adapted to early maturing truck crops than to the crops at present grown.

The crop rotation practiced consists of corn followed by wheat and oats, mixed, then by barley with which timothy and clover is sown. The following year the grass is cut for hay and after that used as pasturage. The mixed crop of wheat and oats is sometimes grown several years in succession. The length of time the fields are pastured is also variable. Little or no commercial fertilizer is used, but stable manure is usually applied to the corn land. As much organic matter as practicable should be supplied this soil with a view to increasing its power to retain moisture. Land of this character is valued at \$60 to \$90 an acre.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Sioux sandy loam.

| Number. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|--------------------------------|--------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
|  |  | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | <i>Per cent.</i> |
| 21438, 22760, 22764, 22766. | Soil..... | 2.6 | 18.3 | 18.4 | 16.4 | 3.9 | 23.8 | 16.3 |
| 21439, 22761, 22765, 22767. | Subsoil..... | 2.7 | 17.4 | 19.3 | 22.8 | 7.8 | 17.1 | 12.7 |

SIoux SILT LOAM.

The Sioux silt loam consists of a dark-brown or black loam surface soil from 10 to 15 inches deep, underlain by a compact silty loam which grades into a yellow silty clay at depths varying from 20 to 30 inches. This in turn is underlain by sand, sandy clay, or gravel.

Most of this type is found in the northeastern part of the county, though small scattered areas occur along Cannon River and some of the smaller streams. A large area of typical material occurs southwest of the city of Northfield, and the type is developed to even greater extent along Prairie Creek and its tributaries in the eastern part of Northfield Township along the county line. Very little of the type occurs in the stream bottoms north of Cannon River.

The surface of the Sioux silt loam is generally level or slightly inclined toward the watercourses. It is an alluvial soil derived from material deposited by the rivers and streams when they flowed at much higher levels than at present.

Corn, oats, wheat, barley, and hay are the leading products. The following yields are reported: Corn 40 to 60 bushels, oats 30 to 40

bushels, wheat 15 to 20 bushels, barley 15 to 20 bushels, and mixed clover and timothy hay from 1½ to 3 tons per acre. The type is much better adapted to these crops than the Sioux sandy loam, as crops do not suffer so much from drought. It is generally well drained, but crops do not mature as early as on the lighter bottom soils, and corn is sometimes caught by early fall frosts, particularly in those areas bordering the larger streams. The gravel stratum, which characterizes the type, lying at greater depths below the surface and being thinner, does not afford as rapid drainage as in case of the sandy loam, and in seasons of heavy rainfall crops are usually late in starting. The type on the whole is well adapted to general farming and more particularly to the production of corn and root crops. Land of this type is valued at \$50 to \$100 an acre.

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

Mechanical analyses of Sioux silt loam.

| Number. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|-------------------|----------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
|  |  | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | <i>Per cent.</i> |
| 22774, 22776..... | Soil..... | 1.1 | 5.0 | 4.8 | 4.3 | 3.5 | 59.2 | 22.3 |
| 22775, 22777..... | Subsoil..... | .7 | 4.8 | 4.8 | 6.3 | 11.4 | 52.8 | 19.1 |
| 22778..... | Lower subsoil. | 4.6 | 21.8 | 19.1 | 14.4 | 5.5 | 22.2 | 12.3 |

SIoux GRAVELLY LOAM.

The Sioux gravelly loam, from 0 to 15 inches, consists of a heavy sandy loam or sandy gravelly loam resting upon sand and gravel that usually exceeds 3 feet in depth. In areas having a depth of 15 inches the texture of the material is quite similar to that of heavier areas of the Sioux sandy loam, but this depth of soil is rare, and the texture is more often a sandy gravelly loam, light in color and variable in depth within the limits given.

Only a small area of this soil is found. It is largely confined to the river and stream bottoms, usually occurring between the present bottoms and the uplands or occupying narrow ridges in the bottoms. It also occupies narrow ridges and erosions in the upland, and narrow bodies are found bordering some of the lakes. The largest areas occur along the source of the Cannon River. The type represents level areas where the gravel bed comes within 15 inches of the surface and upland slopes where erosion has given a gravelly condition. The areas are usually badly cut by washes and gullies.

The Sioux gravelly loam is for the most part alluvial, being derived from sand and gravel deposited by the Cannon River. The upland areas were formed by glacial streams. Beaches, where

developed at all along the lakes, have been correlated with this type, although they are not typical, the material usually being finer and the position entirely different.

When farmed the Sioux gravelly loam is used for the production of grass and grain, but the yields are usually very light unless the rainfall is above normal. Some areas are adapted to fruit growing, and where practicable ought to be used for this purpose.

FARGO SILT LOAM.

The Fargo silt loam consists of a black clay or silty clay loam, from 10 to 15 inches deep, grading into a dull-colored clay which at 20 to 30 inches changes to a yellow and gray plastic clay. Beneath this there usually occurs a thin layer of sand, sandy clay, or sand and gravel.

Narrow bands of this soil are found following stream courses in nearly all parts of the county, meadow areas lying between these bands and the stream beds. The type is developed most extensively in the eastern and southern parts of the county. An area covering more than one-half square mile is found in western Shieldsville Township, and still larger bodies in Wells, Wheeling, Richland, and Warsaw townships.

In the southeast corner of the county the Fargo silt loam occupies a part of the original plain of the Kansan drift, but elsewhere it is a bottom-land type. The topography is generally level, but is characterized by very gentle slopes as it approaches sloughs and streams. The areas are generally poorly drained and water is often found within the 3-foot section in the bottoms.

The soil material along the sloughs has been washed from the higher slopes and has accumulated faster than the sluggish streams can remove it. Some of the type, however, is lacustrine in origin, having been deposited in shallow basins or ponds. A very small part of it can be attributed to stream and river overflows. In general, the soil is similar to the material found in the bottoms of the sloughs, having the same texture and high percentage of organic matter.

The Fargo silt loam is devoted to the production of grass and grain. Under the prevailing conditions of drainage the vegetative growth is usually heavy, but the yield of grain is usually light. The past year, 1909, which was a very favorable one for most crops, the following average yields were secured: Corn 40 bushels, wheat 20 bushels, oats 30 bushels, rye 15 bushels, barley 20 bushels, flaxseed 14 bushels, clover seed 6 bushels, and mixed timothy and clover hay $1\frac{1}{2}$ to 3 tons to the acre. Potatoes rarely do well and corn is a failure in wet years. Sometimes a second cutting of hay can be secured if there is rainfall after the first cutting. The pastures are not very durable and have to be reseeded every third year or the fields

grow up with coarse native grasses. Alsike clover is sometimes used to replace red clover. It does better in wet seasons than the red.

This type if properly drained and cultivated is one of the most valuable soils in the area for corn, wheat, oats, barley, and hay, but drainage is absolutely necessary to secure maximum yields of grain. Generally drainage is easy and the installation of a suitable system should not be delayed. The increased yields of crops will more than compensate for the necessary outlay. Judicious short-course rotations should also be systematically employed. The following yields are reported from well-drained Fargo silt loam: Corn, 60 to 70 bushels; oats, 55 to 60 bushels; wheat, 20 to 35 bushels; rye, 20 to 25 bushels; and mixed hay, from 2 to 3 tons to the acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Fargo silt loam.

| Number. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|------------|--------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
|  |  | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | <i>Per cent.</i> |
| 21436..... | Soil..... | 0.0 | 3.3 | 4.2 | 9.4 | 4.9 | 65.0 | 13.1 |
| 21437..... | Subsoil..... | 1.9 | 6.2 | 7.0 | 15.6 | 10.1 | 39.8 | 19.0 |

FARGO CLAY LOAM.

The Fargo clay loam consists of a gray or grayish-black silty loam, varying in depth from 8 to 12 inches, resting upon a stiff, heavy, dull-colored clay, which at about 24 inches grades into a dark-yellow clay. The last-named stratum has a thickness exceeding 15 feet.

All of this type except a few small areas south of Northfield occurs west of the Cannon River, and most of it north of its junction with the Straight River. A large area of typical material occurs east of Cedar Lake extending in a northwesterly direction to French Lake. A smaller area of the same character lies in the southwestern part of Shieldsville Township. A less typical area occurs in the northwest corner of Cannon City Township. The soils here are slightly sandy, but not sufficiently different to warrant making a new type. This is also a common feature of this type in the central-western part of Bridgewater Township. The Fargo clay loam is well developed in the central and northeastern part of Wells Township and on the uplands north, northeast, and east of Circle Lake, while a large area of typical material occurs southeast of Wheatland, reaching in a south and easterly direction along the divide toward and beyond Lester. Other areas of greater or less extent are scattered through the western half of the county.

The Fargo clay loam occupies level to gently rolling uplands and is characterized by numerous small marshy depressions. These depressions are usually shallow, rarely lying 6 feet below the surrounding lands, and when drained give the surface a pitted appearance. The vegetation in these places consists of slough grass and cat-tails, and the soil here consists of a black silty clay loam which grades into gray or grayish-yellow clay similar to that encountered in the sloughs of the Fargo silt loam.

Occupying the tops of ridges, divides, and plains, this type gives one the impression that it is the remnants of an ancient plain of wide extent, the greater part of which has been removed by erosion. The presence of soft rock through the mass would seem to indicate the Wisconsin drift, but the darker color of the material is not typical of this drift. In many cases the type is derived from the underlying glacial deposits modified by the agencies of disintegration and decomposition. Occasional bowlders are seen upon the surface, but the soils are generally uniformly free from rock fragments except in the deeper cuts, where shale and limestone seem to predominate.

This type, like all others in the county, is used chiefly for the production of grass and grain. Ordinarily corn yields between 30 to 60 bushels, wheat from 15 to 25 bushels, oats from 30 to 60 bushels, barley from 45 to 50 bushels, potatoes from 50 to 100 bushels, and mixed hay (clover and timothy) from 1 to 3 tons to the acre.

The soil is easy to work, but imperfect drainage makes it late. Crops are said to mature about the same time on this soil as on the Carrington silt loam. When well drained the Fargo clay loam is well adapted to general farming and is an especially good corn soil. The need of better drainage is obvious. The position of most areas makes the installation of a drainage system feasible. Land of this character is valued at \$45 to \$80 an acre.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil:

Mechanical analyses of Fargo clay loam.

| Number. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|--------------------------------|--------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
|  |  | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | <i>Per cent.</i> |
| 21440, 22789, 22791, 22795. | Soil..... | 0.8 | 3.4 | 3.3 | 9.1 | 6.5 | 52.7 | 24.1 |
| 21441, 22790, 22792, 22796. | Subsoil..... | 1.8 | 4.7 | 4.6 | 12.8 | 13.9 | 35.4 | 26.8 |

BOONE SAND.

The Boone sand, to a depth of 6 to 10 inches, consists of a fine to medium textured sandy loam, grading into a fine to medium sand,

which in turn is underlain by bed rock at depths varying from 2 to 6 feet. The color of the surface soil is a grayish brown or gray, while the subsoil is mottled brown, yellow, and white.

The Boone sand has a very small extent. Typical areas are scattered through Cannon City, Northfield, and Bridgewater townships. They border the river bluffs and uplands and occur where the glacial drift has been removed by erosion. The area northeast of Dundas is typical only in part. The greater part of it represents a commingling of the glacial drift and the sand, giving a heavier textured surface soil.

With the exception just mentioned, the Boone sand is residual, being derived from the underlying St. Peters sandstone. Comparatively little of it is under cultivation, but when used the chief crops consist of corn, oats, wheat, and hay, of which the following are the yields secured: Corn, 20 to 35 bushels; wheat, 10 to 15 bushels; oats, 20 to 30 bushels; and mixed hay, about 1 ton to the acre.

The loose open structure of this soil permits rapid percolation of soil water, and crops suffer materially for lack of moisture unless the rainfall is very heavy. This type is better adapted to fruit and early truck than to the crops named. Heavier and more frequent applications of manure would do much to increase the yields and make the soil more retentive of moisture.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Boone sand.

| Number. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|------------|--------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
|  |  | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | <i>Per cent.</i> |
| 22802..... | Soil..... | 0.0 | 21.3 | 26.7 | 36.0 | 6.0 | 4.7 | 5.1 |
| 22803..... | Subsoil..... | .0 | 25.4 | 38.9 | 33.2 | .9 | .2 | 1.4 |

MARSHALL LOAM.

The Marshall loam consists of a yellowish-brown or brown silty loam, 6 to 12 inches deep, underlain by a compact yellow silty loam, which grades into a yellow silty clay. Beneath this, at depths varying from 24 to 36 inches, there occurs a loose, incoherent silty material distinctly lighter than the surface soil.

The distribution of this type is restricted. A few small areas occur in the south-central part of Northfield and the north-central part of Wheeling Townships.

The Marshall loam is derived from the weathering of loessial deposits. Leverett attributes the distribution of this material on the slopes facing the east, south, and southeast to the prevalence of

west-northwest winds just prior to the advance of the Wisconsin drift. This type, however, is not all confined to these slopes, for it occurs on the uplands, probably in places where it was caught and protected by vegetation.

Considerable variation occurs in the extent of these loessial deposits, which vary from a few inches to 15 or more feet in thickness. The largest area of shallow material lies west of Nerstrand. It is poorly drained, owing to the level topography and the nearness of underlying boulder clay. Where, however, the loess is deep the soil is exceptionally well drained and crops mature much earlier than on the other upland soil type.

The type is adapted to general farming. Fruits and vegetables are said to do unusually well.

The following table gives the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of this type:

Mechanical analyses of Marshall loam.

| Number. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|------------|-----------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
|  |  | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | <i>Per cent.</i> |
| 22797..... | Soil..... | 0.1 | 1.7 | 4.6 | 12.1 | 10.6 | 50.5 | 20.5 |
| 22798..... | Subsoil..... | .0 | 1.5 | 4.9 | 10.0 | 38.9 | 26.4 | 17.9 |
| 22799..... | Lower sub-soil. | .0 | 1.0 | 5.0 | 13.3 | 25.0 | 42.4 | 13.2 |

PEAT.

Peat consists of partially decomposed organic matter derived from water-loving plants and grasses. The yearly accumulation of roots, fibers, leaves, etc., laid down in the water of small lakes, ponds, and depressions has to a large extent been protected from decomposition by water. This deposition occurring for ages has developed the beds of Peat so common in the western part of the county. The Peat varies in depth from a few inches to 15 or more feet and is often underlain by water.

The numerous lakes and ponds were probably formed by glacial deposition which obstructed drainage, causing areas to become gradually filled with water and subsequently taken by aquatic vegetation. The more shallow depressions were likely formed by local soil washing which accumulated at the base of sloughs and formed barriers to natural drainage. Close to the shore lines or along the drainage ditches the Peat is fine textured, varying in color from black to brownish black, while it is much coarser and lighter in color as the distance increases from these lines.

At present most of the Peat has no agricultural value, but from the better drained areas good crops of wild hay are secured.

The problem of draining Peat areas is much more difficult than in the case of the Meadow areas, but the work should be taken up in cooperation with all the farmers interested. Upon petition by a certain number of landowners, the county officials can order the construction of ditches, payable in yearly assessments, the cost being apportioned against the landowner in proportion to the benefits derived.

MEADOW.

Meadow in this area represents a condition rather than a soil type, and is made to include the low-lying poorly drained areas of variable texture. It occupies river and stream bottoms adjacent to running water or embraces areas in the uplands locally known as sloughs. The greatest variation in texture is usually encountered in the stream and river bottoms, and the greatest uniformity in the sloughs. The stream bottom areas consist of alternating layers of sand, silt, clay, and gravel, while in the sloughs the surface is covered with organic matter underlain by a deep black silty clay loam. This grades into a heavy bluish-black clay, which becomes lighter in color with increased depth and is characterized by thin seams of sand, sandy clay, or gravel at depths ranging between 2 and 3 feet.

The Meadow areas support a growth of slough grass, cat-tails, pond lilies, flags, etc., of which the first is predominant. Slough-grass hay is an important forage crop in this section. Its nutritive value compares favorably with timothy, although it is not valued quite so highly. The yields vary from one-half ton to 2 tons to the acre, depending upon the season. Comparatively little of the slough area can be cut during wet years, but most of it can be in dry years. Hay has been harvested from many of these depressions for years, but in some of these the grass runs out in a few years and red top is often sown to make the stand thicker. Up to a few years ago Meadow land furnished the chief reliance for forage in parts of the county, but now timothy and clover are being grown more extensively. Under former conditions the production of small grain was well supplemented by wild hay, but now that the yields of grain have decreased, the need of better systems of soil management is recognized. It is recommended that all Meadow areas be drained, as they interfere with the proper utilization of the land under systematic rotations. The production of timothy and clover would not only be more lucrative, but are essential to the maintenance of the productivity of the agricultural lands in general.

SUMMARY.

Rice County lies in the southeastern part of the State of Minnesota. It has an area of 500 square miles, of which 14.22 square miles represent the area occupied by lakes, etc.

The eastern and southwestern parts of the county consist of gently rolling or undulating uplands. The northern part is more rolling and along the stream courses broken. The western part of the county is much rougher, the surface being rough rolling to hilly.

The general drainage of the county is north and east to the Mississippi through the Straight, Cannon, and Zumbro rivers and their tributaries.

The area has splendid transportation facilities, no part of the county being over 12 miles from a railway station.

The population of the county is about 30,000 and includes many nationalities.

The chief crops are wheat, oats, corn, barley, rye, mixed and wild hay, supplemented by potatoes, sugar beets, flax, and buckwheat.

Most of the farms are operated by the owners. Land values vary from \$25 to \$150 an acre, depending upon improvement and location with respect to markets and shipping points.

Fourteen soil types, including Meadow and Peat, were recognized and mapped in Rice County. They consist largely of loams, but there is a wide range in texture.

The Carrington loam has the greatest extent of any soil in the county. It occupies the rolling hilly uplands and is used chiefly for the production of grass and grain, but it is well adapted to a wide range of crops. It is a good soil for general farming purposes.

The Carrington sandy loam has a relatively small area. It occupies rolling or eroded uplands. It is devoted to grass and grain, but the yields are usually very light. Potatoes do well. It is naturally better adapted to trucking than to general farming.

The Sioux fine sandy loam is an alluvial soil of small extent. Very little of it is under cultivation. Grass and grain are the principal crops grown. The yields of corn, wheat, and oats are generally light, but rye does very well.

The Sioux sandy loam has a greater area than the Sioux fine sandy loam. It is of alluvial origin and occupies level or sloping areas along river and stream bottoms. It is used in the production of grass and grain, but the yields are usually light and crops suffer in years of scanty rainfall. This type is well adapted to the production of early truck.

The Sioux silt loam is of alluvial origin, and occupies level bottom or areas sloping toward the watercourses. This type is adapted to a wide range of crops and is a good soil for general farming purposes.

The Sioux gravelly loam occupies eroded river and stream bottoms. Comparatively little of the type is under cultivation. Grass and grain are the chief crops. The soil is leachy and the yields are very light. It is best adapted to the production of fruit.

Most of the Fargo silt loam is limited to marginal bands along sloughs and watercourses. It is lacustrine in origin and generally poorly drained. Where drained the soil is very valuable for grass and grain.

The Fargo clay loam has quite a large area in Rice County. It occupies level to gently rolling ridges and divides. It is used for the production of grass and grain. When well drained it is adapted to general farming.

Next to the Carrington loam and Meadow the Carrington silt loam has a greater area than any other soil in the area. It occupies level to gently rolling uplands. The soil is considered one of the most valuable in the county for the production of hay and small grains. The yields of mixed hay and of fodder corn are generally heavier on this type than on any other soil in the area.

The Carrington clay loam is confined to the northern part of the county. It occupies low, rolling, and hilly country or upland valley slopes. It is used for the usual crops, hay and grain, for which it is well adapted.

The Boone sand is a type of minor importance. It is a residual soil derived from the St. Peters sandstone. It is used for the production of corn, oats, wheat, and hay, but the yields are generally light. It is better adapted to trucking.

The Marshall loam is derived from the weathering of loessial, or wind-blown material, and occupies but a small area in this county. It is used for the production of grass and grain, of which it gives somewhat lower yields than the Carrington loam. The soil, however, is well drained and crops mature much earlier. It is well adapted to a wide range of crops and the practice of general farming. Fruits and vegetables are said to do unusually well.

Peat represents partially decomposed organic matter. The areas are usually encountered around ponds and in the beds of old lakes. Such areas have little agricultural value at present, but when drained give good crops of wild hay.

Meadow includes low-lying and poorly-drained land. In the upland the Meadow represents wet depressions locally called sloughs. These are valued for their production of wild hay.

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