SOIL SURVEY

Rock County Minnesota

Series 1938, No. 21

Issued November 1949

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Administration
Bureau of Plant Industry, Soils, and Agricultural Engineering
In cooperation with the
UNIVERSITY OF MINNESOTA AGRICULTURAL EXPERIMENT STATION

How to Use THE SOIL SURVEY REPORT

FARMERS who have lived in one locality for a long time come to know about the soil differences on their own farms and on those of their immediate neighbors. What they do not know, unless a soil survey has been made, is how nearly their soils are like those at experiment stations or in other localities from which higher yields are reported. They do not know whether these higher yields are from soils like their own or from soils so different that they could not hope to get equally high yields, even if they adopted the practices followed in these other places. These similarities and differences among soils are known only after a map of the soils has been made. Knowing what kind of soil one has and comparing it with soils on which new developments have proved successful will remove some of the risk in trying new methods and varieties.

SOILS OF A PARTICULAR FARM

To find the kinds of soils on a particular farm or other tract of land, locate the tract on the soil map, which is in the envelope inside the back cover. This is easily done by finding the township, section, and quarter section in which the farm is known to be and locating its boundaries by such landmarks as roads, streams, villages, and other features.

Each kind of soil is marked with a symbol on the map; for example, all soils marked FDG are of the same kind. To find the name of the soil so marked, look at the legend printed near the margin of the map and find FDG. The color indicated for FDG in the legend is used also to indicate it on the map. FDG stands for Fordville silt loam, gently sloping phase. A section of this report (see table of contents) tells what Fordville silt loam, gently sloping phase, is like, for what it is mainly used, and some of the uses to which it is suited.

How productive is Fordville silt loam, gently sloping phase? To obtain this information look opposite the name of this soil in the left-hand column of table 8, page 59, and note the yields of the different crops produced on it. This table also gives expectable yields for all the other soils mapped, so that the different soils may be compared.

To learn the good uses and management practices for this soil read the section on Soil Types and Phases. Read also the section headed Use, Management, and Productivity of Rock County Soils, in which soils suited to about the same use and management practices are discussed. Find the discussion on the group that contains Fordville silt loam, gently sloping phase. What is said in this discussion about rotations, liming, fertilizing, drainage, erosion control, and other management practices applies to Fordville silt loam soil.

SOILS OF THE COUNTY AS A WHOLE

If a general idea of the soils of the county is wanted, read the introductory part of the section on Soils. This tells where the principal kinds of soil are found, what they are like, and how they are related to one another. Then study the soil map and notice how the different kinds of soils tend to be arranged in different localities. These patterns are likely to be associated with well-recognized differences in type of farming and land use.

A newcomer who considers purchasing a farm in the county will want to know about the climate as well as the soils; the types and sizes of farms; the principal farm products and how they are marketed; the kinds and conditions of farm tenure; kinds of farm buildings, equipment, and machinery; availability of schools, churches, hospitals, highways, railroads, telephone and electric services, water supplies, and industries; and about the cities and villages and population characteristics. This information will be found in the section on General Nature of the Area.

This publication on the soil survey of Rock County, Minn., is a cooperative contribution from the—

BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING
ROBERT M. SALTER, *Chief*
Division of Soil Survey
CHARLES E. KELLOGG, *Chief*
UNIVERSITY OF MINNESOTA AGRICULTURAL EXPERIMENT STATION
W. C. COFFEY, *Director*
F. J. ALWAY, *In Charge Soil Survey*

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SOIL SURVEY OF ROCK COUNTY, MINNESOTA

By W. I. WATKINS, in Charge, M. B. MARCO, and RALPH G. LEIGHTY, Division of Soil Survey,[1] Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture, and HAROLD F. ARNEMAN, OLAF C. OLSON, RUSSELL L. WOLD, A. W. MARSH, and E. A. FIEGER, University of Minnesota Agricultural Experiment Station

Area inspected by MARK BALDWIN, Principal Soil Scientist, and IVER J. NYGARD, Soil Scientist, Division of Soil Survey

United States Department of Agriculture in cooperation with the University of Minnesota Agricultural Experiment Station

CONTENTS

[1] The field work for this survey was done while the Division was a part of the Bureau of Chemistry and Soils.

FRIABLE and moderately heavy dark soils high in organic matter and lime have made Rock County important in the production of livestock and grain in Minnesota. Almost all the land is in farms, and on most of them corn is the principal crop, followed by oats, barley, flax, and hay. The continuous cultivation of soils developed under a prairie grassland cover is tending to break down the granular structure of the surface soil and is making more and more apparent the need for preventing gullying, wind erosion, and soil exhaustion. Increasing numbers of farmers therefore are interested in knowing about practices that will maintain the fertility of their particular soils and permit them to benefit from improved plant strains and tillage operations. To learn the best agricultural uses of the land a cooperative soil survey of the county was begun in 1938 by the United States Department of Agriculture and the University of Minnesota Agricultural Experiment Station, the results of which are summarized in this publication.

SUMMARY OF THE SURVEY

The land in Rock County varies from almost level to rolling, with large areas of nearly level to gently sloping prairies in the central part. The largest areas of rolling land are in the southwestern and west-central parts, but strongly sloping land also occurs along many of the streams. The average elevation is about 1,510 feet above sea level; the highest, 1,650 feet. Drainage is well established, three

main streams carrying water south and southwest into the Missouri River.

Agriculture at present consists chiefly of growing grain and raising livestock. The production of livestock, particularly beef cattle and hogs, occupies an important place. Corn is the principal crop, followed by oats, barley, flax, and hay.

The soils of the county are friable and moderately heavy, dark, and high in organic matter and lime. They are developed under tall grass-prairie vegetation from three broad types of parent material: (1) Loess, (2) unassorted till, and (3) water-sorted drift. The soils are classified and mapped in 20 series, with their several types, phases, complexes, and land types.

From the standpoint of their relation to the general topography of the county the soils are arranged in 15 groups. Soils of the loessal upland, which are placed in the first 4 groups, are the most extensive. Prominent in this group are the Moody soils, of group 1, which aside from being the most widespread, constitute much of the best agricultural land. The Moody soils are well adapted to agriculture by natural high fertility, freedom from stones, nearly level to gently sloping surfaces, and a friable and moderately heavy surface soil and subsoil, which make for ease of cultivation, rapid root development, and satisfactory water absorption and retention.

Vienna soils, found on the glacial upland and classified in groups 5 and 6, are similar to the Moody soils except that they are stony and have heavier textured subsoils. Occurring on undulating to steep terminal moraine topography underlain by friable medium textured till, the Pierce soils of group 6 are droughty. The Alcester soils and Moody silty clay loam, level phase, in group 9, differ from the Vienna and other Moody soils in occupying slightly lower positions and in having deeper and darker surface soils. They are wetter than the Vienna and other Moody soils and slightly inadequately drained.

The soils of groups 7 and 8 on outwash plains and stream terraces are well to excessively drained, owing to the presence, generally within 3 feet of the surface, of coarse water-sorted sand and gravel. From the standpoint of suitability for agriculture, particularly in regard to droughtiness, the Fairhaven soils are similar to the Fordville. The Estherville soils resemble the Sioux, both being more droughty than either the Fairhaven or Fordville. The Fairhaven and Estherville, which occur on higher outwash plains, are older, slightly lighter in color, and contain less organic matter and lime than the Fordville and Sioux, which are found on stream terraces.

The soils of group 10 are poorly drained. Originally they were probably under water most of the time.

Groups 11, 12, and 13 comprise soils of alluvial land in the valleys along stream channels. They are subject in varying degree to inundation during floods. Soils of group 11 are well drained; those of group 12 are subject to temporary high water table and frequent flooding; and those of group 13 are permanently wet.

The shallow, droughty, mainly stony and steep soils of groups 14 and 15, which have one or more characteristics that either hinder or preclude their use for the growing of cultivated crops, are divided on the basis of these characteristics.

Estimates of yields and productivity show for each soil its relation among the soils of the county in terms of relative productivity for the important crops grown under current management and under improved practices. Drainage and cultivation, crop rotation, addition of organic matter and commercial fertilizers, and erosion control are some of the practices necessary to keep the land permanently productive. The recommendations made are of a general nature and may apply to a single soil type or to a group of similar soils.

GENERAL NATURE OF THE AREA

LOCATION AND EXTENT

Rock County is in the extreme southwestern corner of Minnesota (fig. 1), its boundaries on the south and west being formed by the Iowa and South Dakota State lines, and on the north and east by

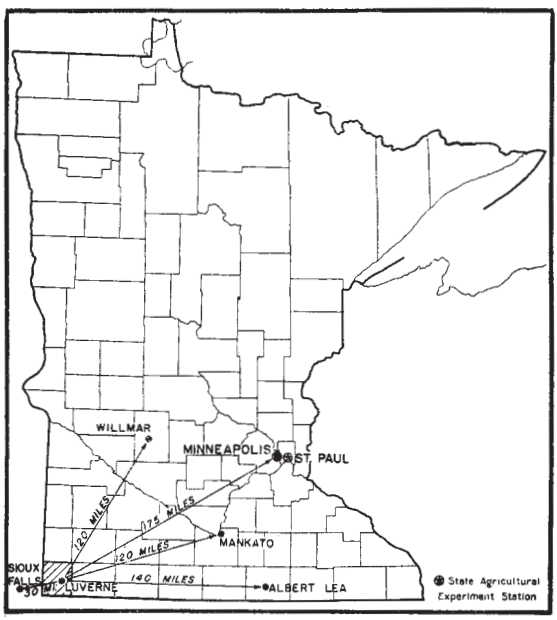

FIGURE 1.—Location of Rock County in Minnesota.

Pipestone and Nobles Counties. The total area is 310,400 acres. Luverne, the county seat, is 30 miles northeast of Sioux Falls, S. Dak., and 175 miles southwest of Minneapolis and St. Paul, Minn.

PHYSIOGRAPHY, RELIEF, AND DRAINAGE

Lying within the prairie region of the upper Mississippi Valley, the entire area of the county was probably overridden (*6*)[2] by one of the early ice sheets during the Kansan stage of glaciation. The

[2] Numbers in parentheses refer to Literature Cited, p. 66.

smooth or undulating surface of the drift plain was subsequently dissected by erosion until it took on a hilly aspect. In some places sand was deposited over the surface or left as outwash plains; in others, where the glacial drift over the Sioux Falls quartzite was not very thick, it was entirely removed by erosion.

The eroded surface of the drift was later covered by loess, or wind-laid material, which gave it a smooth slightly undulating to strongly rolling surface, conforming roughly to the underlying drift topography. The sharper knolls usually received a considerably thinner loessal covering than the valleys or swales.

Although only the northeastern corner of the county was covered by the later Iowan glaciation, glacial sand and gravel outwash probably covered much of the lower elevations, particularly east of the Rock River, and filled much of the valley network developed in the Kansas glaciation. There is considerable evidence that the loess is Peorian. The old outwash is covered in places by what is apparently loess, between which and the Iowan drift there is no definite line of demarcation, the two loessal deposits and the outwash plains blending imperceptibly into each other.

The loess mantle is thickest in the southwestern part of the county and gradually thins out to the north and east. The usual thickness is between 6 and 10 feet. Extremes of 15 feet are found in places throughout the rolling area in the western part of Beaver Creek Township and of 4 or 5 feet in the northern and southeastern parts of the county, where the loess blends into the drift and outwash deposits.

The section south of Chanpepedan Creek and east of the Rock River appears to be covered by loess. In places, especially along the Nobles County line, however, it is almost impossible to tell whether the soils are developed from loess or glacial drift.

The most outstanding physiographic features are the precipitous escarpment of the Sioux Falls quartzite in secs. 13 and 24 to 27 of Mound Township; a swamp in Rose Dell and Denver Townships; and the steep, abrupt escarpments of the old outwash plains bordering the streams in Battle Plain and Vienna Townships.

The outcrops of Sioux Falls quartzite are outstanding in the north-central and northwestern parts; however, in other comparatively large areas the rock projects ½ to 5 feet above the present ground surface. These projections are 1 to 15 feet wide and occur at distances from a few feet to several hundred feet apart, the intervening space usually filled with loess varying from less than 1 foot to 4 or 6 feet thick. Glacial action gave the rocks projecting above the ground a rounded or lenticular shape. This rock is very hard and ranges from pinkish red to dark reddish brown, and the highly polished loess surface glistens in the sunlight as if covered by ice. In fresh exposures it is usually brownish red or red.

Many of these exposed rock surfaces support a growth of bluish-gray lichen and some green moss that give them a bluish color when seen from a distance. The area just north of Luverne, in secs. 13, 14, and 23 to 27, was named Blue Mound because of this phenomenon.

Sioux Falls quartzite is quarried for building stone and makes excellent coarse aggregate for concrete. Its hardness, however, makes crushing expensive and unprofitable as compared with the processing

of gravel or crushed limestone. A quarry at Jasper cuts quartzite for lining porcelain ovens.

The average elevation of the county is about 1,510 feet, the highest land running northwest from Mound being 1,650 feet. The surface varies from almost level to rolling, the greater part being gently to strongly undulating. The more nearly level areas occur in Rose Dell, Denver, Luverne, Clinton, Magnolia, and Kanaranzi Townships and on the stream terraces and glacial outwash. The majority of the strongly undulating areas occur along the Rock River and Split Rock Creek, in the southern and eastern parts of Spring Water, eastern part of Beaver Creek, and western part of Martin Townships. The largest area with rolling relief occurs in the western part of Beaver Creek and northwestern part of Martin Townships.

Although all of the county has good surface drainage, it is doubtful whether the present contour of any large area is the result of erosion. Strips of a fourth to half a mile wide bordering the principal streams show the greatest dissection.

The Rock River and its tributaries drain the eastern half of the county; Split Rock Creek, the northwestern corner; and Beaver Creek, the west-central part. The Rock River and its major tributaries on the east and Split Rock Creek have their origin in the Wisconsin moraine that passes around the county on the north and east. Beaver Creek has its origin within the county and probably at one time served as an outlet for the swamp or shallow lake then covering secs. 12, 13, 14, and 23 of Rose Dell Township and sections 7, 18, and 19 of Denver Township. The opening into the creek in time probably became closed by loess, after which the direction of natural drainage shifted toward the west. Within recent years the area has been artificially drained, and the outlet of the tile system is probably near the same point as the original outlet into Beaver Creek.

CLIMATE

Rock County has a continental climate that borders upon subhumid. The seasons show considerable variation in temperature, but in general the winters are long and cold and the summers comparatively short and hot. Some summers, however, are cool, having few hot days. The nights are usually cool. The winters are sometimes mild, with very little snow and few extremely cold days, or, on the other hand, there may be much subzero weather, with only a few mild days. The fall months are often clear and cold without severe freezing weather until the latter part of November or first of December. The mean annual temperature recorded at Worthington, Minn., is 44.2° F. The maximum and minimum temperatures recorded are 102° and −37°, respectively. The hottest weather occurs from June through September, and the coldest from December through February. During some years snowfall is fairly heavy and may block the highways for 1 or 2 days.

The mean annual rainfall at Worthington (Nobles County) is 27.13 inches, the maximum, 40.5 inches (1941), and the minimum, 14.49 inches (1910). The precipitation may be in the nature of light steady rains or heavy rains of short duration. The heavy rains, during which 1 to 2 inches often fall in a few hours, usually occur late in spring and

in summer. Heavy rains are of doubtful value, however, not only since much of the water is lost by runoff but because of the resulting erosion, especially on the more sloping areas. Snows that fall before the ground is frozen are valuable sources of moisture, which is absorbed by the soil as the snow melts. On the whole the short and comparatively cool summers, with their relative low evaporation, are approximately equivalent to those farther south with a higher rainfall but with more heat and consequently greater evaporation.

The important climatic data at the Worthington station, Nobles County, Minn., which is representative of Rock County, are given in table 1.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Worthington, Nobles County, Minn.*

[Elevation, 1,593 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total for the driest year	Total for the wettest year	Average snowfall
	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*	*Inches*
December	19.4	57	−30	0.61	0.05	0.77	4.2
January	14.1	55	−36	.63	.75	.72	6.0
February	17.2	62	−37	.77	[1]	1.74	6.2
Winter	16.9	62	−37	2.01	.80	3.23	16.4
March	30.0	78	−20	1.26	.08	1.48	7.0
April	45.3	85	8	2.08	.88	2.40	1.7
May	56.5	90	21	3.94	1.74	7.28	[1]
Spring	43.9	90	−20	7.28	2.70	11.16	8.7
June	66.0	101	33	4.29	3.23	7.86	0
July	71.2	102	40	3.39	1.89	3.21	0
August	69.1	96	33	3.76	1.91	2.40	0
Summer	68.8	102	33	11.44	7.03	13.47	0
September	61.1	98	22	3.54	2.90	11.16	0
October	48.4	86	6	1.69	.98	.32	.6
November	32.5	72	−13	1.17	.08	1.16	2.9
Fall	47.3	98	−13	6.40	3.96	12.64	3.5
Year	44.2	102	−37	27.13	[2] 14.49	[3] 40.50	28.6

[1] Trace. [2] In 1910. [3] In 1941.

Weather Bureau reports from Worthington show the average date of the last killing frost in spring to be May 9 and that of the first killing frost in fall, September 30, making an average growing season of 20 weeks, usually sufficient for crops to mature. When spring rains

delay planting, however, the corn crop sometimes is slightly damaged by early fall frosts. Soils on the stream flood plains in spring are usually so wet as to cause delay in planting and in fall are usually subject to early and damaging frosts.

In dry years, hot south winds during July and August cause considerable damage to crops, particularly to those on soils subject to drought. They may prevent small grains from filling and retard corn in its development. In normal years only the more droughty soils are affected to any marked degree. Hailstorms are likely to do considerable damage over limited areas. Storms may be frequent in some years, usually during June, July, and August, and few in others. The degree of damage suffered by crops in affected areas varies from slight to almost complete destruction.

VEGETATION

Except in some of the stream breaks and a narrow strip along the Rock River, the native vegetation consists mainly of grasses, of which there are a number of species. Although more than one grass grows in the same place, certain grasses seem to predominate in a given area. Their distribution is apparently controlled by the physical characteristics of the soil, the determining factor being its ability to absorb and hold moisture.

Lichens, which grow on the smooth quartzite rock surface, present the extreme in tolerance for deficiencies of moisture and plant nutrients. In shady places along streams and in seepage areas, moss grows on rocks with the lichens. White sage (*Artemisia ludoviciana*) grows on many of the gravelly terrace escarpments, especially those that are steep and have gravel within a few inches of the surface. The extent of the area covered by white sage seems to be controlled by degree of slope, porosity of soil, and depth to gravel.

Just back of this fringe of sage, on areas that are ordinarily droughty, blue grama grass (*Bouteloua gracilis*) is found. As most of the terraces underlain by gravel have been cultivated, the relation of the growth of other grasses to these environmental factors could not be studied thoroughly. The relations, however, were evident in virgin areas at Blue Mound Park and were definitely associated with thickness of loess mantel over rock or gravel. In one place scattered areas of side-oats grama grass (*B. curtipendula*) associated with the blue grama were observed, but the side-oats grama appeared to have the heaviest stand and most thrifty growth where the soil was a little less droughty than in the places where most of the grass was blue grama. Blue grama predominates on the more droughty or shallower soils and steeper slopes of virgin areas of Rock outcrop-Ihlen complex, and the side-oats grama grows best in less droughty places.

A scattering of big bluestem (*Andropogon furcatus*) was noticed in places among these grasses, particularly in association with side-oats grama grass. Where western wheatgrass and wild ryegrass predominated it was apparently because the greater depth and more favorable degree of slope permitted the subsoil to absorb and retain water. The difference between the factors influencing the growth of these two grasses and the side-oats grama, however, was not so marked

as that between the sage and blue grama, or blue grama and side-oats grama.

The dominant grass is big bluestem. This grass grows luxuriantly on the well or moderately drained soils that seldom show severe effects of drought. The best virgin growth of big bluestem observed was on an imperfectly drained area with slow underground seepage from the hills. Areas that are inadequately drained and remain wet for considerable periods or late in spring support a growth of cordgrass (*Spartina pectinata*) and barnyard grass (*Echinochloa crusgalli*). Such places are found along some of the small streams and in the lower uplands. Cattails grow in a few small sloughs or seepy areas.

The dominant trees along the streams are oak, willow, boxelder, plum, elm, ash, and hackberry. Inasmuch as early settlers stated that forest growth occurred only along the Rock River, it is concluded that most of the trees have grown since that time. Buckbrush is found along some of the steeper breaks where the upland drops to the stream terraces or bottom lands or on some of the stony slopes and some of the bottom lands, especially on areas of Alluvial soils, undifferentiated, adjacent to larger stream channels. Wild plum trees are found in places, particularly in the well-drained bottom lands, and some on the upland, but these probably have grown since the county was settled. They are apparently most numerous along the Rock River and Kanaranzi and Beaver Creeks.

Practically every house has its shelterbelt or windbreak, usually of ash, boxelder, cottonwood, or willow. There are also a number of black walnut trees of healthy appearance but not so large and vigorous as those farther south.

ORGANIZATION AND POPULATION

The area now comprising Rock County became part of the United States through the Louisiana Purchase (1803) (*8*), but was under the successive jurisdiction of the Territories of Missouri, Michigan, Wisconsin, and Iowa before being incorporated into Minnesota. The Indians gave up their right to the area in a treaty made in 1852. The present area was originally a part of Blue Earth and Brown Counties, Minn. On May 23, 1857, the part now known as Rock County was made a separate county. The county at first extended 10 miles farther west than now. The present western boundary was fixed in 1861, when the Dakota Territory line was established.

The first permanent settlement was made in 1867, although explorers, traders, and trappers had been visiting the area many years before. The townships were organized between 1871 and 1878. Battle Plain Township received its name from an Indian battle that took place near the Rock River.

The majority of the earlier settlers were from the eastern part of Minnesota and Iowa. Settlement was delayed by the Civil War and Sioux Indian raids, and the crops of the early settlers were damaged by drought and grasshoppers. Grasshoppers were so destructive from 1871 to 1875 that seed loans and other relief had to be obtained from the State legislature.

The 1940 census gives the county population as 10,933, of which 71.5 percent is classed as rural. The average rural population is 16.1

persons per square mile. In 1910 the population was 10,222, the rural population making up 75.9 percent of the total, and its density, 15.6 per square mile. The majority of the citizens are of German and Scandinavian extraction.

One of the earliest settlements was on an old stage route to Yankton, S. Dak., near the center of the county on the present site of Luverne. This town, which was proclaimed the county seat in 1870, is now the largest one in the county. The towns of Hills and Beaver Creek in the southwestern part, Magnolia in the east-central, and Hardwick in the north-central part have smaller populations. Steen and Ash Creek in the southern part, Kanaranzi in the southeast, and Kenneth in the northeast are small but important trading centers. A part of the town of Jasper is within the county, the business district in Pipestone County and the section containing the quartzite quarry in Rock County.

All these towns serve as trading centers and shipping points, although their volume of trade has diminished with the construction of good roads. There are cooperative creameries at Hills and Luverne.

TRANSPORTATION AND MARKETS

Rock County is well served by railroads. The Chicago, St. Paul, Minneapolis & Omaha, built between 1876 and 1877, crosses it from east to west through Magnolia, Luverne, and Beaver Creek. The Chicago, Rock Island & Pacific crosses the eastern part in a north-south direction through Kanaranzi, Luverne, and Hardwick, with a branch from Hardwick through Kenneth. A branch of the Illinois Central passes through the southwestern corner through Steen and Hills. Branches of the Great Northern cross the northwestern and southwestern corners through Jasper, Hills, and Manley.

Two concrete Federal highways pass through the county; United States Highway No. 75 passes through the center from north to south, and U. S. No. 16 crosses the county in an east-west direction through Magnolia, Luverne, and Beaver Creek. Besides the main highways the county has a number of good graveled State and county roads from which very few farms are more than 2 miles distant. This network of railroads and surfaced roads furnishes ample facilities for the shipment of farm products, most of which go to the grain and livestock markets in Sioux Falls, S. Dak.; Sioux City, Iowa; and Minneapolis and South St. Paul, Minn. The greater part of the grain is kept for feeding livestock, but what is sold is hauled to elevators at the various towns and shipped to market by railroad. A large part of the livestock is shipped by truck.

CULTURAL DEVELOPMENT AND IMPROVEMENT

The county is amply supplied with rural schools and churches. There are high schools at Luverne, Beaver Creek, Hills, and Magnolia, busses being used to transport rural students to and from school. An active Farm Bureau organization furnishes rural cultural and social life. A 4–H organization provides many social and educational activities and always takes a prominent part in the State livestock show at South St. Paul. Practically all the farms are improved (pl. 1, *A*)

and well equipped with farm machinery. Telephones are common, and electric power and light are used on many farms.

AGRICULTURE

Farming in Rock County as in other places in the Corn Belt has always consisted of growing grain supplemented by raising livestock. The growing season is short, and to save time the majority of farmers plow part of their land in fall, as it dries out more quickly and permits earlier spring planting. Some farmers favor spring plowing, especially during the drier years, for stubble, weeds, and cornstalks have a tendency to hold the snow and prevent the blowing away that so often occurs on fall-plowed land; moreover, land plowed in fall is more likely to be affected by wind erosion. A shift in the acreage grown to the different crops over the years from 1879 to 1939 is shown in table 2, which gives the acreage of the principal crops.

Wheat was the predominant crop prior to 1900, but because of the frequent damaging effects of rust it dropped to minor importance in 1910 and by 1939 was sown on only 936 acres. During the same period flax production and cutting wild prairie grasses for hay were important. Meanwhile the acreage planted to various crops was undergoing change and the number of farms was increasing. In 1880 there were 721 farms in the county and by 1900 they numbered 1,169. Between 1900 and 1940, however, only 198 new farms were reported. Apparently most of the area had been brought under cultivation by 1900 and agriculture was becoming stabilized. This fact explains the decrease in wild grasses cut for hay and the increase in acreage of alfalfa and clover. At present the dominant crops are corn, oats, and barley, most of which are used locally as livestock feed.

TABLE 2.—*Acreages of the principal crops in Rock County, Minn., in stated years*

Crop	1879	1889	1899	1909	1919	1929	1939
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Corn (grain)	5, 551	17, 534	44, 166	60, 051	80, 701	93, 668	86, 167
Oats	7, 974	25, 842	34, 433	63, 464	82, 001	71, 150	67, 488
Barley	1, 762	12, 864	49, 788	38, 235	6, 656	24, 703	[1]18,356
Flaxseed	------	16, 874	1, 722	487	677	3, 005	15, 944
Wheat	36, 018	27, 684	74, 211	2, 276	4, 264	194	936
Hay and forage:							
All hay	10, 031	26, 833	25, 503	34, 791	27, 918	25, 199	25, 062
Alfalfa	------	------	------	29	633	8, 109	11, 319
Clover	------	------	1, 669	548	785	1, 742	[2] 1, 191
Timothy and clover alone or mixed	------	------	------	19, 727	11, 847	2, 870	872
Other tame grasses	------	------	6, 731	844	1, 559	1, 200	4, 271
Wild hay	------	------	17, 377	13, 643	13, 094	11, 278	7, 409
Coarse forage	------	------	350	593	4, 634	[3] 3, 558	[4] 1, 498
Silage	------	------	------	------	1, 900	[3] 1, 394	[4] 1, 765
Potatoes	------	641	1, 094	2, 748	2, 456	1, 095	691

[1] For threshing. [2] Sweetclover. [3] Corn. [4] Corn and sorghum.

Corn is the principal crop and at present probably comprises nearly 50 percent of the crop acreage. The greater part of it is planted in check rows, but some is drilled. This crop is usually cultivated three times, unless other farm operations interfere, when it may get only two cultivations. Hybrid corn is becoming very popular—in 1944 and 1945 hybrid varieties made up fully 90 percent of all plantings. The yields average more than 5 bushels an acre above those of open-pollinated varieties. Farmers report hybrid corn holds the ears better, lodges less, and produces fewer nubbins. The principal hybrid varieties grown are Minhybrid 301, Kingscrost, DeKalb 202, Pioneer 357, and Pioneer 355. The principal open-pollinated varieties are Minnesota 13, Golden Jewel, Murdock, and Silver King. A large percentage of the corn is harvested by machine.

Oats are sown following corn. The land is disked and the seed broadcast with an endgate shotgun or broadcast seeder, after which the land is again disked at right angles to the previous disking. Since cornstalks interfere with drilling, broadcasting is preferred. Gopher, Iogold, Iowa 105, and Iowan were once the most popular varieties of oats, but are being rapidly replaced by Clinton and Bonda, two more recent introductions. Methods used in growing barley are the same as for oats. Flax acreage has increased with the introduction of wilt-resistant varieties, the principal ones of which are Redwing and Bison.

Alfalfa is the principal hay crop. Two to three cuttings are obtained, the number depending upon the season and the soil on which grown. The Minnesota State Highway Department, where possible, constructs the road ditches with a gentle slope, so they may be planted to alfalfa, which is subsequently cut by farmers on adjacent land. This arrangement is advantageous to both parties in providing the farmer an additional source of livestock feed and reducing the cost of road upkeep. The principal varieties of alfalfa used are Grimm, Dakota 12, Cossack, and Ladak.

Sweetclover is an important pasture crop. The greater part of the pastures, however, are native grasses, among which Kentucky bluegrass predominates, with side-oats grama and blue grama in varying quantities.

The value of principal agricultural products by classes from 1899 to 1939 are shown in table 3, which indicates a gradual increase in value of poultry and dairy products. Most of these products are sold to local processing plants.

Cereals rank first in value and domestic animals, second. Domestic animals, among which cattle and hogs lead in importance, are raised both as breeding stock and for market. Most of the grain raised is used for feeding cattle and hogs.

Hereford is the principal breed of beef cattle; however, a number of Shorthorn and some Aberdeen Angus are raised. A number of farmers buy cattle outside the county and ship them in for fattening. Holstein-Friesian and Guernsey breeds predominate among the dairy herds, although the largest percentage of milk cows are mixed breeds. The majority of the swine are raised locally, the main breeds being Duroc, Chester White, Spotted Poland China, and Hampshire. There are only a few sheep compared with the number of cattle and swine.

TABLE 3.—*Value of principal agricultural products by classes in Rock County, Minn., in stated years, 1899–1939*

Products	1899	1909	1919	1929	1939
Crops:					
Cereals	----------	$2, 043, 051	$6, 666, 421	$3, 864, 523	$2, 873, 072
Other grains and seeds	----------	11, 516	37, 832	134, 394	199, 423
Fruits and nuts	$2, 030	7, 417	12, 249	8, 599	----------
Hay and forage	----------	315, 685	803, 431	468, 649	354, 104
Vegetables	----------	81, 350	345, 140	109, 295	1, 533
Livestock:					
Domestic animals:					
Total	1, 176, 185	2, 401, 313	4, 282, 476	3, 734, 317	2, 689, 990
Sold or slaughtered	385, 498	931, 527	----------	----------	1, 968, 153
Dairy products [1]	68, 076	182, 060	401, 238	665, 572	371, 465
Poultry and eggs	26, 629	117, 890	306, 708	494, 106	373, 673
Wool	----------	20, 730	13, 550	13, 916	18, 132

[1] Products sold.

A few farmers specialize in turkey raising. One hatchery keeps a flock of turkey hens to produce part of the eggs needed for hatching. Other eggs are shipped in from California. Some farmers buy the poults they raise. About 20,000 to 30,000 turkeys are raised annually and as a rule are fed and pastured on rape sown in oats or barley stubble.

Commercial fertilizer has been used very little, although its use in general increased rapidly during World War II.

Labor is usually obtained locally except during harvest season, when transient labor is used. Tractors provide power on a majority of the farms.

The Federal census of 1940 gives the number of farms in the county as 1,368, with an average size of 219.4 acres. More than a third, or 514, were between 140 and 179 acres in size; 63 were under 50 acres; 77 from 50 to 99; 619 from 100 to 219; 587 from 220 to 499; and 22 had more than 500.

Farm tenure has changed greatly in the last 60 years, the trend being away from operation on almost complete ownership toward a predominantly tenant and manager basis. Owner-operated farms have decreased from 89.2 percent in 1880 to 39.8 percent in 1940. During the same period tenant-operated farms increased from 10.8 to 59.8 percent. In the largest holdings the land is rented to tenants or other farm owners. The number of farms and tenure in census years from 1880 to 1940 are shown in table 4.

At the time the survey was made cash rentals ranged from $4 to $6 an acre; the greater part of the land, however, is rented on a share-crop basis of two-fifths to the landlord and three-fifths to the tenant, who furnishes seed, labor, and machinery. The tenant has to put the landlord's corn in the crib but the landlord pays for shelling his share. The tenant and landlord usually divide the threshing bill on the same basis as they share the crop. Pasture or hay land rents for $5 cash,

with the landlord generally furnishing the seed for the grass or pasture.

TABLE 4.—*Statistics on farm operation in Rock County, Minn., in stated years, 1880–1940*

Year	Total farms	Farms operated by—		
		Owners	Tenants	Managers
	Number	*Percent*	*Percent*	*Percent*
1880	721	89. 2	10. 8	--------
1890	931	67. 7	32. 3	--------
1900	1, 169	48. 6	50. 5	0. 9
1910	1, 205	42. 5	56. 8	. 7
1920	1, 307	40. 4	58. 9	. 7
1930	1, 338	37. 1	62. 4	. 5
1940	1, 368	39. 8	59. 8	. 4

In 1910 the average value of farms per acre, including buildings, was $67.60. Of this amount, 77 percent represented land; 10.9 percent, buildings; 2.3 percent, implements; and 9.8 percent, domestic animals. In 1920 the average value of land per acre was $209.08, and in 1930, $107.25. Land in 1930 represented 66.7 percent of the value; buildings, 17.7 percent; implements, 5.2 percent; and domestic animals, 10.4 percent. There has been a decided increase in the percentage of value represented by buildings and implements, which are fixed investments. The Federal census data for 1940 showed the land value per acre as $71.94. As the production value of the land remains about the same or greater, the data indicate that a very large part of the shrinkage in value is due to the fact that the farm buildings were constructed during the boom days. Actually, the average yields and farm income over a long period should furnish the basis for the valuation of a farm and determine the extent of any improvements or indebtedness.

SOIL SURVEY METHODS AND DEFINITIONS

In making a soil survey the soils are examined, classified, and mapped in the field and their characteristics recorded, particularly in regard to the growth of various crops, grasses, and trees.

The soils and the underlying formations are examined systematically in many locations. Test pits are dug, borings made, and highway or railroad cuts and other exposures studied. Each reveals a series of distinct soil layers, or horizons, termed collectively the soil profile. Each horizon, as well as the underlying parent material, is studied in detail, and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The chemical reaction of the soil and its content of lime and salts are

determined by simple tests.[3] Other features taken into consideration are the drainage, both internal and external, the relief or lay of the land, and the interrelations of soil and vegetation.

The soils are classified according to their characteristics, both internal and external, with special emphasis upon the features that influence the adaptation of the land to the production of crop plants, grasses, and trees. On the basis of these characteristics the soils are grouped into classification units, the principal three of which are (1) series, (2) type, and (3) phase. In some places two or more of these principal units may be in such intimate or mixed pattern that they cannot be clearly shown separately on a small-scale map but must be mapped as (4) a complex. Some areas that have no true soil—as Alluvial soils, undifferentiated—are termed miscellaneous land types.

The series is a group of soils having the same genetic horizons, similar in their important characteristics and arrangement in the profile and having similar parent material. Thus, the series comprises soils having essentially the same color, structure, natural drainage, and other important internal characteristics and the same range in relief. The texture of the upper part of the soil, including that commonly plowed, may vary within a series. The series are given geographic names taken from localities near which they were first identified. Moody, Fairhaven, Fordville, Vienna, Estherville, and Sioux are the names of important soil series in Rock County.

Within a soil series are one or more types, defined according to the texture of the upper part of the soil. Thus, the class name of this texture—sand, loamy sand, sandy loam, silt loam, clay loam, silty clay loam, or clay—is added to the series name to give a complete name to the soil type. For example, Moody silt loam and Moody silty clay loam are soil types within the Moody series. Except for the texture of the surface soil, these types have approximately the same internal and external characteristics. The soil type is the principal unit of mapping, and because of its specific character it is usually the unit to which agronomic data are definitely related. In comparisons of the type and phases of that type, to avoid the repetition of their complete names, the type is sometimes referred to as the normal phase.

Soil phases are subdivisions of a soil type, each differing from the others in some feature other than major profile features that may be of special practical significance. For example, within the normal range of relief of a soil type some areas may have slopes adapted to the use of machinery and the growth of cultivated crops and others may not. Differences in relief and degree of accelerated erosion may be shown as phases. Even though no important differences may be apparent in the soil profile, there may be important differences in respect to the growth of cultivated crops. In such instance the more sloping parts of the soil type may be segregated on the map as a sloping or a hilly phase.

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[3] The reaction of the soil is its degree of acidity or alkalinity expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality; higher values, alkalinity; and lower values, acidity. Indicator solutions are used to determine the chemical reaction. The presence of lime is detected by the use of a dilute solution of hydrochloric acid.

Examples of soil complexes are found in Crofton-Moody silt loams and Kranzburg-Vienna stony silt loams, in which the soils are so intimately associated that they cannot be separated on a map of the scale used.

The soil surveyor makes a map of the county or area, showing the location of each of the soil types and phases in relation to roads, houses, streams, lakes, section and township lines, and other cultural and natural features of the landscape.

SOILS

The soils of Rock County are developed under the dominant influence of tall grasses. The subhumid climate, with long cold winters and short warm summers, and the prevailing prairie vegetation have combined to produce soils belonging to the Chernozem great soil group. From the eastern part of the county, where they merge with the Prairie soils, the Chernozem soils form a belt extending westward almost into the center of the Dakotas.

In comparison with the soils of the United States as a whole, those of this county are high in natural fertility, particularly organic matter, nitrogen, and lime. Conditions of climate and vegetation have combined to favor the accumulation of large quantities of organic matter in the surface soil so that that top layer of these soils is darker than in upland soils found in other parts of the country. A typically developed soil has the following outstanding characteristics: (1) A deep dark-colored (brownish-black, dusky-brown, or brownish-gray) friable silty surface soil, grading downward into (2) a dusky-brown to weak-brown moderately friable subsurface soil, which in turn gives place to (3) a dark yellowish-brown to moderately yellowish-brown subsoil. A zone of lime accumulation, characterized in its upper part by a layer of lime concretions, begins at depths of 28 to 40 inches.

The soils of the county are developed from three broad types of parent material: (1) Wind-laid silty material, or loess; (2) unassorted glacial till; and (3) water-sorted glacial drift or glacial outwash and stream sediment. Since loess covers most of the county, the most extensive soils have developed on this uniform silty material. Soils developed on unassorted till are confined largely to the two townships in the northeastern part of the county, north and east of Luverne. In these two townships there are also many soils developed from glacial outwash and stream sediment.

Some soils develop side by side under the same conditions of climate, drainage, and vegetation from different parent materials. Although these soils are so similar in a sufficient number of general features that they are classed in the same great soil group, they differ in many other respects, owing to variations in parent material. These variations must be recognized, as they usually have an effect, which at times may be very marked, on the physical and chemical composition of the soil.

Since in its unaltered state loess nearly everywhere has relatively uniform physical properties and since the climate is uniform throughout the county, the differences that now exist among loess-developed soils are due to the influence of varying conditions of topography, drainage, and vegetation. Steeper slopes present a situation compara-

A, Typical group of farm buildings on improved farm in Rock County, Minn.
B, Road cut in Moody silty clay loam, showing 5 feet of loess covering on till.
C, Young corn on Moody silty clay loam, gently sloping phase, showing the effect of sheet erosion during heavy rains.

ble with an arid climate and affect the use of the soil. They are less easily tilled and under cultivation are more vulnerable to erosion. Lack of drainage hinders soil development, so that soils developed under poor drainage are different from those of the well-drained uplands.

From the standpoint of their relation to the general topography of the county, the soils are discussed in 15 general groups in the following pages.

GROUP 1. DEEP[4] WELL-DRAINED SOILS OF THE LOESSAL UPLANDS

The deep well-drained soils of the loessal uplands, which comprise about half of the total area of the county, make up its most important agricultural land. Occurring on level to gently sloping land, they do not need artificial drainage to produce the crops grown in this livestock and cash-grain type (*4*) of farming area.

These soils are friable throughout, permitting ease of cultivation and rapid root penetration. Their medium to fine texture and high organic-matter content enable them to retain the moisture that they readily absorb. Their surface soil ranges from dark brownish-gray to black silt loam or silty clay loam, which is friable, granular, and stone-free and grades downward into yellowish-brown friable stone-free silty clay loam. The following soils are included in group 1:

Flandreau silt loam, deep phase.
Kranzburg silty clay loam and its gently sloping phase.
Moody silt loam and its gently sloping phase.
Moody silty clay loam and its gently sloping and terrace phases.

GROUP 2. SHALLOW TO MODERATELY SHALLOW WELL-DRAINED SOILS OF THE LOESSAL UPLANDS

Similar to the soils of group 1, the shallow to moderately shallow, well-drained soils of the loessal uplands are developed from wind-laid silty materials. They differ, however, in several important characteristics—they occur on rolling rather than level topography, are lighter colored, and have thinner surface and subsoil layers. The soils included in group 2 are as follows:

Crofton-Moody silt loams.
Moody silt loam, rolling phase.

GROUP 3. WELL-DRAINED SOILS OF THE LOESSAL UPLANDS, MODERATELY SHALLOW OVER SAND OR GRAVEL

Although the well-drained soils of the loessal uplands, moderately shallow over sand or gravel, have developed similarly to those of group 1 from wind-laid silty materials, the existence in this group of a permeable substratum mixture of sand or sand and gravel within 3 feet of the surface makes them less able to retain moisture than those of group 1. The following soils are included in group 3:

Flandreau loam and its sloping phase.
Flandreau silt loam and its sloping phase.

[4] Deep, shallow, and moderately deep loess are relative terms and as here used apply to Rock County only.

GROUP 4. WELL-DRAINED SOILS OF THE LOESSAL UPLANDS, MODERATELY SHALLOW OVER BEDROCK

The well-drained soils of the loessal uplands, moderately shallow over bedrock, also are developed from wind-laid silty materials. Because they are moderately shallow, being underlain by bedrock at depths of 3 feet or less, they likewise have a low water-holding capacity. The following soils are in group 4:

Ihlen silt loam and its stony and stony gently sloping phases.

GROUP 5. DEEP WELL-DRAINED SOILS OF THE GLACIAL UPLANDS

The deep well-drained soils of the glacial uplands, which are largely confined to the northeastern part of the county, have their origin in glacial till, but apparently that of an older ice sheet than the Late Wisconsin from which Barnes soils of southwestern Minnesota are derived.

They are developed on upland slopes with a similar slope gradient, in the same climate, and under similar grassland vegetation as soils of group 1. The glacial till from which they are largely derived imparts both a gritty and clayey feel not apparent in the Moody series and other silty soils of the loessal upland.

In spite of their apparently higher clay content, field observations indicate that they have a tendency to be drier than the Moody soils. Crops grown on these soils show greater signs of moisture stress during hot, dry spells than those on some other soils. Their structure permits comparatively free root penetration but less than in soils of the Moody series.

The surface soil is dark brownish gray to nearly black, high in organic matter, friable, and granular; the subsoil is less granular and generally dark yellowish brown, grading to a variegated but dominantly yellowish brown in the lower part. Soft gray spots of lime accumulation and hard lime concretions about the size of a pea are conspicuous in the subsoil. The following types are included in group 5:

Vienna-Flandreau silty clay loams.
Vienna loam and its gently sloping phase.
Vienna silty clay loam and its gently sloping phase.

GROUP 6. SHALLOW WELL-DRAINED SOILS OF THE GLACIAL UPLANDS

In general the shallow well-drained soils of the glacial uplands occur on rolling to steep topography, although minor areas may be undulating. The soils are developed largely from glacial material. The Pierce soils, however, were also influenced by a thin loess mantle in many places. All soils of the group are shallow and subject to drought. The following soils are included in group 6:

Pierce silt loam.
Vienna silty clay loam, strongly sloping phase.

GROUP 7. WELL-DRAINED NEARLY LEVEL TO GENTLY SLOPING SOILS OF THE OUTWASH PLAINS

Like the soils of group 3 the well-drained nearly level to gently sloping soils of the outwash plains also are usually underlain within

3 feet of the surface by sand and gravel. They differ from that group, however, by occupying outwash plains. Their underlying materials, which are water-worn, generally are coarser and more thinly stratified than the soils of group 3, indicating more thorough sorting by water. Soils of group 7 occur on very gentle slopes slightly lower than the adjacent uplands. Included in group 7 are the following soils:

Estherville loam, gently sloping phase.
Fairhaven silt loam, shallow and gently sloping shallow phases.
Fairhaven silty clay loam.

GROUP 8. WELL-DRAINED NEARLY LEVEL TO GENTLY SLOPING SOILS OF THE STREAM TERRACES

The well-drained nearly level to gently sloping soils of the stream terraces are like the soils of groups 3 and 7 in that they are underlain, generally within 3 feet of the surface, by sand and gravel. Unlike the soils of groups 3 and 7 they occupy stream terraces. Their underlying material, moreover, usually coarser and more thinly stratified than that of the soils of group 3, shows more thorough sorting by water. These terraces are about 50 feet lower than the adjacent uplands and 5 to 10 feet above the existing stream flood plains. Included in group 8 are the following soils:

Fordville fine sandy loam.
Fordville loam and its gently sloping phase.
Fordville silt loam, gently sloping phase.
Fordville silty clay loam and its deep phase.
Fordville very fine sandy loam.
Sioux loam.
Sioux very fine sandy loam, gently sloping phase.

GROUP 9. MODERATELY WELL-DRAINED SOILS ON LOWER SLOPES AND IN DEPRESSIONS OF THE UPLANDS

The moderately well-drained soils on lower slopes and in depressions of the uplands, which are usually confined to small areas throughout the county, comprise in the aggregate about 5 percent of the land area. They are situated in upper drainageways, lower slopes, very slightly depressed upland flats, and river terraces subject to seepage and runoff from surrounding uplands or higher elevations. Compared with the average soils of the uplands, their surface soil is in general deeper, darker, higher in organic matter, and of a finer texture. The subsoil is likewise finer textured and grayer.

As these soils warm up late in spring, seedbed preparation, seeding, and planting are delayed. This fact and their lower position make crops on them more subject to early fall frosts. Corn is the predominant crop grown. Small grains, second to corn in importance, grow rank on this type of soil and during wet years often lodge. These soils, nevertheless, are productive, being high in organic matter and lime, and are easy to cultivate. Moderately friable and permeable throughout, they permit good root development. Group 9 includes the following soils:

Alcester loam.
Alcester silty clay loam.
Moody silty clay loam, level phase.

GROUP 10. POORLY DRAINED SOILS IN DEPRESSIONS OF THE UPLANDS

Most of the poorly drained soils in depressions of the uplands have developed on clayey till and originally were inundated for long periods at a time. The surface soils, on which glacial stones and boulders occur in places, are dark and have a neutral to alkaline reaction. Although containing sufficient clay to be sticky, these soils vary from clay to heavy silt loams. The subsoil is a yellowish-gray, moderately olive-gray, or light olive-gray plastic clay loam or silty clay, usually mottled and overlying a compact heavy clayey till.

The surface contour is so flat that, even when artificially drained, the fields are generally flooded during periods of excessively heavy rainfall and the crops ruined. Best yields are obtained during the drier years.

Because of their heavy texture most of these soils are difficult to till. Where cultivated they are plowed during a dry spell in fall. This practice allows time for the clods to disintegrate, or slake down, before spring and facilitates tillage. Soils of this group are sticky when wet and upon drying develop cracks that extend from the surface into the subsoil. The following soils are included in group 10:

Blue Earth silty clay loam.
Parnell silty clay loam.
Rosedell loam.
Rosedell silt loam.
Rosedell silty clay loam and its high phase.

GROUP 11. WELL-DRAINED SOILS OF THE FLOOD PLAINS

Situated in the flood plains above the levels subject to frequent flooding and temporary high water table, the well-drained soils of the flood plains form land that is fertile and highly productive for corn and supports very good pasture. Of the two soils in the group the Volin is the more productive for corn. The following soils are included in group 11:

Cass loam, high-bottom phase.
Volin silt loam.

GROUP 12. SOILS OF THE FLOOD PLAINS SUBJECT TO TEMPORARY HIGH WATER TABLE AND FREQUENT FLOODS

On all the soils of the flood plains subject to temporary high water table and frequent floods, the streams cause erosion and deposit silt every spring as well as at other seasons during heavy rains. These soils as a group are perhaps the most fertile land in the county, being highly productive as cornland and providing excellent grazing. The following soils are included in group 12:

Cass loam.
Lamoure silty clay loam.
Lamoure very fine sandy loam.

GROUP 13. VERY POORLY DRAINED SOILS OF THE FLOOD PLAINS AND LOW TERRACES

Having poor drainage and mucky surface, the very poorly drained soils of the flood plains and low terraces are permanently wet. More-

over, because of their position on terraces adjoining the uplands, the Benoit soils are subject to seepage. Rauville silty clay loam occurs in the low wet areas of the flood plains and on terraces where upland drainage spreads over them. In both positions the soil is subject to flooding and to the deposit of silt by the streams. The chief use of these soils is for pasture and native hay. Some areas of the Benoit soils have been improved by leveling and produce good yields of tame hay. The soils making up the Alluvial soils, undifferentiated, are extremely variable and subject to channel changing and channel-cutting erosion as well as stream deposition. The following soils are included in group 13:

Alluvial soils, undifferentiated.
Benoit soils, undifferentiated.
Rauville silty clay loam.

GROUP 14. SOILS ON ESCARPMENTS OF THE UPLANDS, OUTWASH PLAINS, AND STREAM TERRACES

Of the soils on escarpments of the uplands, outwash plains, and stream terraces, those on strongly sloping escarpments are shallow. Most of them also are stony. All are droughty and more or less subject to erosion under cultivation, characteristics that lower considerably their value for the production of cultivated crops. The following soils make up group 14:

Estherville loam, strongly sloping phase.
Fairhaven silt loam, strongly sloping shallow phase.
Flandreau silt loam, strongly sloping phase.
Kranzburg-Vienna stony silt loams.
Sioux loam, strongly sloping phase.

GROUP 15. NONARABLE SOILS AND LAND TYPES OF THE UPLANDS

The nonarable soils and land types of the uplands are rendered nonarable by the presence of numerous rock outcrops, the variableness of their depth to bedrock, and droughtiness, but they afford some pasture, and some units included in this group could be used for small fruits. The proportion of the soil to rock outcrop is indicated in the names of the mapping units, the one with the greatest proportion being given first. Group 15 includes the following soils:

Ihlen-rock outcrop complex.
Rock outcrop-Ihlen complex.

SOIL TYPES AND PHASES

The soils of Rock County are classified under 20 soil series, which are in turn divided and mapped as 62 units made up of soil types,[5] phases, and complexes. In the following pages the soils are described in detail and their agricultural relations discussed. Their location and distribution are shown on the accompanying soil map, and their acreage and proportionate extent are given in table 5.

[5] When a soil type is subdivided into phases, that part of the type that bears no phase name is referred to as the normal phase of the type.

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

Soil type [1]	Acres	Percent
Alcester loam	561	0.2
Alcester silty clay loam	52,646	17.0
Alluvial soils, undifferentiated	27,466	8.9
Benoit soils, undifferentiated	136	(2)
Blue Earth silty clay loam	139	(2)
Cass loam	144	(2)
High-bottom phase	2,861	.9
Crofton-Moody silt loams	8,937	2.9
Estherville loam:		
Gently sloping phase	652	.2
Strongly sloping phase	34	(2)
Fairhaven silt loam:		
Gently sloping shallow phase	659	.2
Shallow phase	293	.1
Strongly sloping shallow phase	40	(2)
Fairhaven silty clay loam	2,495	.8
Flandreau loam	2,935	1.0
Sloping phase	3,635	1.2
Flandreau silt loam	1,227	.4
Deep phase	331	.1
Sloping phase	953	.3
Strongly sloping phase	962	.3
Fordville fine sandy loam	680	.2
Fordville loam	259	.1
Gently sloping phase	206	.1
Fordville silt loam, gently sloping phase	1,028	.3
Fordville silty clay loam	4,978	1.6
Deep phase	3,128	1.0
Fordville very fine sandy loam	1,922	.6
Gravel pits	88	(2)
Ihlen-rock outcrop complex	3,667	1.2
Ihlen silt loam	880	.3
Stony phase	4,434	1.4
Stony gently sloping phase	1,438	.5
Kranzburg silty clay loam	622	.2
Gently sloping phase	6,820	2.2
Kranzburg-Vienna stony silt loams	1,727	.6
Lamoure silty clay loam	219	.1
Lamoure very fine sandy loam	1,355	.4
Moody silt loam	1,219	.4
Gently sloping phase	117	(2)
Rolling phase	9,125	2.9
Moody silty clay loam	77,695	25.0
Gently sloping phase	40,381	13.0
Level phase	12,321	4.0
Terrace phase	7,692	2.5
Parnell silty clay loam	1,000	.3
Pierce silt loam	470	.2
Rauville silty clay loam	1,160	.4
Rock outcrop-Ihlen complex	350	.1
Rosedell loam	77	(2)
Rosedell silt loam	1,158	.4
Rosedell silty clay loam	935	.3
High phase	132	(2)
Sioux loam	625	.2
Strongly sloping phase	145	(2)

See footnotes at end of table.

TABLE 5.—*Acreage and proportionate extent of the soils mapped in Rock County, Minn.*—Continued

Soil type [1]	Acres	Percent
Sioux very fine sandy loam, gently sloping phase	46	[2]
Vienna-Flandreau silty clay loams	1, 065	0. 4
Vienna loam	232	. 1
Gently sloping phase	3, 637	1. 2
Vienna silty clay loam	6, 282	2. 0
Gently sloping phase	1, 601	. 5
Strongly sloping phase	273	. 1
Volin silt loam	2, 096	. 7
Total	[3] 310, 400	100. 0

[1] Where data are given for phases only the normal type is not mapped in the county.
[2] Less than 0.1 percent.
[3] Includes 9 acres of quarries.

Alcester loam.—Most of this soil type, the principal areas of which border the east edge of the Rock River flood plains (in Vienna, Magnolia, and Kanaranzi Townships), is mapped at the base of slopes of Flandreau loam, sloping phase. Made up chiefly of colluvial material from such slopes, it is variable in profile, but in the main it has a brownish-black friable granular loam surface layer, grading at a depth of 16 to 24 inches into dusky-brown to dark yellowish-brown friable granular loam, and at 30 to 36 inches into either a brown or light brownish-gray silt loam or open porous very fine sandy loam. Although the profile does not have a layer of lime accumulation and seldom contains sufficient lime to effervesce with hydrochloric acid, its pH value is about 7. Slopes vary from 0 to 5 percent, mostly 2 to 4 percent.

Receiving considerable surface runoff from the surrounding higher elevations, this soil is less droughty than most of the Flandreau and Estherville series, although in years of extreme drought crop yields are reduced, especially in localities having a more open sandy subsoil. Both the moisture and soil itself, now lost by the sheet and wind erosion to which this section is subject, could be conserved in part by contour cultivation.

This soil is fertile, permits good root development, and is easy to cultivate. Corn is the dominant crop, but a few areas associated with Flandreau loam, sloping phase, are in pasture.

Alcester silty clay loam.—The most widespread member of the group of moderately drained soils, this soil occurs in the uplands on gentle lower slopes and upper drainageways with gradients up to 3 percent. It usually has a deep surface soil high in organic matter and neutral to alkaline, and the color and texture change gradually from the upper to lower layers. The profile varies in thickness and does not have the definite horizon development of many soils in colluvial locations. Its position makes it less subject to erosion but more liable to the deposit of silt washed from adjacent cultivated slopes.

This soil is associated with both the Moody and Vienna soils of the upland. Where associated with the Moody soils it has a profile characterized by a surface of brownish-black silty clay loam, or, in places, silt loam that breaks into medium granular aggregates. Beginning at 12 to 24 inches this surface soil grades into a dusky-brown, moderate-brown, and yellowish-brown, or in places, yellowish-gray silty clay loam subsoil of granular structure that extends to a depth of 30 to 32 inches. Below this layer there is a calcareous yellowish-gray or gray heavy silt loam, which at lower depths may be mottled with yellowish brown and brown. At depths of 4½ to 6 feet there is generally a thin layer of stratified sand and gravel underlain by clayey till.

Where this type is associated with Vienna soils the profile is similar in color and horizon thickness but contains a smaller proportion of silt. This absence of silt becomes more noticeable with increasing depth, and at about 30 to 36 inches clay loam till is reached. The sand-and-gravel layer is nearly always absent.

Alcester silty clay loam rates higher in productivity for corn than most soils in the county. On well-managed fields hybrid corn yields more than 50 bushels an acre, oats and barley more than 45 and 35 bushels, respectively, and alfalfa about 3 tons. Corn and small grains remain green and vigorous on fields of this soil after crops on other fields suffer from drought. On the other hand, later drying out in spring delays planting until some crops, as corn, may not mature before early fall frosts.

Alluvial soils, undifferentiated.—This unit, which is a complex of many soils, is composed of alluvial soils occurring along most of the streams and small drainageways. Certain soils in which sand and gravel occur at depths of 24 to 36 inches and areas of Cass and Lamoure soils too small to map alone are included. Surface texture ranges from sandy loam to silty clay loam. Where the sand and gravel occur within 3 feet of the surface, however, the texture usually is lighter and the elevation slightly higher. Rising from a few inches to 3 feet above the surrounding soils, these elevations give the landscape a blistered appearance. The slopes of the elevations are gentle, smooth, and regular. Some of the small areas are droughty, the degree depending upon surface elevation and depth to gravel.

Sandy substrata are at uniformly shallow depths in the areas mapped on the flood plains of Kanaranzi and Chanpepedan Creeks; the wetness of these soils for long periods in spring delays planting and their droughtiness usually affects crops through July and August. As a consequence most of these soils in the Kanaranzi Creek flood plain are in pasture or used for hay.

The narrow areas mapped on small drainageways in association with the Moody soils are usually wet or cut by small meandering stream channels and are used as pasture or for hay. The soils in such areas, however, generally have more uniform profiles than those in the larger flood plains.

As a whole, Alluvial soils, undifferentiated, are late in developing a good tilth condition in spring, with the result that crops, especially corn, are sometimes damaged by early fall frosts. In dry years yields are very spotty because of variability in the quantity of available moisture in the different soils. This land type is subject to flooding with

at least the same frequency as Lamoure silty clay loam and with equally damaging effect. Most areas are used for pasture; others are in hay meadow or covered by willow, ash, elm, cottonwood, oak, and plum trees. During successive years of normal rainfall, some areas normally under cultivation probably are too wet for crops.

Benoit soils, undifferentiated.—Occurring on terraces or high alluvial bottoms at the base of lower upland slopes of Rock outcrop-Ihlen complex, these soils usually occupy small elongated areas or series of seepage spots, the largest about ¼ mile wide and 1 mile long. From a short distance they can generally be identified by small humps or frost heaves about 1 foot in diameter projecting 1 to 2 inches above the ground level.

Benoit soils vary in texture and to some extent in color. Poor drainage and calcareous sandy and gravelly subsoils are common. In general their surface consists of a layer of muck or peat about 5 inches thick, under which is a layer ranging from granular sandy loam to silt loam high in organic matter. When wet it is nearly black; when dry, a dark brown. The thickness of this layer is variable but generally less than 12 inches. Below it in some places is an olive-gray sandy loam or sandy clay loam layer, usually about 6 inches thick. Lower still the soil consists of mixtures of calcareous sand and gravel, which are often waterlogged. For the most part these soils are mildly alkaline to neutral throughout.

Almost all of these soils are in pasture, which is considered their best use. Pasture could be improved, however, by plowing down the humps, leveling the surface, and sowing reed canary grass.

Blue Earth silty clay loam.—In small areas throughout the county this soil occupies nearly level shallow lake basins that are now dry most of the year. In the drained lake basin in the northern part of the county it is associated with the Rosedell soils. Natural drainage is poor, and the surface may hold puddles after heavy rains and the subsoil remain wet for long periods.

The surface soil to a depth of 10 to 15 inches is made up of dark-gray and very dark brownish-gray fine granular silty clay loam, highly calcareous and friable, the calcareous well-developed fine granules, which are high in organic matter, giving it a certain fluffiness. Below the surface soil, to a depth of 20 to 24 inches, is a layer of yellowish-gray or olive-gray calcareous silty clay loam or clay specked with small rust-brown concretions. When wet this layer is plastic, although less so than the corresponding layer in Rosedell silty clay loam. Lower down the soil is a yellowish-gray, rust-brown mottled highly calcareous clay loam till. Lime may be present on and below the surface in the form of snail shells and soft spots about the size of a pea.

This soil is well adapted to the production of hay and pasture. Even where the land has been drained, as in the case of the Rosedell soils, the drainage system is not sufficiently adequate to prevent inundation during excessive rains. Although naturally high in organic matter, the soil is not always productive. Applications of phosphate and potash are often beneficial.

Cass loam.—Most of this soil is on the slightly higher elevations of the Rock River flood plains. Occupying an elevation between the Sioux soils and soils of flood plains, it occurs as flat to gently sloping areas.

The surface soil is a very dark brownish-gray to black friable heavy loam 10 to 12 inches thick. The subsoil is dark brownish-gray friable loam to depths of 20 to 24 inches, where it grades into dark-brown or brown loam, and at 30 to 32 inches into yellowish-brown or yellow loam underlain at depths of 36 to 46 inches by sand and gravel several feet thick. The soil contains enough fine and coarse sands throughout the profile to give it the gritty feel characteristic of Sioux loam. The surface soil for the most part is slightly acid, but in places neutral. The underlying material is alkaline to calcareous.

This soil is fertile, permits moderate root development, and has good tilth early in spring. Its internal drainage, however, is excessive. The yields are noticeably affected by drought in drier years but ordinarily the crops suffer little from it. Practically all areas are in cultivation, with corn the dominant crop.

Cass loam, high-bottom phase.—This phase, which differs very little from Sioux loam of the terraces, occurs on fairly low smooth knolls along old stream channels throughout the flood plains of the Rock River. The knolls seldom have a slope of more than 2 or 3 percent and are usually small. Many areas too small to map are included with Alluvial soils, undifferentiated.

The surface layer is dark brownish-gray friable heavy loam 7 to 10 inches thick. The subsoil is very dark-brown or brown friable loam that gradually becomes coarser and lighter with depth, grading into sandy gravelly loam at 20 to 24 inches, and at 26 to 30 inches into very porous sand and gravel. The surface soil is generally slightly acid, but in places neutral. The underlying material is alkaline to calcareous.

Most of the knolls are inundated during severe floods; otherwise they are seldom under water. On the whole this soil is droughty and produces fair yields in dry years. Corn may show the effects of drought even in years of normal moisture. Because of variations in the texture of the surface and depth of gravel, yields on this soil are varied. Most of the phase is in cultivation, but a few areas are in pasture.

Crofton-Moody silt loams.—The soils of this complex, found in the west-central and southwestern parts of the county, are Crofton silt loam and Moody silt loam, rolling phase, so intermingled that it is not feasible to map them separately. The principal areas are in northwestern Martin, western Beaver Creek, and Spring Water Townships, where they are more or less continuous. The complex, which is associated principally with the Alcester, Lamoure, and Moody soils, is marked by hilly relief. The topography of the Crofton soils is hilly and that of the Moody soils, rolling. Both occur in about equal proportions. Gradients range from 10 to 15 percent, with some slopes greater than 15 percent but generally less than 20.

The Crofton soils have a thin surface layer and an abundance of lime concretions at and near the surface. The surface soil generally

ranges from 2 to 7 inches thick and consists of neutral to alkaline weak-brown or dark brownish-gray weakly granular very friable silt loam. After cultivation nearly all of this dark-colored surface may be wholly or partly worn away by erosion or mixed with the subsoil, leaving a concretionary lime zone on the surface. The subsoil extends to a depth of 12 to 18 inches and consists of yellowish-brown to light yellowish-brown silt loam, rather massive, with numerous hard lime concretions. The underlying material, which is light yellowish-brown to yellowish-gray silt loam, is highly calcareous and also contains lime concretions. It is coarser in texture, looser, and deeper than the silty materials underlying the Moody soils.

Moody silt loam, rolling phase, differs from Crofton silt loam in having a thicker surface soil and subsoil, usually without lime concretions at the surface. The phase also occurs on slightly lesser slopes than the Crofton. The surface soil generally is 6 to 10 inches thick and consists of very slightly acid or neutral weak-brown granular friable silt loam. The subsoil to a depth of 18 to 24 inches is silt loam that grades downward from dark yellowish brown to moderate yellowish brown and has a weak prismatic structure that breaks further into fine blocks. The underlying material is similar to that of the Crofton soils.

Estherville loam, gently sloping phase.—This soil, small areas of which occur in Battle Plain and Vienna Townships, has a dark-brown friable granular loam surface layer 4 to 8 inches thick and brown friable loam subsoil of subangular fine blocky structure. The subsoil grades into a fairly compact sandy and gravelly loam at 16 to 18 inches and into thick beds of stratified sand and gravel at 24 to 28 inches. Gravel in varying quantities may occur on the surface in places. Surface slopes vary from 2 to 6 percent.

Because of slight sheet erosion, contour farming and strip cropping probably should be practiced to conserve both the soil and moisture.

The soil is comparatively fertile, permits free root development, and is easy to cultivate. The degree of slope and excessive internal drainage, however, cause it to be droughty in most years. Practically all areas are now in cultivation, with corn the principal crop.

Estherville loam, strongly sloping phase.—This strongly sloping phase, mapped as narrow strips on steep escarpments, has dusky-brown to dark-brown friable granular loam surface soil 3 to 5 inches thick underlain by brown or dark-brown friable granular loam. At 18 or 20 inches it becomes a compact sandy and gravelly loam, and at depths of 20 to 24 inches is characterized by thick beds of stratified sand and gravel.

Slopes always exceed 6 percent, those from 8 to 12 percent predominating. On some areas under cultivation severe erosion has exposed the brown subsoil and in others the gravel.

Most of the soil is in cultivation, but yields are low, owing to the extreme droughtiness caused by excessive surface runoff and by rapid internal drainage. Very little if any corn is produced on the gravelly spots during dry years. This soil should remain in grass or pasture to prevent further erosion and alluvial deposition at the base of slopes.

Since rental arrangements usually require that areas in cultivation continue in tilled crops, not much conservation work is being done. Only an occasional landlord stipulates that the part of his farm made up of this phase be left in grass.

Fairhaven silt loam, gently sloping shallow phase.—This phase is mapped on the more sloping knolls and on narrow outwash plain escarpments, chiefly in Battle Plain Township in the northeastern corner of the county. The surface soil is composed of dark-brown friable granular light-textured silt loam 6 to 8 inches thick. The subsoil consists of brown friable silt loam of subangular blocky structure, grading at about 14 to 16 inches into yellowish-brown or brownish-yellow friable silt loam or gravelly loam, which is underlain at about 20 inches by sand or sand mixed with gravel. Although not calcareous, the soil has a neutral reaction. The sand and gravel usually are not calcareous above 3 feet. Slopes vary from 2 to 6 percent.

Most of the phase is in cultivation, but yields in most years are comparatively low, owing to the droughtiness of the soil caused by its degree of slope and rapid internal drainage. Inasmuch as the soil is subject to a slight sheet erosion and some wind erosion, the narrow strips occurring on escarpments, in particular, should be left in pasture to retard further erosion.

Fairhaven silt loam, shallow phase.—This phase, developed on pre-Wisconsin outwash in association with Fairhaven silty clay loam, is usually mapped on slightly elevated areas of gentle slope. Its surface layer is dusky-brown to weak-brown friable granular light-textured silt loam 6 to 8 inches thick, and its subsoil is brown to weak-brown friable silty clay loam of fine blocky structure. At a depth of 18 to 20 inches the subsoil grades into yellowish-brown gravelly loam or clay loam, and at 22 to 26 inches into yellow fine sand or sand and gravel several feet thick. The sand and gravel are usually calcareous at 3 to 4 feet, and in places even above that depth. The surface soil is neutral but not calcareous. Slopes range from 0 to 2 percent.

The soil is comparatively fertile, easy to till, and permits free root development. It is slightly affected by wind erosion. Excessive internal drainage, however, prevents maximum moisture conservation. Crops are affected by drought in most years.

Fairhaven silt loam, strongly sloping shallow phase.—This phase occurs as narrow bands on steep outwash plain escarpments, but covers only a small total area. It is characterized by a very dark-brown friable granular surface layer about 8 inches thick and a brown friable silt loam subsoil of fine blocky structure, which grades abruptly into sand or sand and gravel at about 18 to 20 inches. The depth to the sand and gravel is variable. All layers are slightly acid. With slopes exceeding 6 percent, this soil is droughty and erodes severely. It should not be cultivated, therefore, but should be left in grass to prevent the slopes from being eroded back into the smoother upland.

Fairhaven silty clay loam.—This soil, mapped in Battle Plain and Vienna Townships on what appears to be old pre-Wisconsin outwash plains, has a surface layer of dusky-brown or dark brownish-gray friable granular silty clay loam 10 to 14 inches thick. The subsoil

is brown to weak-brown friable silty clay loam of fine blocky structure extending to a depth of 20 to 24 inches. Below this layer there is a yellowish-brown or brownish-yellow friable silty clay loam that gradually becomes lighter in color and coarser in texture until at 30 to 32 inches it gives way abruptly to a 2- or 3-inch layer of gravel or a much thicker layer of sand and gravel. In places there may be an underlying layer of yellow gritty silt loam, sandy clay loam, or loam. At 34 to 40 inches below the surface, however, the material is porous yellow sand, containing variable quantities and sizes of gravel. This layer extends for several feet and, in general, is stratified. It may or may not be calcareous. The surface soil is not calcareous but generally has a neutral reaction. The subsurface is slightly acid. Having slopes up to only 2 percent, the soil is not subject to sheet erosion but it suffers some slight wind erosion.

This type grades imperceptibly into the associated Vienna silt loam and can scarcely be distinguished from it. Both have a subsoil gravel layer that cannot always be penetrated to determine whether it is underlain by sand, gravel, or till. The soil occurs on very gentle slopes and appears to lie at a slightly lower level than the associated Vienna silt loam.

Crop yields are affected by drought caused by excessive internal drainage. Practically all of the soil is in cultivation, chiefly to corn.

Flandreau loam.—The surface 8 to 11 inches of this soil, which is associated with old glacial moraine and outwash, is dusky-brown friable granular loam. The subsoil is dark yellowish-brown silt loam of weak fine blocky structure that, beginning at 26 to 28 inches, grades little by little to yellowish-brown or yellow very fine sandy loam, light silt loam, or loamy very fine sand. The loamy very fine sand may extend to 4 feet, but usually the underlying material is composed of stratified sandy silt and clay that vary in thickness and compactness. The soil is slightly acid, becoming about neutral below 36 inches. Lime accumulation is seldom found above the stratified materials. As a rule this soil occurs on almost flat terrain, the slopes being from 0 to 3 percent.

West of the Rock River in Denver and Battle Plain Townships the areas are associated with an old glacial moraine in which glacial till is frequently found within 6 feet of the surface. Areas east of the Rock River and along Beaver Creek seem to be associated with outwash.

This soil, which warms up early in spring, is comparatively fertile, permits free root development, and is easily tilled. Although there is practically no sheet erosion, some wind erosion occurs when the soil is bare and dry. Most of the soil is planted to corn.

Flandreau loam, sloping phase.—This phase, most of which occurs in the northeastern and eastern parts of the county, is mapped in the areas that have a dominant slope of 3 to 6 percent. Its surface of weak dusky-brown friable granular loam, 9 to 12 inches thick, grades downward into a yellowish-brown friable very fine sandy loam subsoil of weak fine blocky structure. At 18 to 24 inches the subsoil is made up of yellow loamy fine or very fine sand. Below 3 to 3½ feet it usually consists of stratified sands and silts that may or may not be

calcareous. Like the normal phase, it is slightly acid, becoming practically neutral below 36 inches. The more porous types of subsoil and substratum generally are less deep and the soil more droughty than the corresponding areas of Flandreau silt loam.

Since the sloping phase is more subject to sheet and wind erosion than the normal phase, strip cropping and contour farming probably should be practiced to conserve both soil and moisture. On a few of the steeper slopes even more intensive conservation measures may be necessary.

Flandreau silt loam.—Relatively small areas of this soil are found in the county, chiefly along the Rock River, on what appear to be old glacial morainal ridges and slopes of gravelly or sandy materials covered by a comparatively thin mantle of loess. The surface is dusky-brown or dark brownish-gray granular silt loam, grading at 8 to 12 inches into dark yellowish-brown granular silt loam, which at depths of 18 to 24 inches gradually gives way to yellowish-brown or brownish-yellow silt loam of fine blocky structure. The thickness of the silt varies, but sand and gravel or stratified sand, silt, gravel, and clay generally occur at about 30 to 36 inches. Calcareous compact clay till is encountered in places at 5 to 6 feet. The surface soil and subsoil are slightly acid to neutral. Slopes vary, ranging from a scarcely perceptible rise to 5 percent. The soil erodes quickly when cultivated, and excessive internal drainage makes it droughty.

Alfalfa yields average 2 tons an acre. The cultivation of alfalfa, however, seems to increase the droughtiness of the soil. Crops planted on fields previously in alfalfa sometimes suffer more from drought than those on soils in which other crops have been recently grown.

Flandreau silt loam, deep phase.—This phase, which likewise appears only in small areas, is developed from loess deposits on morainal gravelly ridges or slopes varying up to 2 percent. The largest single area is on a terrace in sec. 5, T. 104, R. 45. The soil has a dusky-brown or dark-brown friable granular silt loam surface layer 6 to 10 inches thick. The upper subsoil to a depth of 18 to 20 inches is friable yellowish-brown silt loam of ill-defined blocky structure that in places breaks into granular aggregates when disturbed. From this depth downward it becomes lighter in color, grading into brownish-yellow to yellow silt loam at about 24 inches. A yellow or brownish-yellow layer of lime at depths of 34 to 38 inches contains abundant lime concretions as well as disseminated lime. Underlying the lime layer at depths of 3½ to 5 feet are porous beds of sand and gravel. Both surface soil and subsoil are slightly acid to neutral. The largest area in the county contains a small quantity of salines—neutral soluble salts that are harmful to plant growth when occurring in sufficient concentration within the plant-root zone.

Although associated with the Moody soils, the type is slightly lighter in color than Moody silt loam. It also differs in having a gravelly substratum close enough to the surface and of sufficient thickness and porosity to cause crops to be affected by drought in years of subnormal rainfall. The degree of droughtiness depends upon the porosity, thickness, and depth of the sand layer. Otherwise the soil is fertile, easy to till, and easily penetrable.

Flandreau silt loam, sloping phase.—This phase, which is associated with old Iowan moraine, a large percentage being mapped in Denver Township and the western part of Battle Plain Township, differs very little from the normal phase. Its surface soil consists of weak dusky-brown friable granular silt loam, grading to brown friable granular silt loam subsoil at 8 to 12 inches. At about 20 inches the subsoil grades into yellowish-brown or yellow silt loam, which at approximately 36 inches gives way to bedded or stratified sand and gravel. Slopes vary between 3 and 6 percent.

Excessive internal as well as external drainage make this soil very droughty, but this condition probably could be greatly alleviated by strip cropping and contour cultivation. Most of the phase is in cultivation, but the yields are below the average for the normal phase.

Flandreau silt loam, strongly sloping phase.—This phase, which is not extensive, is found chiefly in the uplands bordering the east side of the Rock River flood plains and the larger streams flowing into the Rock River from the east. It has dark-brown friable surface soil 6 to 10 inches thick and is underlain by brown friable very fine sandy loam or silt loam, which grades into gray to light-brown loose fine sand within 24 to 30 inches. The substratum below 36 inches is composed of sand and silt, frequently stratified. The silt layers are usually calcareous, as is the sand in places. The upper soil is seldom calcareous but has a neutral reaction.

Slopes vary from 6 to 15 percent, with the result that the soil is subject to erosion and gullying. Sheet erosion is so severe, especially during heavy rainfall, that in some places the brown subsoil is exposed. In other places bad gullies are being formed. The soil also suffers from wind erosion.

Crops on this soil are affected by drought, especially during excessively dry years. Yields are comparatively low compared with the general average of the county. Intensive soil and moisture conservation is necessary if the soil is to remain suitable for crops. The best use is for pasture or hay. Rental arrangements for farms with these areas, however, are such that tenants usually cultivate them. To preserve this soil and prevent the gradual encroachment of gullies on the better lands above, landlords should stipulate in rental contracts that the phase be kept in pasture or meadow.

Fordville fine sandy loam.—The small areas of this soil are developed on stream terraces throughout the Rock River Valley, usually on slightly elevated areas near the streamward edge of the wider terraces or on the small isolated terrace areas. The surface soil is very dark-brown or dark brownish-gray friable, loose, fine sandy loam 6 to 10 inches thick. The subsoil is brown loam or fine sandy loam that gradually becomes lighter in color and texture and grades into yellow loamy sand and light sandy loam at 16 to 20 inches. The loamy sand extends downward for several feet or grades into sand and gravel below 30 inches. The soil is neutral, but the sandy substratum is usually calcareous. The surface for the most part is sloping, gradients varying up to 3 percent. It is subject to slight wind and sheet erosion.

All of this soil is in cultivation, but crop yields are comparatively low, for although the soil absorbs rainfall rapidly, its porosity causes excessive internal drainage and consequently droughtiness. On the other hand, the sandy nature of this type probably permits crops to utilize a greater percentage of the soil moisture than they could from the heavier silt loams.

Fordville loam.—This soil is developed on small areas of gravelly stream terraces overlain by finer materials. Most of it is mapped in Battle Plain and Vienna Townships on terraces of the Rock River, probably totaling less than a square mile. The dark brownish-gray or dark-brown friable granular surface soil is 6 to 8 inches thick. Gravel occurs on the surface in places. The subsoil is brown friable weakly granular loam that gradually becomes lighter in color and less granular as it grades downward, where at 18 to 22 inches it merges into yellowish-brown sandy loam of fine blocky structure. At about 30 inches there is a brownish-yellow sandy loam, and at 34 to 38 inches a clean sand or sand and gravel. The various layers are neutral throughout, and the lower subsoil calcareous.

Usually this soil occupies nearly level land, but where there are slopes the gradient is less than 2 percent. This soil is droughty, yields being about the same as on Fordville very fine sandy loam. Corn and alfalfa are the principal crops.

Fordville loam, gently sloping phase.—This phase differs little from the normal phase except in its greater slope. It has very dark-brown friable loam surface soil of fine granular structure 6 to 8 inches thick. The subsoil is dark-brown or brown friable weakly granular loam that at about 14 inches becomes finely blocky and lighter in color. At approximately 22 inches it grades into brownish-yellow fine sandy loam and at 30 to 34 inches into sand and gravel. The slightly undulating surface has slopes of 2 to 4 percent. The reaction is neutral.

Inasmuch as the soil is subject to slight sheet erosion, conservation practices, such as contour farming and strip cropping, probably would prove beneficial. The areas are small, however, and such methods might not be economical.

The soil reaches a good tilth condition early in spring, permitting early planting, but in most years plant growth is retarded by drought during July and August. Crop yields are about the same as on the normal phase.

Fordville silt loam, gently sloping phase.—Occurring on the streamward edges of the loess-covered stream terraces, this phase has a very dark-brown to dark brownish-gray finely granular silt loam surface soil 4 to 8 inches thick. The subsoil is brown friable granular silt loam to a depth of 12 to 14 inches, where it grades into yellowish-brown silt loam of subangular fine blocky structure and at 18 to 20 inches into brownish-yellow silt loam. At depths of 28 to 30 inches there is a yellow calcareous layer of the lime accumulation common to the region. At 34 to 38 inches this layer gives way to a calcareous gravelly mottled yellow and gray silt loam, which rapidly grades into clean stratified calcareous sand and gravel extending to depths of 15 to 25 feet. In places where the loess is eroded the surface soil ap-

proaches a very fine sandy loam. In other places gravel occurs on the surface. Small isolated areas having very fine sandy loam surface soil and subsoil are also included in this phase.

Except for the layer of lime accumulation, both surface soil and subsoil are neutral. Lime accumulations, however, are seldom present where the loess covering is less than 3 feet thick, except on the steeper slopes.

Slopes ordinarily vary from 2 to 8 percent, although the abrupt outer escarpments may have short ones of 40 to 50 percent. On the steeper slopes the loessal covering is thin and may be eroded. The depth to gravel varies from 2 to 4 feet. In some places the gravel has been excavated for road and building purposes.

The soil erodes severely, making intensive soil and moisture conservation methods necessary. Crops on this phase are affected by drought, yields usually being below the average for the county. During seasons of ample rainfall, however, good yields are obtained.

Fordville silty clay loam.—This soil is developed on old, almost level stream terraces lying about 10 or 12 feet above the flood plains. It is characterized by a surface layer of brownish-black friable granular silty clay loam 6 to 8 inches thick and a subsoil of granular-structured dusky-brown or dark brownish-gray friable silty clay loam that extends to depths of 16 to 18 inches. The lower subsoil is brown or yellowish-brown friable silty clay loam of fine blocky structure to a depth of 22 or 26 inches, where it grades into yellowish-brown to yellow friable heavy silt loam. At 30 to 32 inches stratified beds of calcareous sand and gravel are found. Most of this soil lacks a prominent lime accumulation layer, but the yellow layer just above the gravel is calcareous. The three upper layers are neutral. The underlying gravel beds, which are several feet thick, cause excessive internal drainage, and there is evidence of very slight wind erosion in places. The surface is almost flat to very gently sloping.

Practically all of this soil is in cultivation. It is fertile, permits free root development, and is easily tilled. Although the moisture-holding capacity is comparatively high, it is not so high as in the deep phase of the type or in Moody silty clay loam; and in most years crop yields are affected during the hot dry months of July and August. Crop damage is especially severe in years of subnormal rainfall.

Fordville silty clay loam, deep phase.—This phase occurs on stream terraces in the western half of the county and in the eastern part along the Rock River and is the only soil in the county characterized by more than 36 inches of silty materials overlying loose stratified sand and gravel. It may occur on very gentle slopes (generally less than 1 percent) or in slightly depressed areas. The surface layer to a depth of 10 to 14 inches is brownish-black friable granular silty clay loam, which grades downward into dark-brown or dark yellowish-brown friable silty clay loam of subangular fine blocky structure. At 20 to 36 inches there is a yellowish-brown calcareous silt loam layer of lime accumulation extending to a depth of 42 to 60 inches, where it is underlain by a mixture of calcareous sand and gravel or by calcareous sand. Both surface soil and upper subsoil are neutral.

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Corn is the crop most commonly grown on this phase, all of which has been under cultivation at some time. With a friable surface layer easy to till and free of stones, this phase makes good farm land. Crops suffer from drought only during very dry years. Even in times of drought corn does not fire so early as on other more shallow terrace soils. Where the fields are in slightly depressed areas, the corn crop is unaffected.

Fordville very fine sandy loam.—Small areas of this type are along the various streams in the southern half of the county and in Battle Plain and Vienna Townships in the northeastern part. Larger areas are along the county line in Kanaranzi Township in Kanaranzi Creek Valley. It has dusky-brown friable weakly granular very fine sandy loam surface soil 8 to 12 inches thick and a brown friable very fine sandy loam subsoil of subangular fine blocky structure. The subsoil gradually grades into yellowish-brown calcareous fine sandy loam at about 24 to 26 inches, and this into fine or medium sand at about 30 to 32 inches. The sands vary in texture but are always loose and porous and may extend to depths of several feet or give way to gravel below 36 inches. The gravel is calcareous as is also the sand for the most part. The soil is neutral, but lime accumulation frequently occurs in the lower subsoil above the loose substratum. The surface is level to very gently sloping, with gradients of less than 1 percent.

The soil develops a good tilth condition early in spring. The sandy substratum, however, makes internal drainage excessive and the soil droughty. Wind erosion may occur when the soil is dry and devoid of cover. Crop yields are best in years of normal or excessive rainfall, otherwise they are comparatively low. Early maturing or drought-resistant crops probably should be grown. All of this soil is in cultivation. Corn is the dominant crop.

Ihlen-rock outcrop complex.—This complex consists of areas in which the Sioux quartzite projects above the surface in sufficiently numerous places to prevent economical cropping. Between the rock outcrops the loess deposit varies from 1 to 6 feet in depth.

The soil has a dark-brown or weak-brown friable granular silt loam surface layer 8 to 12 inches thick. The subsoil is brown to dark yellowish-brown friable granular silty clay loam, grading into yellowish-brown or brownish-yellow silt loam at 26 to 30 inches. Where the quartzite is found below 3½ to 4 feet, there is a layer of lime accumulation at 34 to 38 inches. Slopes throughout this complex commonly range from 0 to 10 percent but are even greater in a few places. Surface and internal drainage are very good. The reaction of surface soil and subsoil is neutral to slightly acid. The soil areas support a good cover of bluegrass, with scattered areas of big bluestem, sideoats grama, and blue grama grasses.

Ihlen silt loam.—This type, developed from loess that drifted over the formerly exposed quartzite, has weak dusky-brown friable silt loam surface soil 10 to 14 inches thick, underlain by yellowish-brown friable silt loam of subangular fine blocky structure, which is replaced at 26 to 30 inches by brownish-yellow silt loam. Sioux quartzite bedrock is encountered at depths of 10 to 36 inches, although in some areas it is covered by 4 to 6 feet of loess. Owing to the fact that the loess

mantle has a more or less smooth surface, while the underlying rock is very irregular at its upper limits, the depth of the loess varies greatly, and in a few places the rocks project above the ground. Slopes are from 0 to 3 percent.

This soil has less water-holding or storage capacity than Moody silty clay loam. Water penetrates the loess and moves laterally over the rock surface, making the soil droughty, particularly where the loess is shallow. Crops on this soil show very spotty growth in dry years but grow well when there is adequate rainfall.

Most of this soil is in cultivation, especially where the rock lies more than 24 inches below the surface. In general, however, the uncertainty of crop yields probably makes it most useful as pasture.

Ihlen silt loam, stony phase.—This phase occurs on level or slightly sloping areas, chiefly in the northwestern part of the county. It is found in large areas, particularly south and southeast of the village of Jasper, in association with the normal phase and with Moody and Kranzburg silty clay loams. The boundaries between this phase and the normal are not always well defined. Areas mapped may also include the normal phase and small areas of the Moody and Kranzburg soils.

This phase differs from the nonstony part of the type mainly in the greater number of loose boulders and outcrops of quartzite bedrock on and near the surface. Like the normal phase, this soil has a dusky-brown granular silt loam surface layer extending to a depth of 6 to 12 inches and a dark to moderate yellowish-brown silty clay loam subsoil 8 to 16 inches deep, underlain by red quartzite bedrock at about 24 inches. Slopes do not exceed 3 percent.

The frequency of stones and rock outcrops is not sufficient to preclude the use of the phase as farm land. Most of this soil is in cultivation. Crop growth and yields are spotty, even in the same field, because of the shallow soil. In places where the bedrock is within 12 inches or less of the surface, crop growth is poor, particularly during years of low rainfall.

The phase is best suited to pasture and hay production. The cost of cropping it, however, due to wear and tear on machinery and the additional time involved in avoiding rock outcrops, together with the lower average yield, reduces the net income materially as compared with that derived from crops produced on the Moody and Kranzburg soils.

Ihlen silt loam, stony gently sloping phase.—This phase differs little from the stony phase, except in its greater degree of slope, which is usually 3 to 6 percent or more. Otherwise the description of the stony phase applies in general to it. Crop productivity and adaptation and present use and management closely parallel that of the stony phase. Crop growth and yields are equally as low and more spotty. Since this phase occurs on greater slopes, it is more subject to sheet erosion than the normal phase, especially where cropped, and is perhaps less desirable for cropland.

Kranzburg silty clay loam.—This soil, which is developed on very shallow loess, has brownish-black or very dark brownish-gray friable granular silty clay loam surface soil 10 to 12 inches thick, grading

downward into a moderate brown or dark yellowish-brown friable silty clay loam subsoil of fine blocky structure. At about 16 to 18 inches the color of the subsoil becomes yellow or brownish yellow, which may or may not contain gray or brown mottlings. Yellow, brownish-yellow, or gray-and-brown mottled clay till begins at 30 to 37 inches. Lime accumulation usually occurs in the lower few inches of the loess mantle or in the upper few inches of the underlying clay till and may or may not be present below 30 inches. Between the clay till and loessal silt there usually is a 1- to 3-inch layer of sand overlain by 1 or 2 inches of calcareous loess. The sand and lime concentrations, however, are not always present, especially where the clay till occurs within 30 inches of the surface.

Usually somewhat lighter in color than Moody silt loam, the soil is slightly acid to a depth of 18 inches, neutral between 18 to 26 inches, and mildly alkaline below 26 inches. Slopes vary from 0 to 2 percent. The tops of the knolls and ridges on which this soil occurs generally have slopes differing from those of the surrounding Moody soils, causing a slight break in the otherwise smooth relief. The soil erodes only slightly under cultivation.

Crops on this soil are affected by drought during the drier years, but show little if any droughtiness in years of normal rainfall.

Kranzburg silty clay loam, gently sloping phase.—This phase, which occurs on the higher and more sloping ridges and knolls, is developed from loess. It has a dusky-brown friable granular silty clay loam surface layer, gradually grading into friable silty clay loam of subangular fine blocky structure, which begins at 16 to 18 inches as yellowish brown and changes to yellow or light yellowish brown at 24 to 28 inches. In places the lower 1 to 4 inches of this layer are calcareous. Clay till underlies the loess at 32 to 36 inches. Between the loess and till there is usually a 1- to 3-inch layer of sand. Although the slopes vary between 2 and 7 percent, those of 3 to 6 percent predominate. The reactions of the surface soil and subsoil are similar to those of the normal phase.

The surface soil of this gently sloping phase is normally slightly lighter in color than that of Moody silty clay loam. In normal years, however, yields on the two soils show little difference. The phase is considerably eroded, especially on the steeper slopes, and strip cropping or contour farming is recommended to conserve moisture and prevent erosion.

Kranzburg-Vienna stony silt loams.—Occurring on steep slopes and narrow strips bordering streams in four townships in the northeastern part of the county, these soils are so closely associated geographically that they cannot well be mapped as separate soil units.

The Kranzburg soil, estimated to occupy 60 to 70 percent of the area, is characterized by a dusky-brown friable stony silt loam surface soil about 8 inches thick and a 10- to 15-inch moderately brown to dark yellowish-brown indistinctly prismatic slightly plastic silty clay loam subsoil. A variegated but predominantly yellowish-brown calcareous clay loam underlies the silty clay loam.

The Vienna soil, which makes up 30 to 40 percent of the complex, does not have the loesslike cover characteristic of Kranzburg. Its 6-

to 12-inch surface layer consists of dusky-brown to dark yellowish-brown stony silt loam, containing a higher proportion of fine sand than the surface of the Kranzburg soil. Before reaching 12 inches the subsoil grades into a predominantly yellowish-brown clay loam, which at 24 inches is usually a yellowish-brown clay loam spotted with lime. The structure of the subsurface layer and upper subsoil is weakly prismatic, breaking further into fine blocks coated with organic matter.

Both the Kranzburg and Vienna soils have pebbles and cobbles of quartzite, basalt, and gneiss scattered through their profiles. They are neutral to slightly acid at the surface but are calcareous at a depth of about 24 inches. As a complex the soils appear on steeper slopes than either mapped separately.

Small cultivated areas of the complex are usually badly eroded, and their crops suffer the effects of drought due to the excessive runoff. Most of the complex is in pasture and hay production, which is recognized to be the best use to which it can be put.

Lamoure silty clay loam.—This dark-colored highly productive soil of the flood plains of the larger streams occurs chiefly in the flood plain of the Rock River on about the same level as other soils of the first bottom land and consists of alluvium that has originated from the soils of the loessal and glacial uplands. In drainage it ranks intermediate between the well-drained Volin soils and the poorly drained Rauville.

The surface layer to a depth of 10 to 18 inches is brownish-black to very dark brownish-gray friable granular silty clay loam. The color changes with increasing depth, first to dark gray and then to brownish gray, slight mottlings of yellowish gray, yellow, gray, and rust brown appearing below a depth of 30 inches. The color is variable in the lower layer but grayish and yellowish shades predominate. In general the texture is silty clay loam, but in places it is silty clay or silt loam, particularly in the subsoil. All the layers are slightly acid to alkaline and may or may not be calcareous. The number as well as the depth of these calcareous layers may vary greatly within short distances. Soluble salts, sometimes injurious to plants, are present in a few spots. The surface for the most part is level, although in a few places it is very gently undulating

Surface and internal drainage are moderate. The majority of fields are subject to early spring floods that delay seeding and planting. In about 1 year in 10, summer floods damage or totally destroy the crops.

Most of this soil is in cultivation, being for the most part planted continuously to corn. Small grains generally lodge. Considered very fertile and productive despite its frequent flooding, this type is recognized as one of the best corn soils in the county.

Lamoure very fine sandy loam.—Most of this soil occurs in the flood plains of Split Rock Creek, Kanaranzi Creek, and the northern part of the Rock River. Developed on alluvial materials, it has a 12- to 16-inch surface layer of very dark brownish-gray friable granular very fine sandy loam. The subsoil is dark brownish-gray friable granular silt loam that gradually becomes lighter in color and heavier in texture

with depth and grades into a dark-gray or gray calcareous plastic silty clay loam at 30 to 36 inches. This layer usually extends to several feet, where it may be underlain by sand and gravel or grade into a grayish-yellow or yellow-and-gray mottled plastic silty clay at 3½ to 4 feet. The different layers of this soil type vary in color as well as in the quantities of lime carbonate they contain. In places, it is calcareous throughout the profile; in others it is slightly to medium acid above 30 inches. Where acid the soil is usually more brownish than grayish.

Although fairly heavy for a very fine sandy loam, it is more uniform than Alluvial soils, undifferentiated, and has a smoother surface generally. It is subject to overflow and like the other Lamoure soils is late in reaching a good tilth condition in spring. Probably 80 or 85 percent of it is in cultivation, corn being the principal crop. Fields are subject to the same overflow and frost hazard as on the other Lamoure soils.

Moody silt loam.—Most of this soil, which is intermediate or transitional between Moody silty clay loam and Flandreau silt loam, is in the eastern half of the county, where it forms a broken belt parallel but not immediately adjacent to the Rock River. Physically it differs little from Moody silty clay loam. Its surface layer is dusky-brown or weak-brown friable granular silt loam 10 to 14 inches thick, below which the soil grades into dark yellowish-brown friable silt loam of fine blocky structure, and at a depth of 28 to 30 inches into light yellowish-brown to yellow silt loam, which merges between 36 to 40 inches into yellow calcareous silt loam, containing lime concretions and disseminated lime. The thickness of the lime layer concentration varies greatly and in places it is absent. Below, at depths of about 5 feet, are stratified sands and silts that may contain small quantities of fine gravel. To a depth of about 30 inches the soil is slightly acid. The slopes are less than 4 percent.

Moody silt loam appears to be distinctly browner, to contain more very fine sand, and to be slightly more droughty during dry years than when there is adequate rainfall. The soil is subject to wind erosion, but damage is usually slight. Yields compare favorably with Moody silty clay loam.

Moody silt loam, gently sloping phase.—This phase, which is associated with Moody and Flandreau silt loams, is very similar to the normal phase of the type, the chief difference being its greater slope, the gradients varying from 3 to 6 percent. The surface soil is very dark-brown or very dark brownish-gray friable granular silt loam 10 to 14 inches thick, grading into dark yellowish-brown friable silt loam of an ill-defined fine blocky structure that breaks into subangular granules, and at 26 to 30 inches becoming brown or yellowish-brown silt loam. There is a lime layer at 34 to 40 inches, and below this, at varying depths, are sands, stratified sands and silts, and clay till. When dry this soil, as a general rule, is less dark than Moody silty clay loam. Its reaction is similar to that of the normal phase.

This gently sloping phase absorbs moisture readily, is fertile, and permits easy root penetration. Easily cultivated, it reaches a good condition for tilth slightly earlier in spring than the heavier textured Moody soils. On the whole, crop yields probably are slightly lower

than on the other Moody soils. Harvests vary with the season, drier years resulting in reduced crops. Because some sheet and wind erosion are in evidence, contour cultivation or strip cropping or both are recommended.

Moody silt loam, rolling phase.—This phase occurs in large bodies associated with Crofton-Moody silt loams, chiefly in Beaver Creek and the western part of Springwater Townships. It has dark-brown or weak-brown friable granular surface soil 4 to 8 inches thick, underlain by dark yellowish-brown or light-brown friable silt loam of subangular fine blocky structure that grades into a light yellowish-brown silt loam at about 18 to 20 inches. At depths of 18 to 30 inches, lime and lime concretions are abundant but become less pronounced with increased depth where gray and brown mottlings begin. At 4 to 6 feet the soil usually is mottled yellow, gray, and brown very calcareous silt loam without marked evidence of lime accumulation. The dominant slope range is 6 to 10 percent. The reaction is about neutral.

This rolling phase differs from the other Moody soils in several respects. The loess seems to be coarser than that from which other Moody soils are developed, and the surface layer is thinner and lighter in color. The depth to the lime layer varies from less than 1 foot to several feet. The lighter color cannot be attributed entirely to erosion, since under virgin cover this soil is thinner than the other Moody soils, but is probably due chiefly to the steeper slope.

This soil type is subject to severe erosion, especially when the ground has been freshly plowed before a heavy rain, and to excessive erosion between corn rows running up and down the slope. In a few places there may be colluvial accumulations 3 to 12 inches deep after heavy rains. Moisture and soil conservation measures should be used and strip cropping and contour farming would be beneficial, but more intensive erosion control methods are probably necessary.

Although the soil is fertile and has good physical properties, crop yields are frequently affected by drought. Yields of grain average 5 to 10 bushels less than on the normal phase.

Moody silty clay loam.—This is the most extensive and important soil in the county. It occurs in large bodies and is an upland type developed from loess on smooth to gently undulating terrain and is associated with its level and gently sloping phases and with the Kranzburg soils. The surface soil to a depth of 10 to 14 inches is brownish-black and dark brownish-gray friable granular silty clay loam, which is black when wet. The surface grades into a brown friable silty clay loam of ill-defined granular structure, and at 22 to 26 inches into a yellowish-brown or yellow friable silty clay loam of weak subangular blocky structure, extending to depths ranging from 30 to 38 inches, where a zone of lime accumulation is encountered. The zone of lime accumulation is yellow or brownish-yellow friable structureless heavy silt loam, containing numerous lime concretions and much disseminated lime. At depths of 5 to 6 feet the soil becomes structureless yellow friable silt mottled with gray and rust-brown, or mottled gray, yellow, and rust-brown silt loam. The layer is calcareous and contains some lime concretions, but the lime does not seem so abundant as in the layer above.

At depths of 8 to 10 feet the loess rests upon compact calcareous clay till, mottled with varying proportions of brown, gray, and yellow (pl. 1, *B*). The percentage of lime in the till appears to be less at a depth of about 3 feet than nearer the surface. Here fewer lime concretions are present and the gray becomes predominant.

In places between the loess and underlying clay till there is a layer of sand or stratified sand and silt that varies from a few inches to more than 2 feet thick. Substratum layers are usually calcareous. The soil above the lime zone is about neutral. The sandy layer is usually thickest on slopes where the loess is deepest; however, it is probably only a few inches thick under most of this soil. In areas where the loess is only 4 to 6 feet thick the zone of lime accumulation usually rests directly on the sandy layer or the till, and no mottled gray, yellow, and rust-brown loess is found.

Depth of loess to the underlying sandy layer, seasonal moisture, thickness, and slope of the underlying sandy layer are important factors in determining the resistance of this soil to drought. Accumulation of salines is present in the lower subsoil or substratum where the soil borders soil areas developed from till.

Slopes vary from 1 to 6 percent, those from 1 to 4 percent predominating. Inasmuch as slopes blend into each other gradually the percentage of change is difficult to determine.

This soil is fertile, easily penetrated by plant roots, and adapted to all crops grown locally. It has good internal and external drainage and retains moisture satisfactorily. Cultivation presents no particular problems. Only the few short steeper slopes included in this type are subject to erosion, which is greatest during heavy dashing rains. There is some slight wind erosion on bare fall-plowed land during winter. Contour cultivation or strip cropping may be needed to control erosion on the steeper slopes.

Moody silty clay loam, gently sloping phase.—This phase, which is very similar to the normal phase and includes a few small areas of it, is found chiefly bordering the Rock River and Split Rock Creek, and in Beaver Creek and Springwater Townships. It is characterized by a brownish-black or very dark brownish-gray friable granular silty clay loam surface layer 8 to 12 inches thick. At 14 to 18 inches below the surface the soil grades into a brown friable silty clay loam subsoil, which in turn merges at 20 to 24 inches into yellowish-brown or yellow friable mellow silty clay loam of weak subangular blocky structure. The layer of lime accumulation occurs at depths ranging from 28 to 38 inches but usually begins between 34 and 36 inches. In places it may be absent. Below the lime layer the soil has the same variations as the normal phase.

Erosion on this phase as a whole varies from slight to moderate. The soil erodes fairly severely when accumulated runoff is of sufficient volume to flow freely. In cornfields runoff causes many rills and gullies between corn rows and sedimentation at the base of the slopes. Sheet erosion, which may be moderate to severe (pl. 1, *C*), is more common than on the normal phase and is particularly bad during short heavy rains. As a result contour farming or strip cropping in addition to good crop rotation should be practiced.

This phase is a good agricultural soil. It is fertile, absorbs and holds moisture readily, is easy for roots to penetrate, and can be worked without difficulty. The same crops can be grown on it as on the normal phase, although slightly lower yields are reported.

Moody silty clay loam, level phase.—This phase, developed over clayey till from loess 5 to 6 feet deep, is mapped in slightly depressed places, gentle slopes at drainage heads, areas bordering small drains high on the watersheds, and at the edge of swamps, such as those in Rose Dell and Denver Townships.

It has a 12- to 18-inch brownish-black granular silty clay loam surface soil, grading downward into dusky-brown to dark-brown silty clay loam. At 24 to 28 inches the soil becomes dark yellowish-gray or olive-brown moderately friable to firm silty clay loam, and at 32 to 34 inches a dusky-yellow or grayish-yellow silty clay loam. There is a yellow calcareous layer of lime accumulation at depths of 36 to 38 inches, and at 3½ to 5 feet the soil has brown and gray mottlings. Yellow, yellowish-gray, or mottled yellow, gray, and brown stratified sand, silt, and clay are found at a depth of 5½ to 6 feet. These are underlain by gray, brown, and yellow calcareous glacial clay at depths of 6 to 7 feet. Lime occurs within 24 inches of the surface and in the lower part of the dark-colored subsoil in places. The surface soil and subsoil above the lime accumulation are slightly acid. Slopes are usually sufficient to provide good surface drainage but seldom exceed 2 percent. Slopes of 1 percent or less, however, predominate.

The surface soil is darker and heavier and the subsoil less brown than that of the normal phase of the type. The deeper black of the surface soil may be traced to the fact that this phase developed under moister conditions than the normal phase and not because of sediments deposited by erosion. The higher moisture in some places may be accounted for by surface runoff, since the phase receives surface water from the surrounding elevations; however, the moisture in other places is probably due to an accumulation of subsurface water. Snow accumulation may explain some of the difference in the quantity of moisture. Borings in 1937 showed that the underlying gravel was almost always wetter than under the normal phase.

Most of this level phase is used for pasture or for hay and corn. Owing to the moisture, a much ranker growth of big bluestem is common on this phase than on the other soils.

Moody silty clay loam, terrace phase.—This soil is developed on the higher terraces bordering the larger streams. The escarpments show the terraces to be underlain by stream or outwash deposits of glacial gravel; but the terraces blend into the loessal uplands, and their fine soil has the appearance of loess.

The surface soil of the phase is dark brownish-black or brownish-gray friable granular silty clay loam 10 to 14 inches thick. The subsoil is dark-brown friable silty clay loam of subangular granular structure extending to a depth of 22 to 24 inches. This layer gradually grades into yellowish-brown or yellow silty clay loam of subangular blocky structure, and at depths of 38 to 48 inches there is a layer of lime accumulation. At about 5 feet the loess is underlain by yellow calcareous silty very fine sand or fine sand and usually at 6 feet by sand

and gravel. In a few places no lime accumulation was noticed, and in others the sandy substratum was at a depth of 6 to 8 feet. Some road cuts, when dry, showed a slight efflorescence of salines on the surface. The reaction of the soil and subsoil above the lime-accumulation zone is slightly acid.

The dominant slope is less than 1 percent, although a few areas bordering some of the drainageways have slopes of 4 to 5 percent. Because of its porous substratum, which permits excessive underdrainage, most of the type shows a slightly droughty condition in extremely dry years. During seasons of normal rainfall, however, it is drought free. This phase is used largely for the production of corn and small grains.

Parnell silty clay loam.—This soil occurs in small depressions in Rose Dell and Spring Lake Townships and in old glacial drainageways, known locally as sloughs, in Battle Plain and Vienna Townships. It is developed from till and sediment that has been washed down from the surrounding loess- or till-covered hills and redeposited in depressions. A few areas on low terraces or of old alluvium now above overflow also are included.

The surface soil, which is high in organic matter and extends to a depth of 12 to 16 inches, is dark-gray or nearly black medium- to fine-granular silty clay loam, friable but moderately sticky when wet. Below the surface to a depth of 26 to 30 inches there is a dark brownish-gray to olive-brown silty clay loam, grading downward from a weak granular to fine blocky structure. Underlying this material is gray or grayish-yellow calcareous silty clay loam or predominantly gray clay. The layers are neutral to alkaline throughout. With slopes of less than 1 percent, this soil has poor surface drainage and a high water table during the wetter seasons, the sloughs remaining too wet to cultivate.

This soil is used chiefly for pasture and the production of hay and corn. In its natural condition it is well adapted for use as pasture land. When drained it can be tilled easily and sown to corn. Small grains, grown to a limited extent and only where drainage has been provided, usually lodge.

Pierce silt loam.—Located on gravelly moraines and eskers that serve as parent material, this type is characterized by a silt loam surface soil on undulating to strongly rolling morainal topography and is underlain at about 24 inches by a mixture of sand and gravel.

The surface layer to a depth of 6 to 10 inches is dusky-brown granular silt loam and grades into brown or yellowish-brown silt loam of fine blocky structure to depths of 18 to 24 inches. A mixture of calcareous sands, gravel, cobbles, and boulders in varying proportions, together with some little clay or silt, underlies this material.

The depth of the rather immature soil profile is for the most part relatively shallow; but there may be variation in the depth to coarse underlying materials, in extreme cases of from 1 to 4 feet within a distance of 50 feet. Another variation is the presence in some places of a silty loesslike surface soil over the coarse-textured materials.

The surface layer is generally slightly acid, but it may be neutral. The underlying material is alkaline to calcareous. Slopes vary from 2 to 25 percent. Where stones are not too numerous for removal, the

less steep areas are in cultivation. The land is droughty, however, and is badly eroded where steep slopes have been cultivated.

Rauville silty clay loam.—Most of this soil, which is confined to wet areas of alluvial bottom lands particularly in Denver, Battle Plain, and Vienna Townships, occurs in the comparatively broad, flat, old glacial drainageways of shallow channel. The surface soil is very dark brownish-gray to black granular silty clay loam 10 to 16 inches thick. The subsoil is dark-gray silty clay loam gradually grading into olive-gray or light olive-gray and yellow very calcareous friable to plastic clay at depths of 30 to 36 inches. The substratum contains lime concretions and may be underlain by sand at 3 to 3½ feet. Although there are exceptions, the profile usually is calcareous below 24 inches.

The soils in the old sloughs have a high water table, and many small areas show frost heaves. Smaller areas on stream terraces are subject to flooding by the adjacent small streams.

As the areas occupied are too wet in most years for profitable crop production, practically all are in pasture or used for native hay, which yields an average of 1½ tons an acre.

Rock outcrop-Ihlen complex.—This complex, like the Ihlen-rock outcrop complex, is characterized by the projection above the ground of sufficient quantities of rock to prevent economical cropping. The number of projecting quartzite rocks is even greater than in the Ihlen-rock outcrop complex. The slopes vary from 0 to more than 6 percent and include many stony escarpments. This complex, however, is used for pasture and, between the rocks, supports a growth of bluegrass mixed with the big bluestem and grama grasses. Because of its greater rock area this complex affords less pasture than Ihlen-rock outcrop complex.

Rosedell loam.—Occurring in only a few small areas, chiefly in the old lake bed and bordering the upland soils, this soil apparently represents a transition between lighter textured upland soils and the other heavier textured Rosedell soils.

The 8- to 10-inch surface layer is dusky-brown slightly granular loam and may contain small quantities of gravel. The subsoil, in which there may also be small quantities of gravel, is dark yellowish-brown crumbly loam mottled with brown and olive gray. At depths of 24 to 26 inches the subsoil passes abruptly into compact brown calcareous clay till mottled with gray, olive brown, and rust brown. Lime occurs either as soft or hard concretions or is disseminated through the till. As a rule this soil is neutral. Slopes range from 0 to 2 percent.

This soil is less subject to inundation than the heavier Rosedell soils, but drainage is required before it can be cultivated. When dry it is compact. Most of the type is used for crops.

Rosedell silt loam.—This soil, developed from a thin covering of loess on till or alluvial deposits, occurs on flat surfaces, the largest area on the west side of the old lake-bed swamps in the west-central Denver and east-central Rose Dell Townships. Other areas are found in sec. 29 of Battle Plain and sec. 22 of Rose Dell Townships.

The 1- to 2-inch upper layer of virgin soil is dusky-brown or dark brownish-gray granular silt loam containing a high percentage of organic matter. The second layer, which extends to depths of 6 or 8 inches, is black to dusky-brown platy silt loam with a few gray specks between the aggregates. The upper subsoil is dark-gray or olive-gray silty clay loam with splotches of pale yellow and strong brown and a few small rust-brown iron concretions. At depths of 16 to 20 inches it grades into olive-colored plastic clay with yellow and brown mottlings and iron concretions. The clay extends to a depth of 28 to 30 inches, where it changes relatively abruptly to light olive-gray calcareous clay loam or silty clay loam mottled with yellow or yellowish-brown and containing gray lime concretions. Varying from 2 to 4 inches thick this layer then grades rapidly into calcareous tight compact clay loam or gray clay till mottled with yellow and brown. The thickness of the layers in this soil varies radically, but at 28 to 32 inches the soil is uniformly underlain by a compact gray calcareous clay till mottled with yellow or brown. The surface soil and upper subsoil are generally neutral.

Because of its flatness the soil must be drained to remove surface water. The tile system, however, does not drain water away rapidly enough to prevent crops from being drowned out during periods of heavy precipitation. A heavy rain may inundate most of the lake bed and entirely destroy the crops. In drier years the crops are good.

The greater part of this soil is in cultivation. Corn, oats, and barley are the chief crops. A few areas are in native hay and pasture, and these should probably be increased, inasmuch as the heavy texture of the soil increases the expense of tilling other crops.

Rosedell silty clay loam.—This soil, the most extensive soil of the lake-bed or swamp area, has a brownish-black or dusky-brown finely granular silty clay loam surface layer 4 to 6 inches thick. The subsoil is finely granular dark-gray or olive-gray silty clay loam with yellow streaks or splotches and a few red specks or rust-brown iron concretions. This layer is very plastic when wet. At depths of 28 to 30 inches the soil becomes calcareous light olive-gray plastic silty clay loam or clay, and at 40 to 44 inches it changes abruptly into yellowish-gray compact till mottled with gray and brown. The substratum contains a high percentage of lime and many lime concretions. This soil is variable in surface texture and in thickness of different layers. For the most part the terrain is flat, the slopes not exceeding 2 percent.

Although when drained this silty clay loam can be planted to corn, it is subject to inundation during heavy rains, and in rainy years a large percentage of the crops may be drowned out. Yields are best during seasons of moderate rainfall but are probably never very high. This soil clods badly when plowed dry; however, it is sticky and difficult to cultivate when wet. The general practice is to break the soil when dry and permit the clods to slake down before planting.

Rosedell silty clay loam, high phase.—This phase occupies the slightly higher elevations in the lake-bed area. The top 16 to 18 inches of black granular silty clay loam is very sticky and plastic when wet and grades into yellowish-gray sticky plastic silty clay loam or calcareous clay, mottled with brownish yellow and rust brown and containing a few iron and lime concretions. At 34 to 38 inches the soil

grades into grayish-yellow clay till with brownish-yellow and brown mottlings and gravel and lime concretions. The surface soil, which cracks severely upon drying, is neutral or slightly acid. Slopes range from 0 to 2 percent.

Although this phase appears to have better internal drainage than associated soils in the lake-bed area it must be artificially drained for the cultivation of corn. Crops grown are very little damaged by water in wetter years and corn in particular thrives well.

Sioux loam.—This soil, which occurs in association with Fordville soils, is developed on gravel terraces lying 5 to 12 feet above the flood plains. Small areas occur in most of the larger stream valleys. The surface soil is very dark-brown or dark brownish-gray friable granular loam 6 to 8 inches thick. The subsoil, usually of fine blocky structure, is brown friable loam extending to depths of 16 or 18 inches, where it grades into a yellowish-brown loam. At 22 to 24 inches the subsoil grades abruptly into calcareous sand and gravel. Like the Fordville loams, this type contains more coarse sand than the heavier textured types and is decidedly gritty. It is slightly acid to neutral throughout. The surface is flat to gently sloping, with slopes of 0 to 1 percent.

This soil is decidedly droughty, especially in seasons of subnormal rainfall, when it is subject to wind erosion. A good rain every 10 to 14 days during July and August is essential to insure average crop development. The soil develops a good tilth condition early in spring. Practically all of it is under cultivation, with corn the predominant crop.

Sioux loam, strongly sloping phase.—This phase occurs as narrow bands, seldom more than 50 feet wide, on short, comparatively steep slopes on the outer edges of terraces. The surface 4 to 6 inches is dusky-brown friable loam. The subsoil is brown friable loam that becomes lighter with depth and at 16 to 24 inches grades into brownish-yellow sand or sand and gravel. The gravel and sand are several feet thick. The soil layers are neutral to slightly acid. Slopes range from 5 to 10 percent.

The soil erodes badly and in places is gravelly on the surface. Inasmuch as it is very droughty, its economic value is doubtful. Since many areas occur in cultivated fields, however, farmers usually consider it more economical to cultivate them and take the yields they can obtain rather than leave the strips in grass.

Sioux very fine sandy loam, gently sloping phase.—This phase occupies narrow escarpments bordering the stream flood plains in a slightly undulating relatively small area. The surface layer is very dark-brown or dark brownish-gray friable granular very fine sandy loam 6 to 10 inches deep. The subsoil is dark-brown or brown friable granular very fine sandy loam that gradually becomes lighter and less granular with depth and grades into yellowish-brown or yellow sandy loam of subangular fine blocky structure at 18 to 22 inches and into sand or sand and gravel at about 24 inches. The soil layers are slightly acid to neutral. Slopes vary from 1 to 5 percent. Crops on this soil suffer considerably from drought in years of subnormal rainfall.

Vienna-Flandreau silty clay loams.—This complex, which usually occurs as narrow strips between the Vienna and Flandreau soils and is confined largely to Vienna Township, is composed of three soils—Vienna and Flandreau silty clay loams and a transitional type between them. The Vienna soil occupies about 70 percent and the Flandreau about 20 to 30 percent of the area covered. So closely are they related, however, that it is impossible to delineate them separately on the map.

Vienna soil is characterized by a dusky-brown silty clay loam surface layer about 8 to 10 inches thick, imperfectly prismatic, in places breaking into medium-sized granules; a dark yellowish-brown silty clay loam subsurface layer 4 to 6 inches thick; and variegated light yellowish-brown, moderate yellowish-brown, yellowish-gray, and rust-brown clay loam till, rather high in lime.

The surface and subsurface of the Flandreau soil are like those of the Moody, but the Flandreau is underlain by brownish-yellow calcareous fine sand at a depth of about 30 inches. Glacial till is ordinarily not encountered at depths under 60 inches in the Flandreau soil, but in the case of this complex, where there is a transitional soil between Vienna and Flandreau soils, a sand layer may occur within 30 inches of the surface and extend to a depth of 40 inches, where calcareous clay till is again encountered. These soils are slightly acid to neutral throughout. Slopes of less than 3 percent predominate.

Most of the land is used for corn and small grains. Crop yields are slightly lower than on the Vienna soils, and the crop growth is generally more spotty.

Vienna loam.—This soil, developed from till, covers an extensive area. It is found on comparatively smooth stream divides associated with the Flandreau and Estherville soils, the largest area occurring in sec. 16 of Vienna Township. The surface layer is dusky-brown or dark brownish-gray friable granular loam or light-textured loam to a depth of 12 to 14 inches. The subsoil is dark yellowish-brown or dark grayish-brown calcareous silty clay loam to a depth of 16 to 20 inches, where it rapidly grades into variegated yellowish-brown and brownish-yellow calcareous sandy clay loam till. The subsoil has a subangular fine blocky structure and is characterized by the presence of some gravel and stones in the subsoil and till substratum. The surface soil is slightly acid to neutral. Slopes are from 0 to 3 percent.

This type is subject to slight wind erosion. Because it absorbs moisture comparatively rapidly, is fertile, easy to till, and permits root penetration, it is considered fair to good for cultivation. Corn is the principal crop.

Vienna loam, gently sloping phase.—The largest areas of this phase are in the eastern part of Denver Township, in association with the loam and the silty clay loam of the Vienna series and the Fairhaven soils. It has dusky-brown or dark brownish-gray friable granular loam surface soil 10 to 14 inches thick. Beneath this, the soil is brown or yellowish-brown friable silty clay loam to clay loam of subangular fine blocky structure to depths of 22 to 24 inches. There it grades into yellow or light yellowish-brown silty clay loam or clay loam, and at 28 to 32 inches abruptly becomes calcareous, compact, heavy clay till, variegated with yellow and brownish yellow or brown, yellow, and gray. In places the upper part of the underlying till is

noncalcareous, but at 5 to 6 feet it is very calcareous, although it contains few lime concretions and lime and more gray and brown mottlings. The soil layers are slightly acid to neutral. Slopes vary from 2 to 7 percent, but the majority range between 2 and 6 percent.

Because of its slope the phase is subject to moderate sheet erosion, especially during heavy rains. The adoption of a cropping system involving contour cultivation or strip cropping would probably not only prevent such erosion but conserve moisture. Like the normal phase of the type this soil does not have so great moisture-storing capacity as Moody silty clay loam, which occupies comparable slopes. The soil is used largely for corn and small grains.

Vienna silty clay loam.—This soil, which is found chiefly in the northeastern corner of the county, occupies almost flat to slightly undulating areas in association with other Vienna soil. The surface soil is dusky-brown or dark brownish-gray friable granular silty clay loam to heavy silt loam 10 to 14 inches thick, grading downward into dark yellowish-brown silty clay loam of subangular fine blocky structure. At depths of 18 or 22 inches this layer grades into a variegated but predominantly yellowish-brown silty clay loam of blocky structure. Mottled yellow, brownish-yellow, gray, and brown calcareous compact heavy clay till, overlain by a 1- to 2-inch layer of gravel, in places so compact that it can scarcely be penetrated with a soil auger, occurs at depths ranging from 32 to 38 inches. The lime in the clay till is in the form of concretions and soft gray spots distributed throughout the layer. At depths of 5 to 6 feet the concretions are less numerous or absent and there is a larger percentage of gray mottlings. The soil reaction is neutral. Slopes usually vary from 0 to 2 percent, but some of 3 percent are included. Sheet erosion occurs on short slopes during periods of heavy rains, especially after the soil has been plowed and is loose.

As a general rule this soil contains more clay and is heavier than Moody silty clay loam. Its moisture-storing capacity, however, is lower, since its layer of heavy clay till, which takes up moisture more slowly and releases a smaller percentage for plants than other kinds of soils, occurs at a shallower depth. It is probable also that when this soil occurs on slopes comparable with those of soil developed from loess, it absorbs moisture less rapidly and loses more by runoff. The surface soil, moreover, appears to have a slightly greater tendency to pack than that of the Moody soil.

This type is fertile but not particularly easy to cultivate. It permits comparatively free and easy root development in the upper 30 inches although not to the same extent as the Moody soil. The soluble salt (magnesium sulfate) found in some places, especially on the lower slopes, is not of sufficiently large quantity to act as a deterrent to the growth of crops, principally corn and small grains.

Vienna silty clay loam, gently sloping phase.—This phase occurs on moderate slopes in association with the normal phase. It is characterized by a surface soil of dusky-brown to dark yellowish-brown friable medium granular silty clay loam, or in places silt loam, which extends to a depth of 8 to 10 inches. From this point the soil grades downward into yellowish-brown silty clay loam of subangular fine blocky structure, which at about 20 inches becomes light yellowish-

brown, moderately yellowish-brown, or dark yellowish-brown silty clay loam of subangular blocky structure. The layer is calcareous and, besides containing many lime nodules the size of a pea, has a few rust-brown spots. The underlying clay till, which occurs about 36 inches below the surface, is variegated but predominantly light to moderately yellowish brown. It is well weathered and contains segregations of lime and many pebbles and cobbles of quartzite, gneiss, and basalt. The soil is slightly acid Slopes range in general from 2 to 6 percent.

The chief difference between this soil and the normal phase is its greater slope, which makes it more subject to sheet erosion. It also has somewhat lighter colored surface soil, which in places is thinner and has slightly better drainage.

Vienna silty clay loam, strongly sloping phase.—This phase occurs in association with Vienna soils in narrow strips on abrupt slopes where the upland drops to the stream valleys or terraces. The surface layer is a 6- to 8-inch dark brownish-gray or dark yellowish-brown weakly granular, slightly sticky, silty clay loam. Underlying this is a somewhat plastic brown or yellowish-brown clay loam subsoil of fine blocky structure, extending to a depth of about 20 inches. Beneath the subsoil is compact calcareous clay loam till more or less variegated, although predominantly yellowish brown. In some areas the till occurs within 12 inches of the surface and stones and boulders are numerous on the surface. Slopes vary from 6 to 12 percent, but soil on many steeper grades is included. This soil has steeper slopes and thinner surface and subsoil layers than the normal phase, and the surface soil is lower in organic matter.

The phase is not suited physically to the cultivation of crops requiring tillage, as surface drainage is rapid and the control of runoff is difficult. Even the less sloping areas now under cultivation are eroding very rapidly. Much of the soil is in pasture, which is recommended as its best long-time use.

Volin silt loam.—This soil occurs on the flood plains of the larger streams, closely associated with Lamoure silty clay loam. The surface layer to a depth of 10 to 15 inches is a brownish-black or very dark brownish-gray friable granular silt loam. Beneath is a brownish-gray to moderately brown slightly plastic silty clay loam, which grades at a depth of about 24 inches into yellowish-gray or light yellowish-brown heavy silt loam, which for the most part is calcareous. Silty alluvium occurs at a depth of about 36 inches. The surface layer is generally neutral or very slightly acid and free from injurious salts.

Differing from the Lamoure soils and other first-bottom soils of the broad flood plains, this type occupies higher elevations on the upper bottom lands, a position that keeps it from being flooded except during periods of extremely high water. It has a more mature soil profile and, as attested by the absence of mottlings and injurious salts, is better drained. Both soils are highly productive.

Since fields of this soil are not so subject to early spring floods as those of almost all the Lamoure soils, they can be seeded and planted approximately as early as land on the adjacent uplands. Practically all of the soil is in cultivation. The principal crops are corn and small grains.

USE, MANAGEMENT, AND PRODUCTIVITY OF ROCK COUNTY SOILS

SOIL GROUPS

In considering the use and management of Rock County soils it is helpful to group together soils that for these practices are alike in suitability. Such a grouping naturally is based on common characteristics of position, composition, profile, chemical reaction, slope, and drainage, already mentioned in connection with the general description of the soils. For convenient reference, however, the groups are listed as follows:

Group 1:
- Flandreau silt loam, deep phase
- Kranzburg silty clay loam and its gently sloping phase
- Moody silt loam and its gently sloping phase
- Moody silty clay loam and its gently sloping and terrace phases

Group 2:
- Crofton-Moody silt loams
- Moody silt loam, rolling phase

Group 3:
- Flandreau loam and its sloping phase
- Flandreau silt loam and its sloping phase

Group 4:
- Ihlen silt loam and its stony and stony gently sloping phases

Group 5:
- Vienna-Flandreau silty clay loams
- Vienna loam and its gently sloping phase
- Vienna silty clay loam and its gently sloping phase

Group 6:
- Pierce silt loam
- Vienna silty clay loam, strongly sloping phase

Group 7:
- Estherville loam and its gently sloping phase
- Fairhaven silt loam, shallow and gently sloping shallow phases
- Fairhaven silty clay loam

Group 8:
- Fordville fine sandy loam
- Fordville loam and its gently sloping phase
- Fordville silt loam, gently sloping phase

Group 8—Continued
- Fordville silty clay loam and its deep phase
- Fordville very fine sandy loam
- Sioux loam
- Sioux very fine sandy loam, gently sloping phase

Group 9:
- Alcester loam
- Alcester silty clay loam
- Moody silty clay loam, level phase

Group 10:
- Blue Earth silty clay loam
- Parnell silty clay loam
- Rosedell loam
- Rosedell silt loam
- Rosedell silty clay loam and its high phase

Group 11:
- Cass loam, high-bottom phase
- Volin silt loam

Group 12:
- Cass loam
- Lamoure silty clay loam
- Lamoure very fine sandy loam

Group 13:
- Alluvial soils, undifferentiated
- Benoit soils, undifferentiated
- Rauville silty clay loam

Group 14:
- Estherville loam, strongly sloping phase
- Fairhaven silt loam, strongly sloping shallow phase
- Flandreau silt loam, strongly sloping phase
- Kranzburg-Vienna stony silt loams
- Sioux loam, strongly sloping phase

Group 15:
- Ihlen-rock outcrop complex
- Rock outcrop-Ihlen complex

PRESENT LAND USE AND MANAGEMENT

Rock County, according to the Minnesota Agricultural Experiment Station (*4*), is in the southwestern livestock and cash-grain area, which is described as lying "between the Corn Belt to the south, the dairy region to the east and northeast, and the small-grain region to the west

and northwest." As in adjacent counties, a large proportion of the land is used for corn and a small proportion for hay and pasture.

In 1939, according to the experiment station (*5*), 96.7 percent of the land in the county was in farms. Of the farm land, 78.4 percent was under cultivation; 2.5 in wild hay; 0.2 in woodland; and 18.9 percent in other uses. Intertilled crops (almost entirely corn) occupied 38.6 percent of the tillable land; small grain, 44.2 percent; and hay, seed, or pasture crops, 15 percent. More specifically, 36.5 percent of the farm land was in corn for grain; 0.7, in silage corn; 28.6, in oats; 7.8, in barley; 6.8, in flax; 4.8, in alfalfa; 0.3, in clover or timothy; 0.5, in sweetclover; 7.5, in pasture; and 6.5 percent in various other crops.

The predominant upland soils of the county, represented largely by Moody and Vienna soils of groups 1 and 5, respectively, support good stands of corn, oats, barley, flax, and alfalfa. Small grains grown on these soils usually do not lodge unless the soil has had heavy applications of barnyard manure or has been planted for several years in alfalfa. Land planted for several consecutive years in alfalfa also has been known to lose a considerable proportion of its moisture reserve, with resulting bad effects on crops grown the following year.

The Crofton-Moody, Moody, Flandreau, and Ihlen soils of groups 2, 3, and 4 are used for the production of the same crops as those of groups 1 and 5. Their smaller water-storage capacity, however, makes them less productive than soils in groups 1 and 5, and this fact, together with their steeper slopes and stony spots, does not permit them to be farmed as intensively as some other soils.

The Alcester and Moody soils of group 9 are used largely for corn. Small grains grow rank and frequently lodge on these soils. Furthermore, since they warm up later in spring, their preparation for seedbed is often delayed beyond the normal planting time, particularly for oats, with a consequent loss of the most favorable part of the growing season for the crop.

In places, these soils occur as small areas in association with those of groups 1, 2, 3, 4, and 5, and may be utilized in the same manner as the soils of these groups. Where small areas occur in association with larger areas of Moody or Vienna soils they may be too wet for seeding in small grains when other soils are being planted. Areas thus skipped frequently are later planted to corn, but many times they are either left to revert to meadow or allowed to remain idle.

The soils of groups 7 and 8 occur on outwash plains and stream terraces, respectively. The Estherville and Fairhaven soils of group 7 and the Fordville and Sioux soils of group 8 warm up early and are among the first to be seeded to small grains in spring. Alfalfa also is grown.

The Blue Earth, Parnell, and Rosedell soils of group 10, which include poorly drained soils in depressions of the uplands, are for the most part planted to corn and to a lesser extent in small grains. Where artificially drained, they become productive cornland, although they will produce hay and pasture crops without artificial drainage. A few fields that have been tile-drained produce high yields of corn during seasons of nearly normal or less-than-normal rainfall. During seasons of excessive rainfall, however, crops on such fields have been ruined by high water.

The soils of the alluvial flood plains are diverse in their agricultural possibilities. They are divided into three groups on the basis of drainage. The well-drained Cass and Volin soils of group 11, being less subject to flooding than other areas, are used for cultivated crops. Corn is the predominant crop because small grains on these soils produce a greater proportion of straw to grain than in other areas, are more apt to lodge, and are easily damaged by floodwaters.

The Cass and Lamoure soils of group 12 are subject to temporary high-water table and frequent floods. Spring floods and frost hazards slightly retard planting, and summer floods sometimes damage or destroy the crops. Nevertheless, group 12 soils, which are probably the most fertile in the county, are highly productive when sown to corn and furnish excellent grazing. Many fields, particularly on Lamoure silty clay loam, are planted year after year to corn. Corn is the dominant crop on all the soils of this group. Small grains are produced to a much lesser extent because of the hazards of flooding and lodging.

The Benoit and Rauville soils of group 13 are permanently wet and Alluvial soils, undifferentiated, are often wet. They are not cropped to corn or small grains, but generally are used for hay and pasture. Besides being subject to overflow, all the soils of the flood plains are affected by stream-bank cutting and deposition of materials carried by floodwaters.

The soils of groups 6, 14, and 15, which are poorly suited to most crops because of their stoniness and steep slopes, are as a rule utilized for pasture and the production of hay.

Aside from the exceptions mentioned in the preceding paragraphs, the kinds of crops grown, and their sequence, the methods of tillage, and the types of machinery in use are about the same on all the arable soils. Planned rotation of crops is not followed. Corn and small grains are alternated or are grown 2 years or more consecutively on the same location. The application of barnyard manure has been the most important method by which the farmers have attempted to maintain soil fertility.

To save work in spring, since the crop season is comparatively short and the farms large, plowing is done in fall. Most corn is planted in check rows, but some is drilled in rows. As a rule corn is cultivated three or more times during the growing season, but in wet seasons, because of delayed planting and interference of the small-grain harvest, the crop may receive only two cultivations. Two-row tractor-driven corn cultivators far outnumber other types. Power-driven corn pickers are common. Farmers plant corn not only because it grows well but because it can be produced economically with modern power-driven machinery. Corn for silage usually is cut with a binder and chopped as the silo is filled; but some is cut and chopped by one operation in the field and hauled to the silo.

Oats and barley frequently follow corn and formerly were sown directly on the stubble, which had been disked in rather than plowed under. The present practice is to plow under the corn stubble in fall. These crops are most frequently cut with a tractor-drawn binder, shocked in the field, and later threshed from the shock. Much of the grain is held on the farm, where it is ground and fed to livestock.

As a whole farmers have not been concerned greatly about the menace of erosion, considering it a natural sequence to cultivation of the land. In the past few years, however, many farmers have become convinced that soil erosion is undesirable and have indicated growing interest in methods for its control.

RECOMMENDED LAND USE AND MANAGEMENT

Land use and management refer to such practices as choice and sequence of crops and crop varieties, application of fertilizers or other amendments, tillage methods, types of machinery used, and weed and erosion control. That the best possible use and management of the land in Rock County has not always prevailed is evident from a careful examination of the soils throughout the county. The granular structure of the surface soils, so strongly apparent in the more nearly virgin grasslands, has begun to break down in many of the continuously cultivated fields. The soil now tends to bake or harden upon drying and is less able to absorb water quickly. Active sheet, gully, and wind erosion are evident. In spite of new, higher yielding, disease-resistant varieties of crops and improved tillage practices, yields remained about the same up to the introduction of hybrid corn. There is no doubt, however, that the productivity of all or nearly all the soils can be increased by the practice of systems of soil management adapted to each particular soil.

The fundamental principles of soil management constitute the six-point Minnesota Soil Fertility and Conservation Program (*2*) covering: (1) Drainage and cultivation; (2) liming acid soils; (3) crop rotation; (4) use of organic matter; (5) application of commercial fertilizers; and (6) erosion-control practices.

The practices recommended in the program are essential to good soil management, but not all principles are applicable to every soil. A knowledge of the chief characteristics of a given soil, as slope, fertility, present drainage system, and state of erosion, as well as its workability and conservability, is absolutely necessary to determine what method or combination of methods is most important.

Facts about the soils of the county are given in the preceding sections. The various soil types, phases, and land types are combined into 15 groups on the basis of soil characteristics that indicate the possibility of similar use and management. Some recommendations apply to only one or more soils; some to one or more soil groups.

The order of the principles listed under the six-point Minnesota program does not relate to their importance in Rock County. For instance, the liming of acid soils has little if any application in this county, where no lime-deficient soils have thus far been found. Furthermore, certain principles may be more important in one part of the county than in others.

DRAINAGE AND CULTIVATION

Any discussion regarding drainage in Rock County logically leads to a consideration of soils of group 10 and to a lesser extent of those of groups 12 and 13.

The poorly drained Rosedell, Blue Earth, and Parnell series, which comprise group 10, have developed under the dominant influence of a permanently high-water table. At the present time sufficient drainage has been established on parts of these areas to grow some crops other than water-tolerant grasses. Corn, and more particularly small grains, however, are still exposed on these soils to the hazard of an intermittent high water table. If these soils can be provided adequate artificial drainage they will have a much wider range of adaptation to the production of different crops.

Each farm constitutes an individual drainage problem, one usually requiring study by a competent drainage engineer. The requirements for depth and spacing of tile differ with different soils, depending chiefly on their texture and the supply of organic matter as reported by Neal (*7*). From his investigation, it is estimated that tile placed at a 4-foot depth should be spaced about 50 feet apart. The construction of an adequate (fault proof) drainage system on these soils is not an easy task and requires considerable outlay.

There is no doubt that the Rauville soils of the alluvial bottom land (group 13) are benefited by artificial drainage. It is to be remembered, however, that although artificial drainage will prevent some flooding by reducing the period floodwaters will stand in a field, it will not prevent all flood hazards. The Benoit soils included in group 13 are generally situated on higher levels than the Rauville. Their position makes them less subject to flooding, but they are kept constantly wet by seepage water. Because of their coarse-textured lower subsoil, Benoit soils are droughty when too thoroughly drained.

Cultivation applies to all soils that are plowed and cropped. It encourages aeration; helps incorporate crop residue and manure; conserves moisture, largely by controlling weeds; and is a means of providing the satisfactory seedbeds so essential to the establishment of good stands of crops, especially legumes and grasses.

Finer textured soils, as the heavy silty clay loams of groups 1, 5, 9, and 10, are likely to puddle if plowed when wet. Fall plowing of these soils may be necessary if plowing is to be done when the soil is at its proper moisture content. By plowing at that season any clods that are formed will often be broken up by the alternate freezing and thawing to which they are later subjected, so that their tilth is improved by planting time in the following spring.

Sloping land should be plowed and cultivated as nearly crosswise of the slopes as possible. The practice, referred to as contour plowing and contour cultivation, tends to conserve moisture by increasing infiltration of water and retarding the loss of surface soil.

In the case of coarser textured soils, particularly the fine sandy loams and loams of groups 7 and 8, which are more subject to wind erosion, plowing should be done in spring if possible. These soils and also the silt loams that are subject to blowing should be left with a rough surface much of the time to prevent the wind from shifting and blowing away the surface soil. The use of field cultivators with duckfoot or sweeps tends to leave more vegetative cover on the surface to protect the surface soil than some other cultivation methods. When it is necessary to back fallow to eradicate noxious weeds, this operation

should be done in strips so as not to expose the entire field to the long sweep of the wind.

CROP ROTATION

Every well-planned farm should be systematically cropped. To be good a crop-rotation system should maintain soil fertility and productivity and conserve the soil without greatly interfering with the farm routine as a whole. In other words, the crop-rotation plan should allow for only as many soil depleting crops as can be tolerated without serious loss to the soil, these meanwhile being balanced with a sufficient number of close-growing crops to renew the fertility. The soil-depleting crops grown in the county are corn, soybeans for grain, and small grains; the soil-conserving crops are legumes and grasses for hay and pasture. Since the principal crop is corn, which is definitely a soil depleting crop, the rotation system will have to include an almost equally large percentage of remedial crops. Broad limits suggested for the utilization of the soil groups in the county are listed in table 6.

TABLE 6.—*General types of crops recommended for various soil groups in Rock County, Minn.*

Soil group [1]	Intertilled crops [2]	Small grain	Hay and pasture [3]	Soil group [1]	Intertilled crops [2]	Small grain	Hay and pasture [3]
	Percent	*Percent*	*Percent*		*Percent*	*Percent*	*Percent*
1	40	20	40	9	50	25	25
2	20	20	60	10 [5]	50	25	25
3	33	17	50	11	60	-------	40
4	33	17	50	12	60	-------	40
5	40	20	40	13	60	-------	40
6	-------	-------	100	14	-------	-------	100
7	33	17	50	15	-------	-------	100
8 [4]	33	17	50				

[1] See included soils in list on p. 49.
[2] Maximum percentage permissible.
[3] Minimum percentage permissible.
[4] Except Fordville silty clay loam, deep phase, which can be utilized in the same manner as the soils in groups 1 and 5.
[5] Where drained.

The percentage of utilization is based on the best interpretation of the results of the use of these soils in this climatic zone under the different cropping practices in the past. Soils of groups 1 and 5 are the most common in the county and their crop balance can best be maintained either by a 5-year rotation of corn-corn-small grain-hay-hay or a 6-year rotation of corn-small grain-corn-small grain-hay-hay. The adoption of a rotation system is not so necessary on the soils of alluvial bottom lands (flood plain), which are all in groups 11, 12, and 13.

It must be emphasized that where the soil is used to the limits suggested, all crop residue, including all barnyard manure produced on the farm, should be returned to the fields, and such soil conservation practices adopted as may be necessary to keep erosion at a minimum.

ORGANIC MATTER AND COMMERCIAL FERTILIZERS

Sometimes called the life of the soil, organic matter is one of the most important constituents of a productive soil. A dark soil high in organic matter is generally considered fertile. In Rock County and adjacent areas native grassland vegetation and climatic conditions have combined to bring about the accumulation of large quantities of organic matter. It took a long time, however, for the deep dark surface layer with its accumulated organic matter to form. Some soils have been able to withstand almost continuous cultivation without having their organic matter renewed. Limited investigations nevertheless indicate that although most of these soils have not suffered irreparably, their breaking point may not be far away.

When soils are under cultivation it may not be economically feasible to maintain as high a reserve of organic matter as was originally found under native grasses, but it is necessary to keep the level of organic matter above the limits for safe and economical crop production. That limit calls for an increase of organic matter in some fields and maintenance of the existing quantity in others. To do this it is necessary to return to the fields all barnyard manure produced on the farm; plow under crop residues; utilize green manures where practicable; and use longer rotations, including several years of close-growing grasses and legumes.

Renewing the fertility of the soil by the application of barnyard manure is a tried and proved method and one of the best means of maintaining organic matter. In recommending the quantity of manure to be applied to the different soils certain facts should be kept in mind. Corn production, which necessitates cultivation at frequent intervals, draws heavily on the supply of organic matter, whereas growing legumes and grasses for hay and pasture tends to maintain the supply. At least one application of 6 to 8 tons an acre of manure should be made to the intertilled crop during the rotations suggested in the preceding section. A second application can and in some cases should be added to fields seeded to legumes and grasses with small-grain crops. In general, the best way to handle manure without loss of nutrients is to haul it directly to the field. Much of the manure is wasted when it is stored unprotected near the barns.

A general recommendation is to turn under all crop residues, including stubble of small-grain and hay crops and cornstalks, or any other plant material. Since more grain is now being harvested with combine, an operation that drops the straw on the land to be plowed under or disked into the soil, the quantity of organic matter added to the soil is being increased. Where grain is threshed and the straw left in piles, which for the most part are burned, a loss of organic matter results.

Where there is a shortage of barnyard manure, green manure should be provided in the rotation system. Sweetclover is perhaps one of the best green-manure crops, but it should be handled in such manner that it will not dry out the soil. Either the whole crop of sweetclover or the aftermath immediately following the harvest should be plowed under in June the year after seeding, and the field fallowed during the remainder of the growing season to eradicate noxious weeds and conserve moisture. Sweetclover, as a green manure or as both pasture and

green manure, is recommended for the wet sticky areas and alkali spots most common in soils of group 10. This crop will help to improve not only the soil tilth but internal drainage as well.

Crops differ in their need for certain fertilizers in the same way that soils differ in their supply of available plant nutrients. Nutrients are continually being removed by crops, but fortunately they can be replaced by the use of commercial fertilizers.

Specific information pertaining to fertilizer requirements of the different soils in this county is not yet available. The Minnesota Agricultural Experiment Station, however, has suggested the general recommendations given in table 7.

TABLE 7.—*General fertilizer recommendations for the soils of Rock County, Minn.*

[Blank spaces indicate that the crop is not recommended or that fertilizer recommendations for the crop are not available]

Soil group [1]	Quantity and kind of fertilizer recommended per acre for—					
	Corn		Small grain seeded to legumes and grasses		Renovation of permanent pasture	
	Pounds	*Formula*	*Pounds*	*Formula*	*Pounds*	*Formula*
1	100	[2] 0–20–0	300	0–20–0	300	0–20–0
2	150	4–12–8	250–300	4–12–8	300	32–0–0
3	100	4–24–12	150–200	4–24–12	300	32–0–0
4			300	0–20–0	300	32–0–0
5	100 or 150	4–24–12 or 4–12–8	200–300	3–18–9	300	0–20–0
6					100–300	32–0–0
7	100	4–24–12	150–200	4–24–12	300	0–20–0
8 [3]	100	4–24–12	150–200	4–24–12 or 0–20–0	300	0–20–0
9	100	4–16–0	300	0–20–0	300	0–20–0
10 [4]	100	0–20–0 or [5] 0–20–20	300	0–20–0	300	0–20–20 or 0–20–0
11	100	0–20–0			300	0–20–0
12	100	0–20–0			300	0–20–0
13	100	0–20–0			300 or 100	0–20–0 or 32–0–0
14					300	0–20–0
15					300	0–20–0

[1] See included soils, p. 49.

[2] Percentages, respectively, of nitrogen (N), phosphoric acid (P_2O_5), and potash (K_2O).

[3] Excepting Fordville silty clay loam, deep phase, which can be treated in the same manner as the soils in groups 1, 5, and 9.

[4] Where drained.

[5] Use only formula 0–20–20 on Blue Earth soils.

The lighter applications of fertilizer for corn are based on hill applications, using fertilizer attachments on corn planters. The

heavier applications to small grain seeded to legumes and grasses are suggested as a means not only of insuring good stands of legumes but also of increasing the growth and yield of the next crop in the rotation.

The recommendations given in table 7 indicate that the available phosphorus content of the soils is low. Since the extent of phosphate deficiency is not known, it is suggested that phosphate fertilizer be tried on strips 2 to 3 rods wide crosswise of the farm to determine the crop response (*3*, *9*).

EROSION-CONTROL PRACTICES

Closely linked with the maintenance of soil fertility is the control of erosion. Measures recommended to maintain or increase soil productivity have the advantage of acting also as a soil-conservation measure. On the predominant cropland of the county, represented by soils of groups 1 to 5 and 7 to 9, erosion can be controlled by the adoption of proper crop-rotation practices, the maintenance of organic matter in the soil, and where needed, the application of commercial fertilizers. By the use of proper cropping practices it is possible to maintain high yields and conserve the soil at the same time. To prevent both loss of moisture and soil on the gently sloping and sloping areas of these soil groups and on Vienna-Flandreau silty clay loams, which occupy similar slopes, farmers should supplement ordinary good farming practices by other erosion-control practices, as contour farming and the sodding of waterways. Sod waterways not only check the formation of new gullies but fill up those already cut in places where natural waterways have been plowed.

Fields of soils in group 2 should be left in meadow and pasture much of the time to prevent sheet and gully erosion from ruining what is left of the soil. Fields of sloping land should not be plowed or cultivated in their entirety, but where possible in contour strips separated by bands of hay or meadow. This practice, called strip cropping, prevents excessive soil washing and gullying. The use of terraces to lead runoff water from long sloping fields, such as are found on Moody soils of group 1, is feasible.

To prevent the blowing away of some of the surface of the sandier soils of groups 7 and 8, some fields of Cass loam, high-bottom phase, soils of group 11, and even many silt loam types, the use of terracing, strip cropping, and similar methods must be supported by the adoption of moisture-conservation and wind-erosion control practices. In the section on Drainage and Cultivation the use of rough-tillage measures to help control wind erosion has been discussed. In addition to the adoption of rough tillage, fields subject to severe blowing should be laid out, as far as possible, crosswise to the prevailing winds. These fields should not exceed 20 rods in width, and should be so arranged, from the standpoint of crop rotation and plowing, that no two adjacent fields are bare at the same time. Where necessary to prevent further soil blowing when corn is cut, several rows of cornstalks should be left standing every few rods to make a windbreak.

No supporting erosion-control practices are recommended for soils of group 10, since they are for the most part nearly level and are not subject to the effects of the wind.

Soils of groups 11, 12, and 13 are not, as a rule, subject to wind and water erosion, but they are affected by stream-bank cutting and by the deposition of materials carried by floodwaters. To protect the more productive bottom land or even farm buildings, mechanical measures may be needed to help confine the stream to its main channel and prevent stream-bank erosion. Wing dams built of willow brush and rock or log-filled rock cribbing may prevent further cutting. These measures should be protected from farm animals and supplemented by vegetation.

Soils of groups 6, 14, and 15 are best suited to permanent meadow and pasture. To control erosion further and increase yields of pasture the plant cover of these pastures needs to be increased. Pasture management (*1*), pasture renovation, and application of manure or commercial fertilizers are recommended.

YIELDS AND PRODUCTIVITY

The estimated average acre yields of important crops on the different soils of Rock County are shown in table 8, under two levels of management. In the B columns are those that may be expected under management practices most commonly followed in the county; in the C columns those that, on the average, may be expected as a result of the use of methods for increasing and maintaining soil productivity at the highest point consistent with profitable farm management. Such methods, as recommended by the State, would include primarily proper crop rotation, application of commercial fertilizer, and maintenance of organic matter through the use of barnyard manure, green manure, and crop residue. Little if any of the land in the county is being managed in this manner.

A comparison is given in table 9 of the estimated yields under both B and C levels of management with the national standards of reference, or national average of yields considered good in areas of the United States where the crop is widely grown. As shown at the head of the respective productivity index columns, the national standard is weighted 100 and the yields of the most important crops on each of the soils are given in terms of a percentage of this standard.

Most of the estimates for yields under ordinary management practices shown in the B columns are based on observations made in the field during the progress of the soil survey in 1937 and 1938 and by interviews with farmers and local and State agricultural authorities. Definite data were obtained for several fields on seven of the most common soils. The estimates for yields resulting from superior management practices given in the C columns are based partly on field observations and partly on information obtained from farmers and staff of the Division of Soils of the Minnesota Agricultural Experiment Station and the extension soil specialist of the University of Minnesota Agricultural Extension Service.

TABLE 8.—*Estimated average acre yields of principal crops under two levels of management on the soils of Rock County, Minn.*

[Estimated yields in columns B are those to be expected under common practices of management; those in columns C are to be expected under the best practices of management. Blank spaces indicate that the soil is not commonly planted to the crop named and no reliable inductive estimates can be made for it.]

Soil	Corn (hybrid) [1]		Oats [2]		Barley		Silage (corn)		Alfalfa (hay)		Other hay		Pasture	
	B	C	B	C	B	C	B	C	B	C	B	C	B	C
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Cow-acre-days* [3]	*Cow-acre-days* [3]
Alcester loam	46	53	46	52	30	33	12	15	3	3¼	2	2½	150	175
Alcester silty clay loam	51	57	53	58	35	38	14	15	3	3¼	2	2½	150	175
Alluvial soils, undifferentiated													100	125
Benoit soils, undifferentiated											[4]2	2¼	100	125
Blue Earth silty clay loam [5]	23	46	35	45	25	27	8	12			2	2¼	150	250
Cass loam	34	40	30	35	20	22	8	10					110	150
High-bottom phase	23	29	36	42	20	22	5	7	1	1¼			100	125
Crofton-Moody silt loams	34	44	30	40	15	18	8	10	1½	2	1¾	2	110	150
Estherville loam:														
Gently sloping phase	28	34	34	36	20	23	8	9	1	1¼			100	125
Strongly sloping phase	23	28	25	27	15	16	5	6	¾	1			80	85
Fairhaven silt loam:														
Gently sloping shallow phase	28	34	33	38	20	23	7	8	1	1¼	1½	1¾	110	130
Shallow phase	29	31	33	35	20	23	7	8	1	1¼	1½	1¾	110	130
Strongly sloping shallow phase													80	90
Fairhaven silty clay loam	35	40	40	43	20	23	8	10	2	2¼	1¾	2	110	140
Flandreau loam	35	40	40	45	25	28	8	9	1¾	2	1¼	1½	100	125
Sloping phase	35	40	40	42	25	28	8	9	1¾	2	1¼	1½	100	125

See footnotes at end of table

TABLE 8.—*Estimated average acre yields of principal crops under two levels of management on the soils of Rock County, Minn.*—Continued

Soil	Corn (hybrid) [1]		Oats [2]		Barley		Silage (corn)		Alfalfa (hay)		Other hay		Pasture	
	B	C	B	C	B	C	B	C	B	C	B	C	B	C
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Cow-acre-days* [3]	*Cow-acre-days* [3]
Flandreau silt loam	35	44	40	47	25	28	9	10	2	2¼	1¼	1½	100	125
Deep phase	40	45	45	50	30	33	10	12	2½	2¾	1½	1¾	120	150
Sloping phase	40	45	40	47	27	28	8	10	2¼	2½	1½	1¾	120	150
Strongly sloping phase	28	32	30	34	20	23	7	8	1	1¼	------	------	90	100
Fordville fine sandy loam	25	32	25	30	17	20	6	7	1	1¼	------	------	70	80
Fordville loam	28	34	35	38	20	22	7	9	1½	1¾	------	------	110	125
Gently sloping phase	28	34	35	38	20	22	7	9	1½	1¾	------	------	110	125
Fordville silt loam, gently sloping phase	28	34	35	38	22	24	7	9	1½	1¾	------	------	110	125
Fordville silty clay loam	34	38	35	40	23	25	8	10	1¾	2	------	------	110	125
Deep phase	40	46	43	48	25	28	10	12	2	2½	------	------	130	150
Fordville very fine sandy loam	28	38	35	38	20	22	8	10	1¾	2	------	------	110	125
Ihlen-rock outcrop complex	------	------	------	------	------	------	------	------	------	------	------	------	90	125
Ihlen silt loam	35	40	35	45	20	23	9	10	2	2¼	1¼	1½	120	150
Stony phase	28	34	35	45	20	23	8	9	2	2¼	------	------	110	130
Stony gently sloping phase	28	34	35	45	20	23	8	9	2	2¼	------	------	110	130
Kranzburg silty clay loam	44	50	48	58	30	33	12	15	2½	2¾	2¼	2¾	150	175
Gently sloping phase	44	50	45	52	30	33	12	15	2½	2¾	2¼	2¾	130	160
Kranzburg-Vienna stony silt loams	------	------	------	------	------	------	------	------	------	------	2¼	2¾	110	130
Lamoure silty clay loam	42	48	38	45	25	30	11	12	------	------	------	------	125	150
Lamoure very fine sandy loam	46	52	40	45	20	23	10	11	------	------	[6] 1¼	------	150	175

Moody silt loam	46	52	50	60	30	33	12	15	3	3¾	2¼	2¾	150	175
Gently sloping phase	46	52	50	60	30	33	11	14	3	3¾	2¼	2¾	150	175
Rolling phase	40	46	43	52	25	27	10	12	2¼	3	2¼	2¾	140	160
Moody silty clay loam	47	53	55	63	30	38	12	15	3	3¾	2¼	2¾	150	200
Gently sloping phase	47	53	55	63	30	33	12	15	3	3¾	2¼	2¾	150	200
Level phase	47	53	55	63	30	33	12	15	3	3¾	2¼	2¾	150	200
Terrace phase	47	53	55	63	33	35	12	15	3	3¾	2¼	2¾	150	200
Parnell silty clay loam [5]	23	46	35	45	18	21	8	12	------	------	------	[4]2	150	200
Pierce silt loam	23	25	28	30	13	14	6	8	1	1¼	------	------	90	100
Rauville silty clay loam	------	------	------	------	------	------	------	------	------	------	------	------	100	125
Rock outcrop-Ihlen complex	------	------	------	------	------	------	------	------	------	------	------	------	80	100
Rosedell loam [5]	34	39	40	43	20	22	8	10	¾	1	2	2¼	150	175
Rosedell silt loam [5]	34	39	40	43	------	------	8	10	¾	1	2	2¼	150	175
Rosedell silty clay loam [5]	23	45	35	40	20	22	8	11	¾	1	2	2¼	150	175
High phase [5]	45	46	40	45	20	22	10	12	1	1¼	2	2¼	150	175
Sioux loam	28	32	30	35	15	17	6	7	¾	1	------	------	100	120
Strongly sloping phase	------	------	------	------	------	------	------	------	------	------	------	------	80	85
Sioux very fine sandy loam, gently sloping phase	23	28	30	33	15	17	7	8	¾	1	------	------	100	120
Vienna-Flandreau silty clay loams	40	43	50	57	22	24	10	12	2½	2¾	1¾	2	125	150
Vienna loam	40	46	50	60	25	27	10	12	2½	3	2	2¼	150	200
Gently sloping phase	40	46	50	60	25	27	10	12	2½	3	2	2¼	150	200
Vienna silty clay loam	40	46	50	60	25	28	12	15	2½	3	2	2¼	150	200
Gently sloping phase	40	46	50	60	25	28	12	15	2½	3	2	2¼	150	200
Strongly sloping phase	23	29	30	40	15	16	6	8	2	2¾	1¾	2	100	150
Volin silt loam	43	46	40	43	15	17	12	14	1½	1¾	1½	1¾	125	150

[1] Hybrid varieties constituted more than 90 percent of the corn planted in 1944.

[2] Tama and Vicland varieties in 1945 and 1946.

[3] Cow-acre-days, used to express the carrying capacity of pasture land, is the product of the number of animal units carried per acre multiplied by the number of days they can be grazed without injury to the pasture; for example, a soil that supports 1 animal unit per acre for 360 days rates 360; a soil supporting 1 animal unit per 2 acres for 180 days rates 90; and a soil supporting 1 animal unit on 4 acres for 100 days rates 25.

[4] Tame hay, mostly reed canary grass (*Phalaris arundinacea*).

[5] Excessive moisture in this soil in wet seasons causes delay in seeding small grains and retards the maturity of all crops, thereby increasing the danger of damage by early fall frost.

[6] Wild hay.

TABLE 9.—*Productivity ratings of the soils under two levels of management for the crops most commonly grown in Rock County, Minn.*

[Indexes in columns B are the yields obtained under common practices of management; those of columns C are the yields that may be expected under the best practices of management. Blank spaces indicate that the crop is not commonly grown on the soil named.]

Soil	Crop productivity index [1] for—													
	Corn (hybrid) (100=50 bu.)[2]		Oats (100=50 bu.)[3]		Barley (100=40 bu.)		Silage (corn) (100=12 tons)		Alfalfa (hay) (100=4 tons)		Other hay (100=2 tons)		Pasture (100=100 cow-acre-days)[4]	
	B	C	B	C	B	C	B	C	B	C	B	C	B	C
Alcester loam	92	106	92	104	75	82	100	125	75	81	100	125	150	175
Alcester silty clay loam	102	114	106	116	87	95	117	125	75	81	100	125	150	175
Alluvial soils, undifferentiated													100	125
Benoit soils, undifferentiated											[5] 100	112	100	125
Blue Earth silty clay loam [6]	46	92	70	90	62	67	67	100			100	112	150	250
Cass loam	68	80	60	70	50	55	67	83					110	150
High-bottom phase	46	58	72	84	50	55	42	58	25	31			100	125
Crofton-Moody silt loams	68	88	60	80	37	45	67	83	37	50	87	100	110	150
Estherville loam:														
Gently sloping phase	56	68	68	72	50	57	67	75	25	31			100	125
Strongly sloping phase	46	56	50	54	37	40	42	50	19	25			80	85
Fairhaven silt loam:														
Gently sloping shallow phase	56	68	66	76	50	57	58	67	25	31	75	87	110	130
Shallow phase	58	62	66	70	50	57	58	67	25	31	75	87	110	130
Strongly sloping shallow phase													80	90
Fairhaven silty clay loam	70	80	80	86	50	57	67	83	50	56	87	100	110	140
Flandreau loam	70	80	80	90	62	70	67	75	44	50	62	75	100	125
Sloping phase	70	80	80	84	62	70	67	75	44	50	62	75	100	125

Flandreau silt loam	70	88	80	94	62	70	75	83	50	56	62	75	100	125
Deep phase	80	90	90	100	75	82	83	100	62	69	75	87	120	150
Sloping phase	80	90	80	94	67	70	67	83	56	62	75	87	120	150
Strongly sloping phase	56	64	60	68	50	57	58	67	25	31	------	------	90	100
Fordville fine sandy loam	50	64	50	60	42	50	50	58	25	31	------	------	70	80
Fordville loam	56	68	70	76	50	55	58	75	37	44	------	------	110	125
Gently sloping phase	56	68	70	76	50	55	58	75	37	44	------	------	110	125
Fordville silt loam, gently sloping phase	56	68	70	76	55	60	58	75	37	44	------	------	110	125
Fordville silty clay loam	68	76	70	80	57	62	67	83	44	50	------	------	110	125
Deep phase	80	92	86	96	62	70	83	100	50	62	------	------	130	150
Fordville very fine sandy loam	56	76	70	76	50	55	67	83	44	50	------	------	110	125
Ihlen-rock outcrop complex	------	------	------	------	------	------	------	------	------	------	------	------	90	125
Ihlen silt loam	70	80	70	90	50	57	75	83	50	56	62	75	120	150
Stony phase	56	68	70	90	50	57	67	75	50	56	------	------	110	130
Stony gently sloping phase	56	68	70	90	50	57	67	75	50	56	------	------	110	130
Kranzburg silty clay loam	88	100	96	116	75	82	100	125	62	69	112	137	150	175
Gently sloping phase	88	100	90	104	75	82	100	125	62	69	112	137	130	160
Kranzburg-Vienna stony silt loams	------	------	------	------	------	------	------	------	------	------	112	137	110	130
Lamoure silty clay loam	84	96	76	90	62	75	92	100	------	------	------	------	125	150
Lamoure very fine sandy loam	92	104	80	90	50	57	83	92	------	------	[7]62	------	150	175
Moody silt loam	92	104	100	120	75	82	100	125	75	94	112	137	150	175
Gently sloping phase	92	104	100	120	75	82	92	117	75	94	112	137	150	175
Rolling phase	80	92	86	104	62	67	83	100	56	75	112	137	140	160
Moody silty clay loam	94	106	110	126	75	95	100	125	75	94	112	137	150	200
Gently sloping phase	94	106	110	126	75	82	100	125	75	94	112	137	150	200
Level phase	94	106	110	126	75	82	100	125	75	94	112	137	150	200
Terrace phase	94	106	110	126	82	87	100	125	75	94	112	137	150	200
Parnell silty clay loam [6]	46	92	70	90	45	52	67	100	------	------	[5]100	100	150	200
Pierce silt loam	46	50	56	60	32	35	50	67	25	31	------	------	90	100
Rauville silty clay loam	------	------	------	------	------	------	------	------	------	------	------	------	100	125
Rock outcrop-Ihlen complex	------	------	------	------	------	------	------	------	------	------	------	------	80	100
Rosedell loam [6]	68	78	80	86	50	55	67	83	19	25	100	112	150	175
Rosedell silt loam [6]	68	78	80	86	------	------	67	83	19	25	100	112	150	175
Rosedell silty clay loam [6]	46	90	70	80	50	55	67	92	19	25	100	112	150	175
High phase [6]	90	92	80	90	50	55	83	100	25	31	100	112	150	175

See footnote at end of table

TABLE 9.—*Productivity ratings of the soils under two levels of management for the crops most commonly grown in Rock County, Minn.*—Continued

Soil	Crop productivity index [1] for—													
	Corn (hybrid) (100=50 bu.)[2]		Oats (100=50 bu.)[3]		Barley (100=40 bu.)		Silage (corn) (100=12 tons)		Alfalfa (hay) (100=4 tons)		Other hay (100=2 tons)		Pasture (100=100 cow-acre-days)[4]	
	B	C	B	C	B	C	B	C	B	C	B	C	B	C
Sioux loam	56	64	60	70	37	42	50	58	19	25	------	------	100	120
Strongly sloping phase	------	------	------	------	------	------	------	------	------	------	------	------	80	85
Sioux very fine sandy loam, gently sloping phase	46	56	60	66	37	42	58	67	19	25	------	------	100	120
Vienna-Flandreau silty clay loams	80	86	100	114	55	60	83	100	62	69	87	100	125	150
Vienna loam	80	92	100	120	62	67	83	100	62	75	100	112	150	200
Gently sloping phase	80	92	100	120	62	67	83	100	62	75	100	112	150	200
Vienna silty clay loam	80	92	100	120	62	70	100	125	62	75	100	112	150	200
Gently sloping phase	80	92	100	120	62	70	100	125	62	75	100	112	150	200
Strongly sloping phase	46	58	60	80	37	40	50	67	50	69	87	100	100	150
Volin silt loam	86	92	80	86	37	42	100	117	37	44	75	87	125	150

[1] Each index is the expected yield expressed as a percentage of a standard yield on the crop under the specified management. The standard yield is listed at the head of the appropriate column and represents the approximate average yield obtained without the use of fertilizer or other amendments on the more extensive and better soils of the United States where the crop is most commonly grown.

[2] Hybrid varieties constituted more than 90 percent of the corn planted in 1944.

[3] Tama and Vicland varieties.

[4] See footnote 3, table 8, p. 61.

[5] Tame hay, mostly reed canary grass (*Phalaris arundinacea*).

[6] Excessive moisture in this soil in wet seasons causes delay in seeding small grains and retards maturity of all crops, thereby increasing the danger of damage by early fall frost.

[7] Wild hay.

LABORATORY DETERMINATIONS

The mechanical analyses of several soils are given in table 10.

TABLE 10.—*Mechanical analyses of certain soils of Rock County, Minn.*

Soil type and sample No.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Fordville fine sandy loam:	*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
322976	0–6	1.7	11.6	12.7	22.6	6.6	28.9	15.9
322977	6–9	.8	6.8	10.9	25.9	8.1	29.8	17.7
322978	9–15	.8	6.3	11.6	29.7	9.5	25.8	16.3
322979	15–20	.4	5.2	12.6	36.2	12.2	20.4	13.0
322980	20–30	.9	5.5	13.2	40.9	14.6	15.4	9.5
322981	30–48+	3.5	11.3	13.1	30.4	14.0	18.1	9.6
Moody silty clay loam:								
3229132	0–12	.1	.3	.4	.7	1.0	65.0	32.5
3229133	12–17	0	.2	.3	.5	1.3	63.5	34.2
3229134	17–24	.1	.1	.3	.5	2.3	63.2	33.5
3229135	24–36	0	.1	.2	.7	3.3	68.8	26.9
3229136	36–45	.1	.2	.1	.6	3.5	72.3	23.2
3229137	45–62	.2	.4	.5	.8	6.4	70.8	20.9
3229138	62–66	8.6	8.5	6.1	5.9	6.1	36.7	28.1
3229139	66–74	1.4	5.1	6.2	9.9	5.4	35.1	36.9
3229140	74–86	1.8	5.4	6.5	10.5	5.6	33.5	36.7
Rosedell silty clay loam, high phase:								
3229182	0–18	.3	1.1	1.6	1.9	1.8	55.4	37.9
3229183	18–36	.5	1.9	2.3	2.5	2.8	60.4	29.6
3229184	36–50+	3.8	10.4	11.3	13.1	6.8	34.4	20.2
Moody silt loam:								
3229278	0–3	.2	1.4	3.2	7.2	6.2	56.5	25.3
3229279	3–14	.2	2.4	5.0	8.1	5.8	51.0	27.5
3229280	14–21	.1	2.4	5.8	10.7	7.1	48.8	25.1
3229281	21–29	0	2.6	6.2	12.2	9.6	47.6	21.8
3229282	29–38	.1	2.3	4.7	10.8	10.4	53.1	18.6
3229283	38–50	.2	.9	1.4	2.7	7.5	67.6	19.7
3229284	50–54	3.0	12.0	18.3	28.8	7.1	15.9	14.9
3229285	54–60+	2.5	6.5	9.5	16.4	8.4	28.1	28.6
Flandreau loam:								
3229286	0–5	.6	6.4	9.8	13.4	4.2	42.3	23.3
3229287	5–11	.5	5.9	9.2	13.8	4.8	42.5	23.3
3229288	11–16	.3	5.0	8.0	13.1	4.7	43.9	25.0
3229289	16–20	.4	4.6	8.9	14.4	6.1	41.4	24.2
3229290	20–28	.5	5.9	12.0	21.5	8.2	32.8	19.1
3229291	28–50	.8	7.4	15.5	31.9	11.7	20.9	11.8
3229292	50–54	.7	3.7	7.6	11.3	9.3	51.1	16.3
3229293	54–60	1.7	8.8	15.2	25.6	8.2	26.6	13.9
3229294	60–68	2.5	6.2	8.3	14.8	7.7	30.4	30.1

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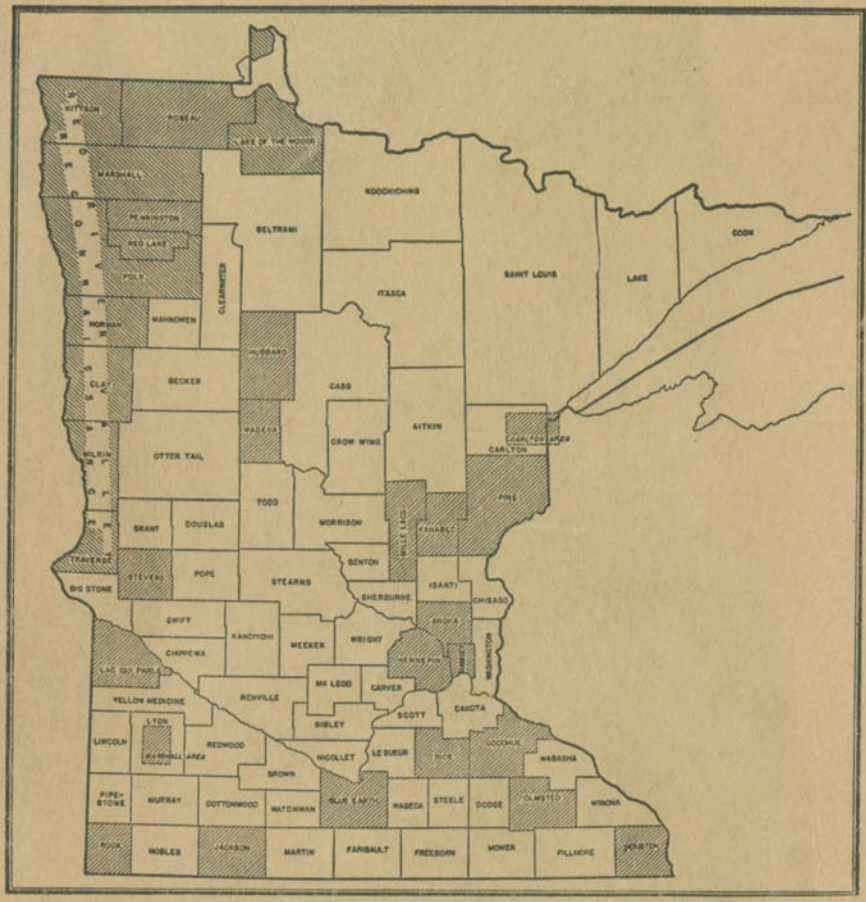

Areas surveyed in Minnesota shown by shading.

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