WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

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SOIL SURVEY

OF

GREEN LAKE COUNTY

BY

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INTRODUCTION

The chief things which determine the crops and kind of farming to which a soil is adapted are: Amount of organic matter, drainage conditions and topography or lay of the land, and the texture or fineness of grain. On the basis of amount of organic matter, topography, drainage conditions and other factors, soils are divided into groups called *series*. Each series represents a definite combination of these factors and to each *series* a proper name is given. Just as we have Holsteins, Jerseys, Poland Chinas, and Percherons in livestock, so we have Miami, Colby, Plainfield and other *series* of soils.

Where soils are closely related through similar sources of the material from which derived, mode of origin, topographic position, etc., so that the different soils constitute merely a gradation in texture of otherwise uniform material, such a group is called a soil *series*. It corresponds to the family which is made up of different individuals having the same parentage. The Miami series, for example, includes light colored, glacial material where the soils have been derived largely from the underlying limestone, and the soils in the series range in texture from a clay loam to sandy loam and gravel. The name used for a soil series usually indicates the locality where that particular series was first recognized and mapped by the Soil Survey.

Each series is further subdivided into *types,* on the basis of texture or fineness of grain.

Soils are grouped according to texture into soil classes, a soil class being made up of soils having the same texture, though differing in other respects. A fine sand, for example, may be light colored and of alluvial origin, while another fine sand may be dark in color and of residual origin, while a third fine sand may have been blown into sand dunes by the wind, yet all of these soils would belong to the same class, because the greater proportion of the

soil grains have the same size or texture. Thus we may have different kinds of clays, loams, sands, etc., and the class to which any soil will belong depends upon the size of the individual soil grains of which it is composed, and not upon its color, origin, topographic position, or agricultural value.

The textural classification is very important since it has to do with the water holding capacity of the soil. It also determines the ease with which a soil can be worked, and has much to do with the crops to which the soil is best adapted.

SOIL CLASSES

Soils Containing Less Than 20% Silt and Clay

Coarse sand.—Over 25% fine gravel and coarse sand, and less than 50% of any other grade of sand.
Sand.—Over 25% fine gravel, coarse and medium sand, and less than 50% fine sand.
Fine sand.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.
Very fine sand.—Over 50% very fine sand.

Soils Containing Between 20–50% of Silt and Clay

Sandy loam.—Over 50% fine gravel, coarse and medium sand.
Fine sandy loam.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.
Sandy clay.—Less than 20% silt.

Soils Containing Over 50% of Silt and Clay

Loam.—Less than 20% clay, and less than 50% silt.
Silt loam.—Less than 20% clay, and over 50% silt.
Clay loam.—Between 20 and 30% clay, and less than 50% silt.
Silty clay loam.—Between 20 and 30% clay, and over 50% silt.
Clay.—Over 30% clay.

A soil type is a soil which is quite uniform throughout its entire extent in texture, color, topographic position, and other physical properties, and having a distinct agricultural unity, that is being adapted to the same crops, and requiring the same treatment. It is also uniform in the source of material from which it is derived, and the mode of origin which, taken together, determine the chemical composition. Since the soil type is the unit in classifying and mapping soils, and the basis upon which experimental work should be conducted, every farmer should be familiar with the soil types on his farm, and their leading characteristics.

SOIL SURVEY OF GREEN LAKE COUNTY

CHAPTER I

GENERAL DESCRIPTION OF THE AREA

County Surveyed

Green Lake County lies slightly southeast of the center of Wisconsin, and the city of Green Lake, the county seat, is 90 miles by rail from Milwaukee. The greatest length north and south is 24 miles. The greatest width east and west is 18 miles, and its area is 360 square miles, or 230,400 acres.

One of the most interesting surface features of Green Lake County and economically considered, by far the most important, is the extensive area of prairie land which occurs as a high plain or plateau in the southeastern part, at an average elevation of about 1,000 feet above sea level. The surface of this plain is for the most part level or gently rolling. It is confined chiefly to Green Lake, Mackford, and Manchester Townships, and includes some of the best farming land in the county.

This rolling plain extends northward to Green Lake. This lake has a maximum depth of 235 feet and the water level is 796 feet above sea level, which makes the lake bottom or valley floor, between 400 and 500 feet lower than the high plain. This valley or trough which has a sandstone floor, extends in a northeast-southwest direction and at one time probably joined Puckaway Lake, but is now separated from the marshes bordering that lake by a marginal moraine about one-half mile wide.

North of Green Lake is another elevation similar to the one south of the lake, but nearly 100 feet lower. The bedrock north of the lake is chiefly Lower Magnesian limestone, and that south of the lake is Trenton limestone. The

drop from the limestone formations forms an escarpment with steep slopes which is a conspicuous feature of the landscape. North of Green Lake this drift-covered escarpment extends westward almost to Princeton and then swings northeastward to Berlin, and north and east of this general line the land is rolling. Mount Tom in section 11, T. 16 N., R. 12 E., is a prominent hill of sandstone capped with limestone, with an elevation of more than 150 feet above the adjoining lowland.

The northwestern part of the county forms part of the central plain of Wisconsin. It is a low, nearly level region of sandy soils and marshland drained by the Fox River and its tributaries, and has an elevation ranging from 760 to about 800 feet. South of the extensive marshes which border Lake Puckaway the land is gently rolling and the soils are loamy.

Fox River, which forms the main drainage channel, is interrupted in its course by Lake Buffalo and Lake Puckaway. Lake Buffalo is a shallow crescent-shaped lake in Marquette County, about 12 miles long and three-fourths mile wide; and Lake Puckaway, partly in Green Lake County and partly in Marquette County, is 7 miles long and 1½ miles wide. The rock floor of the preglacial valley at Lake Puckaway is buried to a depth of more than 300 feet. Extensive swamps border Fox River, and these swamps and lakes regulate the flow of lower Fox River and prevent or diminish floods.

The elevation of certain points in Green Lake County, as compiled from the records of the Geological Survey, and from other sources is given below:

ELEVATION OF DIFFERENT POINTS IN GREEN LAKE COUNTY

Place	Authority	Elevation in feet
Markesan*	Chicago, Milwaukee & St. Paul Railway	859
Green Lake, surface of water	United States Geological Survey	796
Green Lake (city)*	Chicago & North Western Railway	902
Princeton*	Chicago & North Western Railway	881
Berlin*	Chicago, Milwaukee & St. Paul Railway	768
Lake Puckaway	United States Geological Survey	764
Saint Marie*	Chicago & North Western Railway	895
School No 8, Green Lake Twp.	United States Geological Survey	1,024
Searles School, Green Lake Twp.	United States Geological Survey	1,014
Dalton	Chicago & North Western Railway	824

*Gannett, H., A Dictionary of Altitudes in the United States. U. S. Geological Survey Bul. 274, 1072 p. 1906 (Ed. 4)

The following table shows the population of the county and of several of the communities within the county as reported by the census for the years 1900, 1910, and 1920:

POPULATION OF GREEN LAKE COUNTY FOR THREE CENSUS YEARS

Place	1920	1910	1900
Green Lake County	14,875	15,491	15,797
Berlin (city)	4,356	4,586	4,448
Green Lake (village)	456	563	450
Princeton (village)	1,275	1,269	1,202
Markesan (village)	959	892	706

Green Lake County was formed from territory which was previously a part of Marquette County and was organized in 1858, and the present boundaries were defined in 1860. Green Lake County was named for its principal body of water, the lake being named by the French "Lac Verd," which the early settlers translated into Green Lake. Among the early settlers were many Germans and English, and some Irish, Poles, and Scandinavians. Many early settlers came also from the older Eastern States. The first settlement was made in this region some time between 1830 and 1835.

The country roads are undergoing rapid improvements, and several State and county trunk highways also traverse the county. The materials used in improving the roads consist of concrete, crushed rock, and gravel. A concrete road connects Green Lake and Berlin and another one extends part way from Green Lake to Princeton, and many roads are macadamized. The dirt roads in the northern and western parts of the county are sandy in places, but throughout these sections, as elsewhere, main trunk highways are under construction. All parts of the county are reached by rural mail routes and telephone communication is available everywhere.

The towns do not afford a market for all the farm produce, but they supply shipping facilities which render the markets of Milwaukee and Chicago very accessible. Much of the marketing is done through cooperative shipping associations.

Origin of Soils

The underlying rocks in the northwestern and western portions of Green Lake County are mostly sandstone, while in the southeastern and eastern portions the rocks are mostly limestone. The entire county is within the glaciated portion of Wisconsin and the entire region was, during past ages, covered by a vast field of ice. This ice field moved to the southwest through the Green Bay lowlands and spread out to the westward, grinding up the underlying rocks and carrying along large quantities of soil-forming material, which was left upon the surface when the ice melted. As the ice moved over various formations in reaching its most advanced position the resulting soil-forming materials were quite variable. From this complex mixture of geological material a variety of soils have been derived. These range from light sands to silt loam and clay loams, with numerous areas of marsh land and lakes in the low places.

As these soil materials have been exposed to the agencies of weathering for a long period since their first deposition, leaching has removed considerable amounts of lime, which existed in some of the soils when first formed. As a result of this action acidity, which was always common on the sandy material, has developed to a greater or lesser degree in the surface of the soils derived from limestone drift.

As a result of the variability of the soils, there is also variability in the adaptation of crops to which these various soils are best suited.

Soils of Green Lake County are classified as 31 types and 6 phases, representing 12 series, not including peat and rough stony land. Carrington soils are dark-colored, well-drained prairie soils derived from calcareous glacial drift. The Carrington soils mapped are silt loam with a level phase, loam with a gravelly phase, and fine sandy loam.

The Dodgeville series includes dark-colored, well-drained soils, underlain by limestone. Dodgeville silt loam is the only soil of this series mapped in Green Lake County.

The Miami soils include light-colored upland soils developed under forest conditions, principally from calcareous, medium-textured glacial drift. The soils are grayish brown or light brown with yellowish-brown subsoils which in the

heavy types are comparatively free from coarse material. Areas of deep Miami soils are usually smooth, with long and gentle slopes.

The Coloma series includes light-colored upland forest soils developed from sandy materials which were trans-

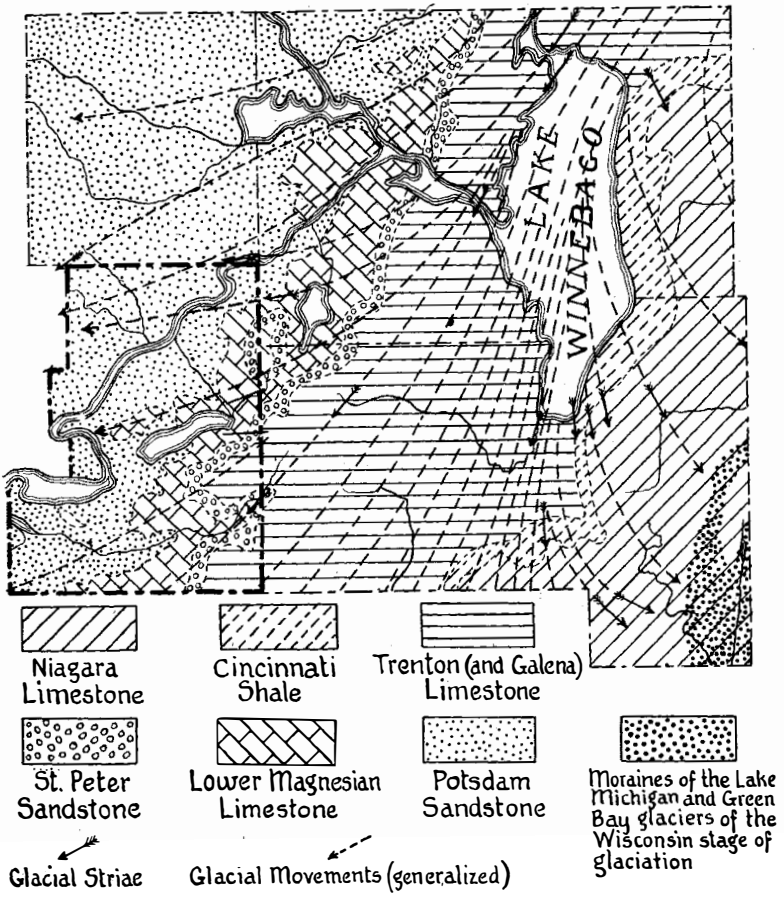


Fig. 1. Sketch map showing underlying rock formations and direction of glacial movement in Lake Winnebago area.

ported through glacial action from sandstone formations principally, and to a less degree from crystalline formations. The mapped types of this series are Coloma fine sand and Coloma sand.

The Waukesha series includes dark-colored prairie soils

developed from calcareous, water-laid gravel. These soils occur on stream terraces or outwash plains, and are not subject to inundation. The types mapped in this series are Waukesha silt loam, loam, and fine sandy loam.

The Fox soils are light colored like the Miami soils, with parent material of stratified gravel and sand which contains a high proportion of limestone. The land is level and the subsoils are sandy or gravelly at depths ranging from 2 to 4 feet. The soils mapped in this series are Fox silt loam, Fox loam, and Fox sandy loam.

The Plainfield series includes light-colored soils developed from alluvial material derived mostly by glacial action on sandstone rocks. This material is sandy and occurs on stream terraces or outwash plains above the present flood plains of the streams. The mapped soils of this series are Plainfield sand and Plainfield fine sand.

The Superior soils have light-colored surface soils with subsoils of heavy red clay. The land is level. The only Superior soil mapped is fine sandy loam.

The Clyde series includes dark-colored soils which occur in poorly drained depressions in the upland and in stream bottoms. Clyde silt loam and Clyde loam with alluvial phases are mapped in this county.

Poygan soils have dark-colored surface soils with heavy, red clay subsoils developed from heavy-textured, water-laid deposits, under poor drainage conditions. Poygan clay loam and Poygan silt loam are mapped in Green Lake County.

The Dunning series includes dark-colored sandy soils in poorly drained areas. The soils are acid and occur usually outside the limestone region. Only one member of this series, Dunning fine sand, was mapped in this county.

The Genesee series includes light-colored first-bottom land which is subject to flooding. Genesee silt loam is the only soil of this series mapped in this county.

Peat consists of accumulations of vegetable matter in various stages of disintegration and decomposition, mixed with more or less mineral matter. This land is low and very poorly drained.

Rough stony land includes steep, rough, rocky, or broken

areas, which may have outcrops of limestone, sandstone, and granitic rocks.

In the following pages of this report the different soils are described in detail and their relation to agriculture discussed; the accompanying soil map shows their location and distribution in the county; and the following table gives their names and extent:

ACREAGE AND EXTENT OF GREEN LAKE COUNTY SOILS

Type name	Acres	Per cent
Carrington silt loam	26,112	13.7
Level phase	5,504	
Carrington Loam	1,536	1.0
Gravelly phase	704	
Carrington fine sandy loam	2,176	.9
Dodgeville silt loam	1,856	.8
Miami fine sandy loam	25,472	11.1
Miami sandy loam	15,488	6.7
Miami loam	11,200	4.9
Miami silt loam	6,520	2.9
Miami gravelly loam	1,344	.6
Miami gravelly sandy loam	1,344	.6
Miami silt loam, deep phase	15,296	.6
Miami silt loam, shallow phase	1,728	7.3
Miami loam deep phase	3,008	1.3
Coloma sand	7,808	3.4
Coloma fine sand	6,976	3.0
Waukesha loam	1,344	.6
Waukesha fine sandy loam	832	.4
Waukesha silt loam	502	.2
Fox sandy loam	1,920	.8
Fox loam	1,280	.5
Fox silt loam	448	.2
Plainfield sand	7,360	3.2
Plainfield fine sand	4,480	1.9
Superior fine sandy loam	960	.4
Clyde silt loam, alluvial phase	8,448	3.7
Clyde loam, alluvial phase	7,988	3.4
Clyde silt loam	6,912	3.0
Clyde loam	1,600	.7
Poygan silt loam	2,944	1.3
Poygan clay loam	2,688	1.2
Dunning fine sand	4,416	1.9
Genesee silt loam	64	1.
Peat	31,552	17.3
Peat shallow phase	8,250	
Rough stony land	2,304	1.0

CHAPTER II

GROUP OF HEAVY SOILS

Miami Silt Loam

To depths ranging from 6 to 8 inches, the cultivated surface soil of the Miami silt loam is mellow brown or grayish-brown silt loam low in organic matter. The subsoil of reddish-brown silty clay loam material is plastic and sticky when moist and hard when dry, and continues to depths ranging from 24 to 30 inches. Below this is a shallow layer of friable, gravelly, moderately calcareous loamy material, underlain by the parent material which is a hetrogeneous mass of unweathered gravelly till originating principally from limestone. The surface soil is slightly gravelly, and the subsoil contains enough sand to make it gritty. Some crystalline bowlders occur on the surface and throughout the soil and subsoil. In a few areas near the prairies the color of the surface soil is darker than typical. In section 24, Kingston Township, where the slopes are steep, the limestone substratum lies near the surface.

The Miami silt loam, as mapped, includes numerous small patches of other soils, such as gravelly loam, loam, fine sandy loam, and Miami silt loam, deep phase. Sandy and gravelly areas usually occur on knolls and steep slopes, whereas the more silty areas are gently undulating and subjected to very little erosion. Miami silt loam differs from Miami silt loam deep phase in that the brown surface soil is darker, the subsoil has a reddish tinge, and the calcareous parent material is nearer the surface.

The largest areas of silt loam are in Brooklyn Township and smaller areas are in Berlin, Green Lake, Manchester, Kingston, and Mackford Townships. The land is moderately undulating to choppy and broken, but most of it is smooth enough for the use of improved machinery in planting, cultivating, and harvesting crops. Surface and internal drainage are good.

It is estimated that 75 per cent or more of this soil is under cultivation. The principal crops are corn, oats, and mixed clover and timothy with a considerable acreage of rye, barley, alfalfa, potatoes, beans and wheat. Nearly every farm has a few apple trees, but there are no important commercial orchards. The yields of all crops are equal to or somewhat greater than those grown on Miami silt loam deep phase.

MIAMI SILT LOAM, DEEP PHASE

The cultivated surface soil of Miami silt loam deep phase is a layer from 8 to 12 inches thick, of light grayish-brown smooth silt loam comparatively low in organic matter. This is underlain by yellowish-brown heavy silt loam which gradually becomes heavier with depth changing to silty clay loam, and to yellow clay loam below a depth of 20 or 24 inches. This heavy material continues to a depth of 3 or 4 feet, where gritty or gravelly calcareous material is mixed with the clay and silt. The soil within 3 feet of the surface is loesslike in structure and texture and free from coarse material; but the deeper part of the subsoil is chiefly unassorted till consisting of calcareous clay, sand, gravel, and fragments of limestone and crystalline rock.

A few bowlders are present in some areas, but as a whole the land is free from them. The underlying rock is chiefly limestone, and this crops out on some of the steeper slopes. The surface soil, according to the litmus-paper and Truog tests is slightly acid. This soil is very uniform in color, but where it borders the Carrington soils of the prairies it is darker than the typical soil and contains more organic matter. In such places the change is so gradual from one kind of soil to another that no definite boundary can be determined.

Miami silt loam deep phase differs from Miami silt loam in that it has a more pronounced gray color, a smaller quantity of coarse material, a greater thickness of silty surface soil, and fewer surface stones and bowlders. Both are light-colored upland soils, originally forested and are spoken of as "clay land" to distinguish them from the darker-colored prairie soils.

The total area of Miami silt loam deep phase is approximately 24 square miles. It usually borders the prairies, the largest areas occurring in the townships of Mackford and Green Lake, and small patches in the townships of Manchester, Brooklyn, and Marquette.

This land is gently rolling, and modern farm machinery can be used on more than 90 per cent of it. The most elevated surfaces of the county are covered by prairies. On the slopes extending from these deep Miami silt loam has been developed. Adjacent to the prairies are level areas where drainage is poor and the surface soils are darker and deeper than typical Miami silt loam. Farther down on these slopes and also on slopes bordering Green Lake and various drainage ways are long narrow belts with comparatively steep rough surfaces where there is danger of erosion. On such surfaces the soils are well drained and withstand droughts better than most of the soils of the county.

Miami silt loam deep phase is one of the most productive soils of the county, and approximately 80 per cent of it is under cultivation. Some of the areas along the south shore of Green Lake and on the steeper slopes along Grand River are forested and in places contain considerable merchantable timber. The growth consists chiefly of several varieties of oak, elm, hickory, maple, basswood, and wild cherry.

General farming, with dairying, is the principal form of agriculture. The most important crops are corn, hay, oats, barley, wheat with some peas, alfalfa, and a little hemp. Potatoes are grown chiefly for home use.

This soil is treated in about the same manner as Carrington silt loam, but because it contains more lime it is better adapted to clover and alfalfa. Less corn and oats are grown on this soil than on Carrington silt loam.

In the cultivation of this soil fall plowing is common, although on account of its friability it can be worked early in the spring. The subsoil is retentive of moisture, and a good surface mulch enables it to resist drought. Barnyard manure is the principal fertilizer, and as dairying is extensively practiced a good supply is always available. From 10 to 15 loads to an acre are usually applied every four or five years to sod land to be plowed for corn. Green-manure

crops are used to a small extent. Cultivation is not usually difficult as the surface soil is very silty and pulverizes readily, but where the subsoil is exposed on slopes or where the surface soil is shallow and the heavier material is turned up by the plow, some difficulty is experienced.

The usual crop rotation consists of corn, barley, and oats, one year each, followed by mixed timothy and clover. Wheat may take the place of oats or barley, or it may be made another step in the rotation. Grass is usually left for two years, being cut for hay the first year, and used as pasture the second year. In localities where there is permanent pasture land, as on areas of Clyde soils and peat, the upland soil is used very little for pasture.

One of the special crops on this soil is sugar beets. Yields average from 12 to 15 tons an acre, and the sugar content is high. Because the soil is silty and friable, it is comparatively easy to maintain a good surface mulch, and the work of cultivating the crop is less arduous than on heavier soils. Alfalfa is considered an important crop, but its acreage does not equal that of clover. Most farmers grow potatoes for home use and frequently have some to sell. Normal yields range from 150 to 200 bushels an acre and the quality is good. Hemp is also an important though a rather new crop grown on this soil.

Miami Silt Loam, Shallow Phase

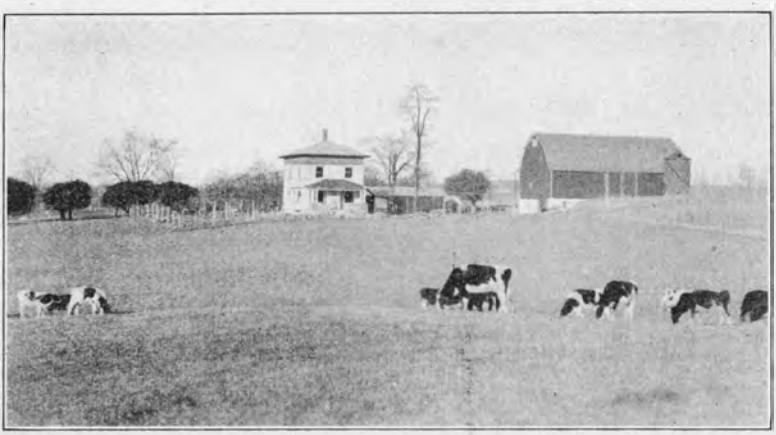
Miami silt loam, shallow phase, occurs on ridges, slopes, and hilltops, where at depths ranging from 12 to 30 inches the soil material is underlain by limestone or unassorted glacial till. On such areas the topsoil is practically the same as that of Miami silt loam, but the subsoil contains more gravelly material, and drainage is better. In general, soil of this phase is cultivated in about the same way as Miami silt loam deep phase.

Fox Silt Loam

The surface soil of Fox silt loam is medium-brown or dark-brown friable silt loam from 6 to 8 inches deep. This is underlain by reddish-brown loam or fine sandy loam to a depth of about 20 inches, where fine sand or gravel ap-

View on Miami Fine Sandy Loam.

View on Carrington Silt Loam.



Farmstead on Miami Silt Loam.

pear. Mapped areas include numerous patches which are not typical, some of which closely resemble loam, and others are heavier than silt loam. There are patches where the dark-brown friable silt loam material rests on unweathered sand and gravel at a depth of about 3 feet. In a few small areas Fox silt loam is almost as dark as Waukesha silt loam. The surface soil is slightly acid, but the deep, gravelly subsoil is well supplied with lime, the gravel consisting principally of limestone.

The total area of Fox silt loam is less than 1 square mile. Areas are mapped in section 12, Manchester Township, in sections 7, 9, and 10, Mackford Township, and section 35, Green Lake Township.

The land is level or nearly so, except where this soil occurs on steep terrace slopes bordering watercourses. Because of the open subsoil natural drainage is good and in places excessive. Most of this soil is in farms, but because of its occurrence in small areas very few if any farms are made up entirely of it. It is devoted to general farming and dairying. Where the surface is sloping or steep the land is best suited to permanent pasture. Fox silt loam is similar to Miami silt loam and methods of improving it are the same.

Carrington Silt Loam

Carrington silt loam is a prairie soil the topsoil of which consists of very dark brown or nearly black silt loam, rich in organic matter to a depth of 12 or 14 inches. The upper part of the subsoil is dingy-brown or brown silt loam material, which becomes yellowish brown with depth. To a depth of about 3 feet, the lower part of the subsoil is yellowish-brown silty clay loam material. Underlying this is the substratum which consists of very calcareous glacial till composed of clay, silt, sand, and gravel. The line of demarcation between the yellowish-brown silty clay loam material and the substratum is well defined, the upper part being free from bowlders and gravel and almost entirely leached of calcium carbonate, whereas the underlying till contains many stones and bowlders and much gravel, and effervesces with hydrochloric acid. Both the Truog and

litmus-paper tests indicate that the surface soil is acid and needs lime.

Included in mapped areas of this soil are some patches of soils which are not typical Carrington silt loam. Where the land is level or almost level, the dark-colored surface layer is thicker, darker, and contains more organic matter than where the surface is rolling. On some steep slopes and small ridges, the unweathered glacial till is nearer the surface than it is in the typical soil. In places where Carrington silt loam borders Miami soils it is somewhat lighter in color and contains less organic matter, but where it borders Clyde soils it is darker, contains more organic matter, and its subsoil in some places is mottled. On some gravelly knolls the underlying bedrock of limestone is near the surface, and from these places limestone for agricultural use may be procured.

Carrington silt loam is the most important agriculturally, and with the exception of peat, is the most extensive soil in Green Lake County. It is the predominating soil of the prairie region which includes some of the most productive soils of the State. Carrington silt loam is confined almost entirely to the eastern half of the county, the largest areas being in Green Lake and Mackford Townships where unbroken areas of approximately 20 square miles or more occur. Smaller and more irregular tracts are in Berlin, Brooklyn, and Manchester Townships. In Green Lake and Mackford Townships, Carrington silt loam generally adjoins Miami silt loam.

The land is level or gently rolling and the natural drainage is good except where the surface is level or nearly so. Such areas are mapped separately as silt loam, level phase. The soil as a whole retains moisture well and because of its large supply of organic matter it withstands drought better than most of the other soils of the county. This silt loam was originally covered with a growth consisting chiefly of prairie grasses. Adjoining light-colored soils and a few other places there were scattered clumps of oak trees and along drainage ways and in other moist places some soft maple. In some places small wild-cherry trees now grow along fence rows and some forest trees have been planted on farmsteads and along some of the highways.

More than 95 per cent of this land is improved, almost the only untilled land being that along fence rows and roadsides and around buildings.

The chief crops are corn, hay, oats, barley, wheat, and alfalfa; and hemp and peas are two important special crops. Sugar beets, potatoes, and flax are also grown to a small extent. General farming, including grain growing and dairying, is the most important form of agriculture on this land. More beef cattle and sheep are raised on the prairies than elsewhere in the county and many farmers derive a large part of their income from the sale of hogs.

Hemp growing has been developed in Wisconsin within the last 15 years and the center of the industry includes the prairie region of Green Lake County. The production of this crop requires special machinery for harvesting and this machinery is usually owned jointly by the farmers or by the owners of hemp mills where the fiber is prepared for market.

The farms on the prairies are somewhat larger than elsewhere and the system of farming is more extensive. Where dairying is being extended there is a tendency to reduce the size of the farms, but throughout the county as a whole the average size is increasing.

Land values on the prairies are generally higher than elsewhere in the county. Farms on which Carrington silt loam predominates range in current value from $150 to $250 an acre, depending upon location, roads, and farm improvements. The current value of land without buildings is approximately $100 an acre.

CARRINGTON SILT LOAM, LEVEL PHASE

The level phase of the silt loam is mapped separately because of its topography. It occurs on level or nearly level upland, mostly as patches within areas of the typical soil. It differs from typical silt loam in that the soil is more nearly black, the surface soil is deeper, and there is a tendency toward mottling in the subsoil. It is not so well drained as the typical soil, and in places it requires artificial drainage for the successful production of cultivated crops.

Areas of level silt loam adjoin areas of typical Carrington silt loam in the southeastern part of the county, principally in Green Lake and Mackford Townships.

Dodgeville Silt Loam

To a depth of 10 or 12 inches, the surface soil of Dodgeville silt loam consists of dark-brown or nearly black silt loam. This is underlain by a rather dark brown silt loam layer which gradually becomes yellowish brown in color and heavier in texture with depth. The subsoil below a depth of 24 inches is yellow or yellowish-brown silty clay loam or clay loam material which contains sufficient fine gravel, grit, and small stones to make it decidedly gritty. At depths ranging from 2 to 3 feet is the substratum of unassorted glacial till which rests upon limestone bedrock.

On some areas, the gritty subsoil is within 12 or 18 inches of the surface, and in a few places the underlying rock is within 2 feet of the surface. The color of Dodgeville silt loam is usually lighter than that of Carrington silt loam, and the surface is more irregular. Gravel, crystalline bowlders, and angular limestone fragments occur on the surface and throughout the soil.

Dodgeville silt loam occurs throughout the prairie region where it is associated with Carrington silt loam. It is inextensive, covering only about 5 per cent of the prairie region, and occurs as long, narrow strips along the tops of low ridges or on the steeper slopes of small hills and ridges. Because the land is sloping and the subsoil gravelly, drainage is everywhere good and in a few places excessive.

Dodgeville silt loam requires the same treatment as Carrington silt loam, but it is less acid because the limestone material is closer to the surface, and it is consequently better adapted to growing alfalfa. As drainage is better than on Carrington silt loam, the soil can be worked a little earlier in spring and sooner after rains, but as this soil occurs in such small patches advantage is seldom taken of this condition. The same crops are grown and the same methods of farming are followed as on Carrington silt loam, but the soil is not considered so valuable.

WAUKESHA SILT LOAM

Waukesha silt loam, to a depth of about 12 inches, is very dark brown silt loam, containing a comparatively high proportion of organic matter and some fine sand. The upper subsoil is dark-brown silt loam, grading downward to brownish-yellow silt loam or silty clay loam which contains a small quantity of sand. At depths ranging from 24 to 36 inches, yellow fine sandy loam or sandy loam is encountered which is abruptly underlain by gravelly sandy loam, and this in turn by stratified beds of gravel and sand. The soil, as mapped, includes patches of loam not sufficiently extensive to warrant separate mapping. In such areas the stratified beds of sand and gravel are more than 3 feet beneath the surface. In a few places the stratified beds of sand and gravel are within less than 2 feet of the surface.

Waukesha silt loam is developed chiefly in the southern part of the county within the drainage basin of Grand River. Most of this soil is in sections 23 and 24 of Manchester Township and in sections 7 and 8 of Mackford Township, partly within the city limits of Markesan.

The surface varies from level to very gently undulating. but in section 23, Manchester Township, it is rolling. Natural drainage is good, and where sand and gravel beds are within 2 feet of the surface the soil dries out somewhat during dry periods. Waukesha silt loam was originally prairie land and the native growth consisted of prairie grasses. A few trees grew along streams but the land in general was treeless.

Waukesha silt loam is all in well-improved farms, is excellent farming land, and is used for general farming and dairying. Corn, oats, barley, and hay are the principal crops, corn occupying the largest acreage. Some wheat is also grown.

Because areas of this soil are so small, few if any farms are located entirely upon it, but it ranks among the higher-priced farm lands of the county.

CHEMICAL COMPOSITION AND IMPROVEMENT OF HEAVY SOILS OF GREEN LAKE COUNTY

These soils are very similar in the texture and structure of the surface and the upper portion of the subsoil section. They differ chiefly in color. The Waukesha, Dodgeville and Carrington silt loams are dark colored prairie soils and are high in organic matter and nitrogen. The Miami and Fox soils are light colored and are timbered soils low in organic matter. The types are so closely related that with few exceptions, methods for the improvement of one will apply to the others.

The four elements of plant food with which the farmer is concerned in his farming operations, and the ones which are the most apt to be deficient are nitrogen, phosphorus, potassium and lime or calcium. He should know the part which each plays in the development of the plant and what are the best methods of maintaining an adequate supply in the soil.

The surface soil has lost much of the lime it originally contained. The subsoil at depths of 3 to 4 ft. is still well supplied with lime.

The lime requirements on Carrington silt loam and deep Miami silt loam is from 2 to 3 tons per acre. A plot experiment with alfalfa on Carrington silt loam just south of Ripon brings out the benefit of lime very markedly. The check plots, that is, the plots where no fertilizer or lime was used, yielded an average of 1701 pounds of alfalfa per acre. Where 250 pounds of a 2-16-2 fertilizer were used, a yield of 2557 pounds of alfalfa was realized. Where 3 tons of lime were used in addition to the 250 pounds of 2-16-2 fertilizer, a yield of 5411 pounds was secured.

The shallower soil, typical Miami silt loam, for example, will, as a rule, require less lime than the deep soils. In fact, in many cases the lime requirement is negligible, due to the abundance of limestone fragments and gravel in or near the surface soil. In all cases, where a liberal supply of manure is used, less lime is needed.

Where such crops as corn, clover, and oats are grown with manure applied once during each rotation a smaller

amount of lime will be needed. The greater need will usually be on the higher places rather than on the lower slopes. In general, 2 tons of good ground limestone are enough for alfalfa and sweet clover fields and one ton for the fields growing corn, oats and clover.

Phosphorus exists in all soils in small amounts. Many of the best types in the state contain only 1,200 pounds or less to the acre, 8 inches deep, and this is in a form which becomes available to crops very slowly. Phosphorus is constantly being lost from the farm in crops, milk and in the bones of animals sold. It is well understood that when grain, hay, potatoes or other cash crops are sold, this element is removed from the farm. It cannot be supplied through the air, therefore in the long run, the loss must be made up through additions of phosphorus fertilizers in some form.

Twenty samples of Carrington silt loam showed an average of 1,332 pounds of phosphorus per acre 8 inches. This amount ordinarily is considered a fair supply. The total number of pounds of phosphorus in the soil, however, cannot be taken to indicate very definitely the need for phosphorus fertilizers. The system of farming and the nature of the soil are important factors in determining the need for phosphorus. Where grain farming is practiced for a long time, the available phosphorus is rapidly withdrawn from the soil. Soils that are acid do not have their phosphorus in as available a form as do neutral or alkaline soils. It is also true that the phosphorus is not as available to plants in the dark colored or black soils as it is in the light colored soils. If, therefore, we have a dark colored soil that is acid and that has been cropped to grain for many years, we may expect that though the total amount of phosphorus is fair the soil is actually in need of a phosphate fertilizer due to the probable unavailable condition of the phosphorus that is in the soil. These conditions fit, quite exactly, the Carrington silt loam and Waukesha silt loam. Moreover, actual use of phosphate fertilizers by farmers on these soils has proven their value by increasing the yields of both hay and grain crops.

Eleven samples of Miami silt loam averaged 1080 pounds of phosphorus per acre 8 inches. This is but a fair amount

for this soil but 1080 pounds of phosphorus in Miami silt loam seems to be more satisfactory than the larger amount in the Carrington silt loam. This condition undoubtedly, as mentioned above, is due to the more available condition of the phosphorus in this lighter colored soil. Miami silt loam in many cases, however, responds to phosphate fertilization. In a study of the loss of phosphorus from the farms of Sheboygan County, it was found that approximately 200 pounds of phosphoric acid per average farm was being completely lost annually.

On good upland soil where dairying or general farming is practiced, the use of 200–300 pounds of 18% or 20% phosphate or 100 pounds of 44% superphosphate to the acre every four or five years will maintain the phosphorus supply. If much grain, potatoes, or other crops are sold, more phosphate should be used. Also, where the soil is known to be relatively low in phosphorus, larger applications should be used.

If considerable amounts of bran or cotton seed meal are fed, which are relatively high in phosphorus, the supply of this element may be maintained. It would usually be necessary to feed at least one-half ton of bran or cotton seed meal to each cow on a dairy farm per year to maintain the phosphorus supply of the soil. Since comparatively few farmers do that, some phosphate fertilizer should be used.

Potassium exists in these soils in large amounts, but in relatively unavailable form; chemical analyses show that they often contain from 30,000 to 40,000 pounds an acre eight inches, while these same soils will contain only about one-eighteenth as much phosphorus. On most soils of fairly heavy texture, when livestock is maintained and the manure carefully used so it is not leached and there is considerable actively decomposing organic matter in the soil, a sufficient amount of potassium will become available from year to year to supply the needs of general farm crops. There are some crops that need relatively large amounts of potassium such as potatoes, tobacco and cabbage and they will often be benefited by some addition of potash in the form of commercial fertilizer.

Nitrogen is chiefly responsible for the dark green, healthy color and rapid growth of corn or other crops on well

manured land. It is important to have sufficient amounts in the soil but when in excess, it is detrimental for some crops. The quality of the grain may be injured by too much nitrogen. When the grain lodges the kernels do not fully mature.

The supply of organic matter and nitrogen in the prairie soils is considerably higher than in the light colored timbered soils. Seventeen samples of Miami silt loam contained an average of 2,436 pounds of nitrogen while five samples of Carrington silt loam contained an average of 5,200 pounds of nitrogen. These amounts are considered a fair supply where a crop rotation including a legume is used. Clover, alfalfa, peas and beans if properly inoculated when planted have bacteria on their roots that take the free nitrogen from the air and store it in the plant roots. This is the cheapest method of obtaining nitrogen and one which the farmers should use to the fullest extent. On the ordinary dairy farm at least one-fourth of the land under cultivation should be seeded to clover or alfalfa. This should be fed to stock or plowed under as green manure to insure keeping up the supply of nitrogen and organic matter.

A rotation with a legume plowed under will secure nitrogen and reduce danger from diseases, and when supplemented with phosphorus and potassium fertilizers the legumes thus treated will take the place of manure, which can be used for other crops on the farm.

Certain crops such as tobacco, potatoes and vegetables are grown by farmers who do not keep much livestock and who do not rotate these crops with legumes. This is not a good practice. See chapter on agriculture for more information on farm practice and types of farming.

CHAPTER III

GROUP OF LOAMS AND FINE SANDY LOAMS

MIAMI LOAM

The surface soil of Miami loam, to depths of 8 or 10 inches, is brown loam which usually contains some gravel. This is underlain by reddish-brown clay loam material to depths ranging from 20 to 30 inches. Below this lies a shallow layer of gravelly loam or loam material, underlain by stony, calcareous, gravelly till composed largely of limestone. In some places this layer of till is so close to the surface that the surface soil approaches a gravelly loam or gravelly sandy loam in texture. A few crystalline bowlders are present on the surface and throughout the soil and substratum. In section 19, Manchester Township, and in a few other places, where the surface is almost level, areas of this soil are underlain by bedded limestone at depths between 30 and 40 inches. There are other level tracts where the surface soil is darker than typical and contains more organic matter. In the western part of the county are patches in which the deeper subsoil material consists of sand, owing to its proximity to underlying sandstone.

Areas of this loam are well distributed throughout Green Lake County, the most extensive occurring in Manchester Township, and smaller tracts in Marquette, Kingston, Green Lake, Brooklyn, Princeton, and Berlin Townships. This land is undulating or very choppy, with numerous knolls, ridges, and depressions. Because of this irregular surface and the open gravelly subsoil, the natural drainage is good.

A large proportion of the loam is under cultivation, and some of the land is forested with oak, hickory, and maple. All crops common to this region grow well on this soil. Corn, oats, and hay are the principal crops. Alfalfa and clover do very well. Dairying is carried on extensively. The manurial requirements and crop adaptations of this

soil are similar to those of the silt loam, and the suggestions offered for the improvement of the silt loam apply also to this soil.

Miami Loam, Deep Phase

The cultivated topsoil of Miami loam deep phase consists of a 10-inch layer of light-brown loam, underlain to a depth of about 20 inches by yellow or yellowish-brown loam. The subsoil is friable silty clay loam material to depths of about 3 feet, where it is underlain by parent material of unassorted glacial till consisting of sand, gravel, and clay. To a depth of 3 feet the soil is free from coarse material, and in this respect it differs from Miami loam.

Mapped areas of loam include some patches of very fine sandy loam in Brooklyn Township, some small areas where the subsoil is very fine sand, and others where the soil is dark brown and heavier than in the typical soil. Areas of deep Miami loam are inextensive, occurring in the townships of Manchester, Green Lake, Brooklyn, and Berlin. As a rule, this land is gently sloping and is well suited to the use of modern farm machinery. Drainage is good, except in a few places where the land is level.

The soil was originally forested, principally with oak and hickory, but most of it is now cleared and used for general farming and dairying. The chief crops are corn, hay, small grain, and alfalfa. The same methods of cultivation and fertilization are used as on typical silt loam, resulting in about the same average yields.

Miami Gravelly Loam

The topsoil of Miami gravelly loam is light-brown or brown loam, carrying considerable gravel and is from 6 to 10 inches deep. The subsoil is yellowish-brown or reddish-brown, friable, gravelly loam or gravelly clay loam material to depths ranging from 30 to 40 inches. Below this is the parent material of coarse, calcareous glacial till. Many small patches of Miami gravelly fine sandy loam, fine sandy loam, loam and silt loam are included with mapped areas of this soil. In places inclusions of silt loam are so numerous that it is difficult to determine whether the silt loam or the

gravelly loam predominates. Beds of gravel occur in many places in the deep subsoil.

Areas of this soil, although inextensive, are widely distributed throughout the county, occurring in Manchester, Marquette, Berlin, Brooklyn, St. Marie, and Princeton Townships. Many patches too small to indicate separately are mapped with such soils as Miami sandy loam, and fine sandy loam. This soil occurs on small knolls, hills, and ridges, or on slopes bordering drainage ways. On most of this land modern farm machinery can be used, but slopes on which it would be difficult or impracticable to use a tractor or self-binder, are numerous.

Because of the unevenness of the surface and the gravelly surface soil and subsoil, natural drainage is good and in many places excessive. Where the land is level this soil is well adapted to alfalfa and clover, probably more so than any other soil in the county, chiefly because of its abundant supply of lime.

The crops grown, methods used, and yields obtained compare very favorably with those on the Miami loam. A larger proportion of this soil is in wood lots and permanent pasture than is the case with other upland soils. The rough areas afford good grazing and the land can be utilized to good advantage where dairying is carried on.

Miami Gravelly Sandy Loam

Miami gravelly sandy loam is, for the most part, brown sandy loam containing gravel, underlain by reddish gravelly clay loam material, which in places is heavy. The subsoil in most places is underlain by beds of gravel, or extremely gravelly glacial till, principally limestone. The surface soil is not acid or only slightly so, probably owing to the influence of the lime from the gravel. Some glacial bowlders are scattered over the surface and throughout the soil. In some areas the soil is unusually sandy, but in others the surface soil is loam.

Areas of gravelly sandy loam are small but widely distributed throughout the county, occurring on small knolls or narrow ridges in Mackford, Manchester, Marquette, Princeton, and Berlin Townships. The land varies from

gently rolling to choppy. Because of the uneven surface and gravelly subsoil, natural drainage is good and in places excessive.

The smoother areas of gravelly sandy loam are cultivated in the same manner and planted with the same crops as sandy loam, whereas the steep slopes and ridges are, for the most part, either forested or used for permanent pasture. Because of its high lime content, this soil is well adapted to alfalfa. It is somewhat lower in agricultural value than the heavier soils. Suggestions offered for the improvement of sandy loam, fine sandy loam and loam, apply also to this soil.

Miami Fine Sandy Loam

The topsoil of Miami fine sandy loam consists of friable, dark-brown fine sandy loam to depths varying from 8 to 12 inches. This is underlain by reddish-brown, calcareous, gravelly loam or gravelly clay loam material, which continues to a depth of 2 or 3 feet where it grades into unassorted glacial till consisting of a mixture of sand, clay, gravel, and bowlders.

In Brooklyn Township there are some areas on which the surface soil is very fine sandy loam. In areas near the prairies, the color of the soil is darker than typical. Where the gravelly layer is near the surface the soil approaches a gravelly loam in texture. In many places some gravel is present on the surface as well as in the soil, but where this condition exists extensively such areas are mapped as gravelly loam or gravelly sandy loam. There are some bowlders on the surface and in some places these are so numerous that they have been gathered from the fields and piled into stone fences. In some areas the color of the subsoil is yellowish brown instead of reddish brown as in the typical soil and the material is less gritty. Adjoining areas of Coloma soils, the surface of this soil is more sandy and on a few small patches the fine sand layer extends to a depth of 2 feet.

Miami fine sandy loam is one of the important and extensive soils of the county. There are no large unbroken tracts, but there are a large number of areas where the con-

tinuity is broken by patches of other soils of the Miami series. This soil occurs throughout the county, and is most extensively developed in Brooklyn, Manchester, Princeton, Marquette, and Kingston Townships.

The land for the most part is gently rolling, although in some places it is nearly level and in others irregular. Only where the slopes are steep or the ridges are sharp is the use of modern farm machinery impracticable. The level areas are inextensive, but are the most desirable. Drainage is good, but there is sufficient clay in the subsoil to retain moisture, and only the more sandy areas suffer from drought.

In the remaining wood lots oak is now the chief growth. Some fair timber still remains, but most of the merchantable timber has been cut. Probably 80 per cent of this soil is cultivated. It is much esteemed because of its easy tillage and quick response to fertilization. It is fairly productive. The acreage in corn is about 30 per cent greater than that in oats or mixed clover and timothy, the crops next in importance. Rye, barley, potatoes, alfalfa, wheat, and melons are also grown.

The soil is treated in practically the same way as the Miami loam. Corn is followed by small grain, and this by mixed timothy and clover. Very little fertilizer other than barnyard manure is used, although marked increases in yields of almost all crops have been obtained by the use of acid phosphate. With an application of ground limestone, a much better stand of clover and alfalfa is obtained.

Although Miami fine sandy loam is easily cultivated and improved, a decrease in the productiveness of many farms has taken place, owing to neglect to rotate crops, grow clover, and prevent the washing away of the soil on the hillsides. The steeper slopes should be seeded to grass and used for permanent pasture, or for growing alfalfa. On the more gentle slopes contour cultivation and the growing of winter crops of rye or wheat following corn is advisable.

MIAMI SANDY LOAM

The surface soil of Miami sandy loam consists of dark grayish-brown sandy loam to a depth of 6 or 8 inches. This is underlain by a 10-inch layer of yellowish-brown sandy loam, which in turn is underlain by reddish sandy clay loam

material, which becomes somewhat heavier at a depth of about 2 feet, and is in places stiff reddish silty clay loam. The typical unassorted calcareous glacial till consisting of sand, limestone, gravel, and some clay occurs from 30 to 36 inches below the surface.

This soil varies in texture from sand to loam. The topsoil may consist of loamy medium sand, but where this is the case, the deep subsoil usually contains enough clay to give the soil the agricultural value of sandy loam. Where sandstone lies near the surface, the subsoil is sand. In section 20, Kingston Township, and in a few other areas, the material rests on a sandstone formation at depths of less than 3 feet. On some knolls and slopes gravel appears on the surface and may be mixed with the soil. However, gravel, stones, loam and bowlders are not so numerous on this soil as on loam and fine sandy loam. The supply of organic matter in the surface soil is uniformly low, and most of the surface soil is acid.

This soil is most extensively developed in the Townships of Kingston, Marquette, Berlin, Princeton, and Manchester, the largest area covering 5 or 6 square miles in the central part of Berlin Township. The sandy loam is closely associated with fine sandy loam and loam, and in many places borders Coloma fine sand.

The surface of this soil is mostly gently rolling and modern farm machinery can be used on most of it. However, in western Kingston Township and at a few other places steep slopes occur, where there is danger from erosion and where self-binders and tractors can not be used to advantage. Where sandstone lies within 3 or 4 feet of the surface the land is level or very gently sloping and in places has the appearance of terrace land. Because the surface is undulating and the soil is gravelly and sandy, natural drainage is good, and in the more sandy areas is excessive.

Some of the steep slopes are forested, chiefly with oaks and hickory, but the greater proportion of the soil is cultivated and is in improved farms. Being sandy, it is not so desirable as the loam or silt loam, but it is fair agricultural land, and many good farms are located on it. It has the advantage of warming up early in the spring, is easily cultivated, well drained, and responds quickly to fertilization.

The chief crops are corn, oats, rye, barley, potatoes, and wheat. Hay is also grown, but not in such quantities as on the heavier soils. There are good fields of alfalfa, especially where the gravelly clay loam is close to the surface and the soil is well supplied with lime. Rye is grown more extensively than on the heavier soils and gives good yields, and some of the farmers reported very good yields of corn. The same methods of cultivation, fertilization, and crop rotation are followed on this soil as on the loam and fine sandy loam.

CARRINGTON LOAM

To depths varying from 12 to 14 inches the topsoil of Carrington loam consists of dark-brown or black friable loam. The upper part of the subsoil is rather dark brown loamy material to depths ranging from 18 to 24 inches, where the color is yellowish brown and the texture is slightly heavier. The lower part of the subsoil is loamy material which ranges in texture from fine sandy loam to clay loam. The parent material is gravelly, medium-textured, glacial till in which limestone predominates.

The total area covered by this soil is about 1,500 acres. It is closely associated with the silt loam in Berlin, Brooklyn, Mackford, Manchester, and Green Lake Townships. The areas range in size from a few acres to less than half a square mile.

Areas of this loam may be level or gently rolling and the drainage is good. The coarse material allows excess moisture to move downward through the soil and be drained away, but sufficient clay is present to retain moisture very well.

This is a prairie soil which originally was covered with prairie grasses. In a few places it was thinly wooded with oak and a few wild cherry trees.

Practically all of the Carrington loam is under cultivation and highly improved. About the same crops are grown and the same methods of farming are followed as on the silt loam, but the yields probably average a little lower. The methods of improvement are practically the same as those suggested for the silt loam.

Carrington loam, gravelly phase.—To a depth of 6 or 8 inches the topsoil of Carrington loam, gravelly phase, consists of dark-brown or nearly black fine sandy loam, or silt loam. The subsoil is yellowish-brown, gritty silty clay loam material to a depth of about 2 feet, where it is gravelly clay loam material. Crystalline bowlders occur on the surface and rounded limestone gravel throughout the soil. In some places beds of gravel occur in the lower depths and in a few places near the surface. On ridges where the limestone bedrock is not far below the surface, limestone and chert fragments are present on the surface and throughout the soil, and a few outcrops of limestone occur.

Tests made with litmus paper in the field indicate that the surface soil of this phase is acid even where the limestone gravel comes close to the surface. The subsoil, composed principally of material derived from limestone which has not been leached so much as the surface soil, is well supplied with calcium carbonate.

This soil covers about 700 acres, the largest areas occurring in the southeastern part of Mackford Township on low narrow ridges which extend in an east-west direction. One of these ridges which crosses section 22 is more than a mile long. The ridges usually range in height from 5 to 20 feet and interfere very little with cultivation. Patches of this soil, many of which are too small to be mapped separately, occur in Green Lake, Brooklyn, and Berlin Townships.

Because of the open character of this soil and because the land is rolling, natural drainage is good and in some places excessive. Crops suffer from drought, especially where the gravel comes within 18 inches of the surface. Most of this soil is farmed along with Carrington silt loam, but it is not so productive. The crops grown and methods of cultivation are practically the same as on the silt loam. Because the subsoil contains much limestone, this soil is better suited to alfalfa than the silt loam. The soil warms up early in the spring and may be cultivated soon after heavy rains. If a large area occurs, it is used as permanent pasture.

Carrington Fine Sandy Loam

The topsoil of this fine sandy loam consists of dark grayish brown fine sandy loam, varying in depth from 10 to 14

inches. The subsoil material is stiff, yellowish-brown fine sandy clay loam underlain at depths of about 2 or 3 feet by yellowish silty clay loam material. Mapped as fine sandy loam are some areas which differ from the typical soil, in that the color of the surface soil is light gray owing to lack of organic matter. There are some small areas where the surface soil is darker than typical; some areas where the underlying formation is within 3 feet of the surface and the subsoil material is sandy, as in section 20, Kingston Township; and some patches where the surface soil is very fine sandy loam.

Carrington fine sandy loam covers a total area of 3.4 square miles. It occurs principally in the southern half of the county, the largest area being mapped in the central part of Kingston Township, and others in Manchester and Mackford Townships.

The surface of this fine sandy loam is mostly gently rolling with a few steep slopes, but modern machinery can be used to advantage in cultivation. Because of the surface features and the sandy nature of the soil the natural drainage is good. The subsoil is sufficiently heavy in most places to be retentive of moisture.

The fine sandy loam is good agricultural soil, although not so productive as silt loam. It warms up early in spring and responds readily to fertilization and improved methods of cultivation. Although this soil is used chiefly for general farming and dairying, it is naturally better suited to truck crops. Corn does very well because it may be planted comparatively early in the spring. More rye is grown on this soil than on the heavier soils. It is also better adapted to the production of potatoes than is the silt loam. On account of the acid condition of the soil, some difficulty is experienced in maintaining a stand of clover or alfalfa, but by the use of lime these crops can be grown. The same methods of culture are followed as on the loam and silt loam, but the fine sandy loam has a somewhat lower value.

WAUKESHA LOAM

Waukesha loam consists of very dark brown or nearly black loam, underlain at a depth of about 10 inches by rather dark brown loam which with increasing depth

becomes lighter in color and more sandy in texture. At depths varying from 18 to 24 inches is clay loam material which is underlain by sandy, gravelly material at a depth of about 3 feet.

The total area of this loam is 2.1 square miles, the largest areas occurring in the southern part of the county along Grand River in Manchester Township.

This land is level or gently sloping and usually borders low, poorly drained soils such as those of the Clyde series. Drainage is usually good, but in some low places it is slightly deficient in the spring when the water table is high. Where the gravel subsoil is close to the surface, the land may suffer from lack of moisture during dry periods.

This soil has been developed under prairie conditions, and the original growth consisted chiefly of prairie grasses. Some trees bordered the watercourses, but the greater part of the land was treeless.

Practically all this soil is now under cultivation, and is considered fertile and productive. Corn is the chief crop and oats are probably second in acreage. Most of the general farm crops common to the region are grown, and give fairly good returns.

Waukesha Fine Sandy Loam

The surface soil of Waukesha fine sandy loam, to a depth of 10 inches, consists of dark-brown or nearly black fine sandy loam. This is underlain by material of practically the same texture but of chocolate-brown color. Below 18 inches, a yellowish color appears, and at depths varying from 20 to 28 inches the content of gravel increases very much, and the material grades downward to beds of stratified sand, or sand and gravel. This soil is somewhat variable and in a few places the subsoil is heavier than in the typical soil. The surface soil gives an acid reaction.

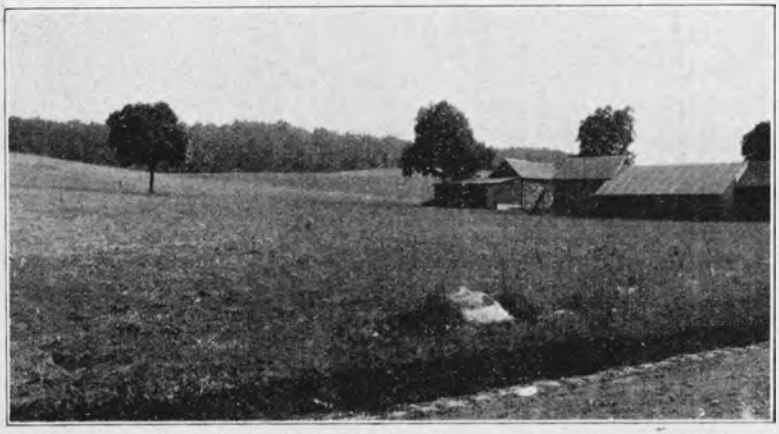
Waukesha fine sandy loam is of very small extent and is confined chiefly to the southern part of the county along the valley of Grand River. Some of the larger areas are located in sections 7, 11, and 14 of Kingston Township.

The surface of this soil is level or nearly so, and because of the open subsoil the natural drainage is good.

This fine sandy loam is a prairie soil of alluvial origin,

Pasturing Clyde Silt Loam.

Seed Clover on Plainfield Sand.



View Showing Gently Rolling Topography of Coloma Sand.

having been deposited by streams when the volume of water was much greater than at present. The parent material was glacial till which came in part from limestone and in part from sandstone. Although some trees formerly grew along watercourses, the land as a whole was nearly treeless and the chief growth consisted of prairie grasses.

This fine sandy loam is a fair agricultural soil. It is all farmed and produces most of the crops common to the region. It is farmed in the same manner as the loam but is better suited to truck crops than to general farming operations.

Fox Loam

Fox loam consists of light chocolate-brown friable loam to a depth of 8 or 10 inches where it grades to friable reddish-brown loam. Below a depth of 18 inches a reddish-brown gritty clay loam material occurs, which at a depth of about 2 feet is underlain by stratified, calcareous sand and gravel. Fox loam is very variable in texture, ranging between the heavier silt loams and the more sandy soils. Litmus-paper tests show that the soil is acid in many places, but the deeper part of the subsoil contains much limestone gravel and is neutral or slightly alkaline.

This soil is of small extent, and is developed chiefly in sections 12, 14, 15, 16, and 33 of Manchester Township. Small scattered areas occur in a few other places in the southern part of the county, some of which are too small to be shown on the map. This land is level or very gently sloping, and the drainage is good. The area in section 33, Manchester Township, is about 40 feet higher than the marshland adjoining and from a distance it appears to be a high plain or terrace, but a closer view shows that owing to erosion the surface is somewhat uneven.

Nearly all this soil is under cultivation, and the principal crops are corn, oats, barley, rye, and hay. Some potatoes are grown and the soil is well adapted to truck farming, but this industry is not carried on extensively. The farm practices followed and the yields secured are about the same as those on Fox silt loam. The soil is easy to cultivate, and a good mellow seed bed can be readily developed. The soil is deficient in organic matter.

Superior Fine Sandy Loam

Superior fine sandy loam, to a depth of 8 or 10 inches, is brown medium or fine sandy loam. The subsoil is light-brown or pinkish fine sand material underlain at depths ranging from 18 to 30 inches by the red clay substratum characteristic of the Superior soils. The depth to this heavy clay ranges from 1 to 3 feet, but it is everywhere present. The color and texture of the surface soil may vary but it is everywhere light colored and sandy, being in some places sand or fine sand.

Areas of this soil are small and occur on lowlands along Fox River, mostly in the northern part of the county near Berlin. A few patches, some of which are too small to be mapped, occur at other places close to the river in the western and southwestern parts of the county.

This land is level or nearly so, and because of its sandy nature drainage is usually good. In a few areas where clay is close to the surface, drainage is somewhat deficient. As a rule, tile drains are not needed, but in some places they would be beneficial. This soil is used principally for general farming, but it is better adapted to truck crops and intensive farming.

Chemical Composition and Improvement of Loams and Fine Sandy Loams

In this group, there are a number of types which, with the exception of Miami loam, fine sandy loam and sandy loam, are individually of minor importance. As a group, however, they cover a large area within the county. They are important agriculturally as indicated by the large extent to which they are cultivated and by their productivity.

While there is some variation in the texture, structure, and color of the types of this group, there is sufficient similarity between them to allow the discussion of general methods of improvement. One variation that warrants some consideration is that of texture. The loams of the group are somewhat better soils than the sandy loams due partly to a better supply of plant food but mainly to their having a greater water-holding capacity. Crops grown on

the sandy loams will suffer from dry weather sooner than they will when grown on the loams.

The principal differences between this group of soils and the group of heavy soils are: (1) a smaller supply of plant food, (2) better response to fertilization, (3) smaller water-holding capacity, (4) more easily tilled, and (5) they warm up quicker in the spring.

As with the group of heavy soils, lime is of prime importance in the improvement of these soils. It is true that the coarser textured a soil is (that is, the more sand that it contains) the lower is its lime requirement. A sandy loam, for example, that proves to be strongly acid may have its lime requirement met with two tons of lime per acre whereas a silt loam that tests strongly acid may demand three and one-half tons to meet its lime requirement. In general the soils of this group need about two tons of lime per acre to grow such crops as alfalfa. Miami loam, fine sandy loam and sandy loam are, as a rule, exceptions to this for limestone gravel is generally present in sufficient quantities to prevent acidity from developing. Waukesha loam and fine sandy loam and Carrington loam probably will need more lime than the other soils of this group.

The phosphorus content of these soils is only fair. In fact, in many cases it is indeed very low, especially in old fields, where grain farming has in the past been carried on extensively. The average amount of phosphorus in seven samples of Miami loam proved to be 931 pounds per acre eight inches and the average amount in four samples of Miami fine sandy loam was 603 pounds. The average Carrington sandy loam contained 957 pounds. As was stated in the discussion of the heavy soils, it must be remembered that too much emphasis must not be placed upon the actual amount of phosphorus that a soil may contain, for the phosphorus content of any soil type varies considerably. The farmer's aim is not to grow his crops on the basis of the amount of phosphorus that is already in the soil, but to plan his crops and methods of improvement so as to build up and maintain the fertility at that point where he will receive the most profitable yields.

The only completely satisfactory way of determining the need for phosphorus of any particular soil is by actual field

experiment. The farmer himself should study his soil needs in this way. It has been found quite universally true that this group of soils (especially the prairie soils) respond profitably to phosphate treatment. On those soils that are acid, it is advisable to first apply lime, for phosphate fertilizer is not as effective under acid soil conditions as it is under conditions where the acidity has been corrected.

The situation in regard to potassium is considerably different from that in respect to phosphorus. The total amount of potassium per acre eight inches approximates 25,000 pounds or fully twenty times as much as the supply of phosphorus. Where general farming is conducted and where there is maintained a good supply of vegetable matter in the soil, this amount will doubtless be sufficient. Where special crops are raised which require a large amount of potassium this element may be supplied to advantage in the form of a commercial fertilizer.

The supply of organic matter is of great importance to these soils. Most of them have a small amount with which to start. The moisture-holding capacity of these soils, which is somewhat deficient, can be improved by increasing the vegetable matter in the soil. This can be accomplished by conserving the stable manure and by turning under a green manure crop whenever it is economically possible. Rye sown in the corn at the time of the last cultivation will produce a good growth to be "turned under" the following spring. It often pays to "turn under" the second crop of clover rather than harvest it. The improved tilth, fertility and moisture conditions for the next year's crop will more than pay for the sacrificed crop, especially if there is a good supply of clover hay for winter feeding without it. An abundance of organic matter is of especial value to the sandy loams, for they are more subject to drouth than are the other soils of this group.

The nitrogen supply of a soil is closely related to the supply of its organic matter. The building up of the amount of organic matter in the soil, unlike phosphorus, potassium, and lime, can be accomplished without purchasing it. All legumes that are properly inoculated will take nitrogen from the air and "fix it" in the soil thereby increasing the

supply. Nitrogen is the most costly fertilizer to buy, it is lost from the soil easier than any of the other plant food elements, it is one of the most important ones concerning the growth of plants, and it is the easiest and cheapest one for the farmer to supply. These are some of the reasons why it is urgently advocated that the farmer should grow legumes on at least one-fourth of the tillable land of his farm.

Loams and sandy loam soils have three desirable characteristics; they are easily tilled, they warm up quickly in the spring, and respond readily to fertilizer treatment. These characteristics make them well adapted to special crops that demand considerable tillage, rapid growth, or an abundance of readily available plant food that may be added as commercial fertilizer. Potatoes, sugar beets, and various truck crops are more successfully grown on these soils than on the heavier soils for these reasons. It is necessary when growing these crops to give the soils of this group more attention to maintain the fertility, partly because of the fact that they are lower in fertility than the heavier soils, but more because of the fact that these special crops require a higher degree of fertility to produce satisfactory yields. When these soils are used for the production of special crops their fertility can be maintained through the use of a rotation in which a legume is grown, as a green manuring crop, to supply the necessary nitrogen and organic matter. The other elements, chiefly phosphorus and potassium, are supplied in commercial fertilizers and barnyard manure. When this system is followed, one-third or one-fourth of the land should be sown to a legume, such as clover or soybeans, which has large powers of gathering nitrogen from the air. A part of the phosphorus and potassium should be used for the growth of the green manuring crop. The fertility used in this way will become available for the succeeding crops through the decomposition of the legume when plowed under. The remainder of the fertilizer to be used should be applied on this ground at the time of fitting it for the special crops.

CHAPTER IV

GROUP OF SANDY SOILS

Plainfield Sand

Cultivated Plainfield sand to a depth of 8 inches consists of loose, open brown sand containing a small quantity of organic matter. It has a little gravel scattered over the surface and mixed with the soil. The subsoil is yellow medium sand, which becomes coarser in texture with increased depth, and below 30 inches contains considerable coarse sand and fine gravel. In some places where the subsoil contains considerable iron the material has a brownish or a reddish color. Where the soil borders marshland the color is darker than typical owing to a larger percentage of organic matter; and where it is adjacent to heavier soils the texture approaches sandy loam and the soil is of better quality. In a few places sufficient clay is present in the subsoil for the material to feel slightly sticky, which increases the agricultural value of the soil. Virgin soil of this kind contains more organic matter within the first inch or two of the surface than is found in old fields, but under cultivation this is soon lost.

Plainfield sand covers a total area of 11.5 square miles, and occurs chiefly in the northern and western parts of the county. The largest areas are in the northern parts of Berlin and Seneca Townships, and many smaller areas in St. Marie, Princeton, and Marquette Townships. Plainfield sand occurs on the terraces along the old flood plain of Fox River.

The surface is level or slopes very gently toward the stream along which the soil occurs. In places it occurs as islands in the marshland country, where it is usually only from 1 to 3 feet higher than the wet land. Here the water table is close to the surface and the soil may be wet in the spring. Most of this land is high enough to be well drained, and in some places drainage is excessive.

The original forest growth consisted mainly of red and black oak, jack pine, and some Norway pine. The best timber has been cut, but a large number of small jack pine and some oak still remain, the largest of which range from 8 to 12 inches in diameter.

Probably 40 per cent of this land has been cleared and cultivated, but some farms have been abandoned. The chief crops grown at the present time and the average yields during the most favorable years are as follows: Corn, from 15 to 25 bushels an acre; oats, from 20 to 25 bushels; rye, from 12 to 20 bushels; buckwheat, from 12 to 16 bushels; and potatoes, from 100 to 150 bushels. Potatoes are the chief cash crop. A little hay, consisting of clover and timothy, is produced, but the stand is thin and the yield seldom amounts to 1 ton an acre. Some sorgo (sweet sorghum) is grown which yields about 24 gallons of sirup to the acre.

Because Plainfield sand is easily cleared and cultivated, some farmers believe that it is preferable to heavier, higher-priced land. The methods of cultivation, crop rotation, and fertilization followed on many farms are not best suited to soils of this character. Very little livestock is kept, and consequently very little manure is available. Because of this and failure to plow under green-manure crops, the organic matter in the soil is rapidly depleted. The best farmers make a good living from their farms, but most of the farm buildings reflect the generally poor condition of the soil.

The limiting factors in crop production on this soil are low water supply, low fertility, and low organic-matter content.

PLAINFIELD FINE SAND

To a depth of 6 or 8 inches, cultivated Plainfield fine sand consists of light-brown or grayish-brown fine sand which contains some organic matter. The subsoil is yellow, fine sandy material to depths of more than 3 feet. Mapped areas of Plainfield fine sand include variations from the typical soil in which the subsoil material is rust-colored or brownish yellow, and others in which the soil is medium sand or very fine sand in texture. The soil is free from gravel, and lit-

mus-paper tests indicate that the surface soil is acid. In its virgin condition the surface inch or two usually contains sufficient organic matter to give the soil a rather dark color, but when cultivated this becomes oxidized and the lighter color prevails.

Areas of Plainfield fine sand occur in all the townships in the western half of the county, and also in Berlin and Manchester Townships. There are no large tracts of this soil but many small irregular patches ranging in size from a few acres to half a square mile.

This land is level or gently sloping, and occurs principally on stream terraces and on small islands in marshland parts of the county. The elevation of these islands in the marshland is generally only a few feet higher than the marsh, and in such places the water table is near the surface. Because of the sand in soil and subsoil, crops suffer for lack of moisture during dry seasons. Areas adjoining marshland suffer least in this respect, but early in the spring they are sometimes too wet.

Much of this land has been cleared and placed under cultivation, but much that has been cleared is no longer used as plowland. A large acreage of this soil supports a growth of brush, scrub oak, and jack pine. The chief crops are rye, potatoes, corn and beans, and a small acreage is in oats and hay. Considerable difficulty is experienced in obtaining successful stands of grass, because the soil dries out, it is in need of lime, and is low in fertility. Yields of all crops are low, except where attention is paid to fertilization, liming, and rotation.

Coloma Sand

Coloma sand consists of light-brown fine or medium sand to a depth of 6 inches, where it is underlain by yellow fine sand, in places containing some fine gravel. The topsoil and subsoil are loose and open and contain but little material as fine as silt, but in some areas the subsoil is sticky.

The larger areas of Coloma sand are in the vicinity of Berlin and in the northwestern part of the county. The surface is gently rolling, and in no place is the land too

steep for cultivation. The drainage is very good. The native growth on this soil consists chiefly of scrub oak and jack pine. Heath growths have come up on abandoned fields. Some fields have remained idle for several years because of the small yields secured. Where the soil is cultivated, the chief crops are rye and potatoes, less important crops being hay and beans, but yields are small and unsatisfactory. Where crops are forced to mature early and where it is profitable to use large quantities of soluble fertilizers, this soil is especially suitable for truck crops. For the improvement of this soil, legumes should be grown. Small grain, clover, followed by corn is a good three-year rotation, in which the second cutting of clover should be plowed under.

Coloma Fine Sand

Coloma fine sand is similar to Coloma sand, differing mainly in the texture of the surface soil. Also the surface soil contains more organic matter, and the moisture-retaining capacity is greater.

Mapped as Coloma fine sand are some areas where the soil is of different texture, as in western Brooklyn Township where the topsoil and subsoil of some areas consist of very fine sand, and in some other areas silt or clay layers near the surface influence the moisture-retaining capacity of the soil.

Areas of Coloma fine sand occur principally throughout the central part of the county and smaller and more scattered areas in the northeastern and southwestern parts. Drainage conditions and agricultural possibilities of Coloma fine sand are similar to those of Coloma sand.

Fox Sandy Loam

The topsoil of Fox sandy loam consists of brown or grayish-brown sandy loam, underlain at depths ranging from 8 to 12 inches by reddish-brown sandy loam. The subsoil below a depth of 20 inches is gravelly sand material, which grades into beds of stratified sand and gravel, the gravel being largely limestone. In some places no gravel is pres-

ent in the subsoil, and here the subsoil is a yellow sand or fine sand which in places has a reddish cast.

Areas of this soil are inextensive, and occur chiefly on the terraces along Grand River and its tributaries in Kingston and Manchester Townships. Mapped with Fox sandy loam are some small areas where gravel occurs in the surface soil. The largest of these areas is in section 16, Manchester Township.

This land is level or gently sloping, except in a few places where the terraces have been eroded. The soil is open and porous, and drainage is good and in places excessive. Most of the terraces are well above the present flood plains of the streams and none of the soil is subject to overflow.

Most of this land is included in farms, but it is not all well improved. As compared with heavier soils it is of rather low agricultural value, although under careful management yields are fair. Rye and potatoes are grown, and these crops are better suited to this soil than most of the other crops. Corn does fairly well especially if improved methods of fertilization and cultivation are used. It is not good pasture soil, although some hay is grown on it. It is better suited to truck crops than to general farming, but the small size of the areas and their location make truck growing on a large scale impracticable.

CHEMICAL COMPOSITION AND IMPROVEMENT OF SANDY SOILS IN GREEN LAKE COUNTY

The sandy soils are the lowest in fertility and have a lower water-holding capacity than any of the other soils herein discussed. Their nitrogen supply is about one-half and the phosphorus and potassium supply about two-thirds of that found in the silt loam soils. They are, however, with proper methods of improvement and maintenance of the fertility, capable of producing fair and profitable crops. All of these soils are droughty and must be farmed with the aim of conserving all of the available moisture and plant food.

In the improvement of these soils, one of the first steps is to recognize the potash deficiency and take action to correct it. Sandy soils are naturally low in potassium. Cash

cropping of various kinds without returning anything to the fields quickly uses the most available potassium. Potassium in plants is found mostly in leaves and stems.

Alfalfa, which yields 2½ tons of hay per acre, takes from the soil 111.5 lbs. of potash. It would require an annual application of 223 lbs. of 50% muriate of potash or 11 tons of average manure to meet the potassium needs of this alfalfa crop. Most other crops require less potash.

Muriate of potash is the principal potassium fertilizer used in Wisconsin.

One ton of unleached manure contains about 10 pounds of potassium. The liquid portion of the manure carries about 60% of the total potassium, and as this is readily lost by leaching, manure should be carefully handled, preferably by the use of manure pits so as to conserve as much as possible of the liquid portion. As indicated, the phosphorus supply in sandy soils is also limited, and this supply should be supplemented by the use of commercial fertilizers.

When about 5 or 6 loads of manure are applied and when this is supplemented with 200–300 pounds of a 0-10-10 fertilizer once during a three or four-year rotation, this will be sufficient to maintain this potash and phosphorus supply.

These sandy soils show varying degrees of acidity and when alfalfa is to be grown it is necessary to apply about 2 tons of ground limestone to meet the needs of this crop. Lime will also aid other crops, especially the legumes like clover, but alfalfa needs the lime to a greater extent than other crops.

Nitrogen* and organic matter are also needed to improve these sandy soils, but these can usually be supplied by growing legumes and by turning under a legume as a green manuring crop. This is the cheapest way to get nitrogen and organic matter and it is a practice that should be followed by all farmers who have sandy soils.

Consideration should be given to the use of early maturing grain crops that may be harvested before the summer drought. Rye is the most satisfactory crop in this respect. Oats, barley, and wheat do not do so well on the sandy soils.

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* For more complete information on the management of sandy soils consult Bulletin of Wis. Exp. Sta. on this subject.

Corn on manured land produces good yields and matures earlier than on heavier soils.

Another point to consider is the prevention of blowing of the sand. The farmer should plan to keep the ground covered with a crop as much of the time as possible. Hay crops will do this satisfactorily as will also small-grain seeded to clover or alfalfa. Corn, especially when it is removed early for silo filling, leaves the ground bare. This may be prevented by sowing rye between the rows at the time of the last cultivation. Blowing may also be reduced by growing grain, corn and hay crops in alternate strips, running north and south. Timber strip at intervals will also serve the same purpose.

In the light of the factors concerned in management of sandy soils the following rotations can be recommended for these soils:

Rotation 1. Alfalfa, 2 to 4 years. Corn or potatoes. Grain one year seeded to alfalfa again.

Rotation 2. Rye, seeded to clover. Clover for hay with second crop plowed under, corn or potatoes.

Soy beans or vetch may be sown after the rye if clover does not make a catch and be plowed under to add organic matter.

CHAPTER V

GROUP OF POORLY DRAINED SOILS

CLYDE SILT LOAM

The topsoil of Clyde silt loam consists of a nearly black, smooth silt loam very high in organic matter. This is underlain at a depth of 10 or 12 inches by silt loam material which is somewhat lighter in color in the upper part of the layer, but gradually changes with depth, through dark grayish-brown, to drab, bluish, or yellow mottled silty clay loam material, which continues to a depth of more than 3 feet. In places the lower part of this layer contains small lenses of fine sand.

The chief variation in Clyde silt loam is a covering of peat which in some places reaches a depth of 8 inches. When such land is cultivated the underlying mineral soil is mixed with the peat, so that after a few years the material has the character of a mineral soil.

Clyde silt loam occurs chiefly in the eastern half of the county in depressions in areas of Miami and Carrington silt loam. The largest area is in the northeastern part of Mackford Township. Smaller areas are mapped in Green Lake, Brooklyn, and Manchester Townships.

The surface of Clyde silt loam is low, level, nearly level, or slightly depressed. The drainage is poor, and some form of artificial drainage is necessary before general farm crops can be successfully grown. Tile drains have greatly increased the producing power of this soil.

The native vegetation on this soil consisted of elm, ash, willow, soft maple, and grasses. All the timber has been removed and most of the areas are cleared and cultivated or used for pasture.

Where well drained this soil makes excellent farming land, and is considered the best corn land in the southern part of the State. It is also well suited to the production of hay and root crops. Small grains have a tendency to

lodge, and the quality is not so good as that of those grown on light-colored upland soils. If corn is grown for two or three years in succession the grain crop following is not so apt to lodge as it is if it follows corn grown for only one year.

CLYDE LOAM

Clyde loam includes dark-colored, low poorly drained land, where the surface texture is fine sandy loam or loam and the subsoil is gray or mottled yellow and gray sandy clay. Lenses and strata of fine sand are present throughout the soil. The soil has the same general characteristics, similar agricultural value, and occurs under practically the same conditions as Clyde silt loam. When thoroughly drained it would be well suited for the production of corn and truck crops.

CLYDE SILT LOAM, ALLUVIAL PHASE

The topsoil of this silt loam is dark-brown or black silt loam, which contains a large quantity of organic matter. This is underlain at a depth of 10 or 12 inches by dark-colored silt loam, which with increase of depth, becomes grayish-drab or mottled silt loam material grading at a depth of about 2 feet into a mottled yellow, drab, and brown, fine sandy substratum. The material composing the substratum continues to a depth of more than 3 feet, and in places contains thin seams of clay or silt. A common variation occurring in this soil is a covering of peat, several inches thick, over the surface soil. In a few small areas this peat layer, as a result of recent inundations, has been covered with a silt loam deposit. In some places the color is brown or yellowish brown because the soil is lower in organic matter. This soil resembles typical Clyde silt loam in color and drainage, but differs by having sand rather than heavy material in the substratum.

Areas of this silt loam occur on lowlands along Fox River in the northern and western parts of the county, the most extensive being in the townships of Berlin, Seneca, St. Marie, and Marquette. This land is level or slightly depressed, and drainage is poor. Some of it is inundated

during times of high water; and on areas near Fox River the water table is within 2 or 3 feet of the surface during much of the time.

Most of this land is now treeless, being covered with coarse grasses some of which along Fox River are of the marsh varieties. The original tree growth consisted of soft maple, elm, willow, ash, alder, and some moisture-loving shrubs. There is very little merchantable timber on this land.

Because this land is low and wet, not much of it has been improved. On some areas bordering the upland and along well constructed ditches where drainage is sufficient, crops can be grown. On such areas yields are good, but most of this soil is not well drained and is suitable only for hay and pasture. This soil especially where it is deepest, is very good and when drained is suited to corn, hay, cabbage, onions, and root crops. Proper drainage is the first and most important step in the improvement of this silt loam, but no great improvement can be made at present because of the Government locks on Fox River. The construction of ditches and drains where the present fall is sufficient is the only means of improving drainage at present.

CLYDE LOAM, ALLUVIAL PHASE

The topsoil of this loam, to a depth of 10 or 12 inches, consists of black loam, containing a large quantity of organic matter. The subsoil is mottled gray, drab, or yellowish fine sand to depths of 4 or more feet, and in places contains lenses of silt and clay. The surface soil in many places contains considerable fine sand and in a few places this material is covered with several inches of peat which becomes mixed with the mineral soil material upon cultivation and soon disappears. Underlying some of the loam, as in sections 10 and 12 in Kingston Township, is a bed of pinkish-red clay material similar to that which forms the subsoil of the Superior soils. Some patches of fine sandy loam are included in mapped areas of this soil.

Areas of this loam cover 12.4 square miles. This soil occurs on lowlands along Fox River in the northern and western parts of the county in Berlin, Seneca, St. Marie,

Princeton, and Marquette Townships, and along Grand River in the southern part. The land is level, and very poorly drained. In its present condition it is used chiefly for pasture, and some hay is grown. Areas bordering the river are very wet and are covered with flood waters for long periods during spring and early summer, partly on account of the locks in Fox River which retard the drainage.

Much of the land is treeless, but in some places the growth consists of soft maple, elm, ash, alder, and willows. Practically all merchantable timber was removed long ago. The chief use of this soil is for hay production and for pasture, although small patches are under cultivation. When properly drained it is a good soil for corn, hay, and truck crops, such as cabbage and onions. Grains can be grown, but there is danger of lodging.

Any great improvement in drainage on the lower-lying areas will be difficult or impossible so long as the locks remain in the river, but some of the land lying at a distance from the river and bordering the highland has sufficient fall so that under present conditions it can be successfully drained.

Poygan Silt Loam

Poygan silt loam is very dark grayish-brown silt loam to depths ranging from 10 to 16 inches, containing much organic matter, and underlain by a red clay subsoil. On some small areas, a layer of peat covers the surface. In places, the subsoil is blue clay instead of the typical red clay.

Areas of Poygan silt loam occur on lowlands along Fox River in Berlin, Seneca, and St. Marie Townships. Natural drainage is poor, and tile or other drains are necessary before the soil can be successfully cultivated. When drained it is good soil for corn, hay, and root crops.

Poygan Clay Loam

Poygan clay loam, to a depth of 6 or 8 inches, consists of heavy nearly black clay loam, grading downward into gray clay, which, at depths varying from 12 to 24 inches,

is underlain by a heavy compact, pinkish-red clay, similar to that underlying soils of the Superior series. In places, a thin layer of peat covers the surface, but after a few years of cultivation this disappears. In some places, the subsoil is a heavy blue clay instead of red clay, but the texture and structure remain the same, the difference in color being due to differences in degree of oxidation. Where drainage conditions are very poor the subsoil is mottled. Thin seams of sand occur in the subsoil in a few places.

Poygan clay loam is of small extent in Green Lake County, and is confined to the valleys of Fox River and its tributaries. It occurs in Berlin, Brooklyn, St. Marie, Kingston, and Marquette Townships and covers a total area of 4.2 square miles.

The surface of this soil is low and level and the natural drainage is very poor. It occupies some of the lowest land along Fox River and must be drained before cultivated crops can be safely grown. The original water-loving trees and grasses included soft maple, willow, elm, and ash. Most of the trees have been cut and removed.

Only a small part of this land has been cleared, drained, and cultivated. When thoroughly drained the soil is fertile and well adapted to a variety of crops, including corn, hay, sugar beets, cabbage, and root crops. Small grain is apt to lodge, and the quality of the grain is not so good as that of grain grown on light-colored upland soils. Tile drains should be installed, as practically all the soil is so situated that it can be successfully drained.

DUNNING FINE SAND

The surface soil of Dunning fine sand, to a depth of about 4 or 6 inches, consists of black fine sand which contains a high percentage of vegetable matter. In places there is sufficient organic matter to make the soil peaty or mucky sand. This dark material grades into dark-gray fine sand, which in places becomes gray or nearly white and is stratified in the lower part of the subsoil. This light-colored material continues to a depth that is undertermined but always greater than 3 feet. The color of the surface soil varies from black to brown, yellowish, or mottled brown

and yellow, owing in part to poor drainage and in part to iron stains. In a few places there is sufficient clay in the deep subsoil to make it somewhat sticky. The surface soil in places is 14 inches deep. Included with mapped areas of this soil are a few small areas of Dunning sand, which is a soil type gradational between Plainfield sand and shallow peat.

Dunning fine sand is widely distributed in the northern and western parts of the county. It is confined entirely to the lowlands bordering Fox and Grand Rivers. The largest area, a continuous tract of several square miles, is immediately north of Lake Puckaway in Marquette Township. Most of the other areas are much smaller and in places border areas of peat.

This land is level, low, and naturally very poorly drained. Some of it is sufficiently high so that water seldom covers the surface, but in other places from 1 to 3 feet of water may cover it part of the year. Much of this land lies so low and so close to the river that drainage will be difficult unless the Fox River locks are removed.

The original growth consisted of willows, elm, soft maple, and coarse marsh grasses, but at present much of this land is open and treeless and covered with grass, cat-tail, and rushes, but on the driest places, some oak, jack pine, poplar, and white birch are present.

Only a small part of this soil is under cultivation, and crops usually are poor because of excessive moisture in the soil. Alsike clover, wild hay, and corn are the principal crops. Some potatoes are grown on the better-drained areas.

This soil is of low agricultural value. Although the surface soil is well supplied with organic matter, it is deficient in mineral plant food elements, is too sandy for most crops, and is acid. Drainage is the first step toward its improvement, and this may be so difficult that the expense would not be justified under present conditions.

Genesee Silt Loam

The topsoil of Genesee silt loam is dark brown, and the subsoil material is brown or yellowish brown. The texture

ranges from heavy fine sandy loam to silt loam. Areas occur as narrow strips of alluvial land along streams, and are subject to annual overflow.

This land has low agricultural value, but in a few places it is used for grazing. It is doubtful if it is possible to improve this soil at present, because of the high cost of artificial drainage and protection from overflow. Where improved, it is good farming land, especially for such crops as hay and corn.

Chemical Composition and Improvement of the Poorly Drained Soils

Green Lake county has a large acreage of poorly drained soils that are comparatively fertile and if properly drained would produce abundant crops. All of them have an abundant supply of nitrogen. It generally ranges from 4,000 to 10,000 pounds per acre 8 inches. Phosphorus ranges from 1,200 to 2,400 pounds per acre while potassium runs from 25,000 to 40,000 pounds per acre 8 inches. Where the soil has a thin covering of peat, the phosphorus and potassium are present in the surface soil in smaller amounts.

That portion of these soils found on terraces usually shows some need for lime. Ground limestone on such places can be used to advantage. In many cases the soils do not need lime. They are so situated that they receive the wash from higher lands which contain lime material. This lime-bearing water has prevented the development of an acid condition in these soils. Where acidity is found it is usually so slight that but little or no lime is needed except as indicated above.

The most important step and the first step in the improvement of these soils is to supply adequate drainage. Tile drains and some open ditches have been installed and a portion of the land is now devoted to cultivated crops. Considerable areas, however, are still undrained and are used chiefly for pasture and hay. The drainage of these lands frequently requires the development of drainage districts, but there are numerous tracts which are so situated that they can be reclaimed by individual efforts. On the

other hand there are some areas so situated that artificial drainage is impracticable. Such areas should be used for permanent pasture and timber.

A condition which sometimes develops on this soil is shown when corn turns yellow on areas of small extent. In such cases the use of some form of potash or strawy horse manure is helpful. In most places, and especially where the surface has a thin layer of peat over it, there is a relatively larger supply of nitrogen than phosphorus and potassium. For this reason, it is a good practice to use the manure on the upland soils which are deficient in nitrogen, and apply mineral fertilizers to the low land when these are needed. In many cases which show a marked need of potassium during the first few years of cropping, usually where the soil is high in organic matter to a depth of a foot, this lack of potassium frequently disappears after a few years of cropping as a result of the settling of the surface so that deep plowing mixes up some of the soil high in potash.

In spite of their content of both phosphorus and potassium, it is not infrequently true that these soils show low availability of these elements especially of potassium. This is probably due to the inert condition of much of the organic matter which protects the earthy part of the soil. Where thoroughly good artificial drainage has been developed and nevertheless poor crops are secured, this result will usually be found to be due to lack of available potassium and in some cases also of phosphorus. A direct experiment should be made in these cases with potassium and phosphate fertilizers as suggested in Bulletin No. 309 of the Wisconsin Experiment Station.

Some of these soils are capable with thorough drainage and proper fertilization and cultivation, of being made among the most productive lands in the state.

PEAT

The material classified as peat consists chiefly of accumulated vegetable matter in varying stages of disintegration and decomposition, having more or less mineral matter mixed with it. In color, peat varies from brown to

black. The depth of the material forming this soil is also extremely variable, typical peat being more than 18 inches deep and ranging from that depth to as much as 15 feet. Shallow peat ranges from 6 to 18 inches deep. Usually the shallow peat is more thoroughly decayed, and is of darker color. The mineral material underlying most of the peat is fine sand.

The color of peat and the stage of its decomposition are also variable. These variations are important, but they are not indicated on the soil map, except as they are indicated by the depth of the peaty material. Most deep peat is brown, and the structure is fibrous, which shows that it has not reached an advanced stage of decomposition. In its rawest condition the stems, leaves, grasses, and moss from which it was formed are still visible. This raw peat, in many places, continues to depths ranging from 3 to 6 feet or more, but usually peat in its lower depths is more decayed and darker than that nearer the surface. In some places deep peat is so thoroughly decomposed that its fibrous character has disappeared. Peat of this kind has more agricultural value than raw peat. In general, shallow peat is somewhat more decayed and of darker color than deep peat, and in some places it approaches muck in composition. Areas where the peat is well decomposed are small.

The mineral matter under the peat beds consists chiefly of white or grayish fine sand; but where areas of peat adjoin areas of Miami fine sandy loam and Miami loam, the underlying layer is sticky, stony material, or sandy clay loam material. In the southeastern part of the county, some areas of peat occur along some of the drainage ways, where surrounding upland soils are heavy. On such areas the material underlying the peat is heavy in texture.

Peat is the most extensive soil in Green Lake County, occurring to some extent in every township. The largest areas are in the northern and western parts of the county in the lowlands adjacent to Fox River. Areas of deep peat are more extensive than those of shallow peat, the largest being along White River in Seneca Township, along Fox River in Princeton Township, and along Grand River in Marquette and Kingston Townships. Areas of shallow

peat occur throughout the same regions as deep peat and in many places they border large marshes. Shallow peat may be considered a gradational soil between typical peat and soils of the Dunning series.

Tracts of peat soil are comparatively low, flat, and very poorly drained. Water stands on the surface of many of the marshes during spring and early summer, and when in this soggy condition the land is so soft that it will not support the weight of cattle. During late summer, especially in dry seasons, the marshes dry out so that farm animals are safe, and the peat frequently becomes so dry that danger from fire is great. All soils included in mapped areas of peat are sufficiently high in organic matter to burn when dry.

Some large drainage ditches have been extended into and through the peat areas, but these supply only partial outlets, so that numerous lateral ditches supplemented by tile drains are necessary before crops can be profitably grown. The drainage of most peat areas along Fox River is obstructed by dams in the river.

The forest growth on peat marshes consists of tamarack, alder, poplar, willow, and various other water-loving trees. Only a small acreage of peat marsh is forested, most of it being open and treeless. On open marshes there is a growth of coarse marsh grass, wire grass, or sphagnum moss, interspersed with a small and stunted growth of water-loving shrubs. Some of the marsh grasses are pastured or cut for hay.

Although areas of peat are extensive in Green Lake County, this land is at present of little agricultural importance. Some cultivation is being attempted, but in most places drainage is inadequate, and crop failures have resulted because of an excess of moisture on land which produced fair or good crops of timothy hay during a series of dry seasons. Commercial fertilizers and lime are needed, but are not used very much on marshes now under cultivation.

Crops most commonly grown on peat are buckwheat, rye, timothy, potatoes, and root crops, and some cabbage and onions. Some attempts are made to grow corn, but be-

cause of the danger of summer frosts this crop is uncertain.

Some tracts of peat are utilized to a small extent for pasture and hay, although wild marsh grasses have low feeding value. These marshes are frequently burned over to destroy the dead grass and trash upon the surface, and a moderate stand of clean grass usually follows, which makes fairly good pasture while it is young and tender. If the marshes are burned over during dry seasons the peat itself is in danger of being burned.

Yields of crops mentioned, when grown without fertilization on raw, brown, fibrous peat, are usually low and unsatisfactory, but where peat is well decomposed and black, fair crops may be obtained for a few years without fertilization. On some areas where a few inches at the surface have been burned, sufficient concentration of mineral elements prevails to insure two or three fair crops. The fire, if uncontrolled, however, may be more detrimental than beneficial, for deep holes may be formed and the surface of the ground lowered to such an extent that the land will no longer be sufficiently drained.

It is well known that frosts frequently occur on marshland when there is none on higher land. This is partly because the cold air which forms on the surface of all ground at night, tends to flow down and collect in low places; but it is also because the loose, spongy soil of peat marshes does not conduct the sun's heat downward, and consequently, the material beneath the surface does not become warmed as in mineral soil. The little heat absorbed by the surface is rapidly lost at night by radiation, so that the freezing point is frequently reached on peat when it would not be on mineral soils.

This difficulty with peat marshes can be overcome somewhat by heavy rolling, which, by compacting the soil, enables it to conduct heat downward more readily. It will also tend to hasten decomposition, causing the peat to take on more quickly the character of muck. Killing frosts may occur on marshland at any given point as early as on upland soil having good air drainage, situated 150 miles farther north. Frost may occur two weeks or more earlier on the marshland regions of Green Lake County than on the

hilltops. This means that corn and potatoes, although safe crops for the upland region, are not safe crops for the marshland.

Chemical Composition and Improvement of Peat

Peat soils are comparatively low in phosphorus, potassium, and sometimes in lime, but high in nitrogen and organic matter. The average phosphorus content of peat in this region, according to analyses, is 0.135 per cent. This means that to a depth of 1 foot, an acre of soil contains approximately 675 pounds of phosphorus.

The deficiency of potassium in this soil is greater than that of phosphorus. It contains an average of 0.3 per cent of potassium, whereas good upland clay loam soils average 2 per cent. The average potassium content in the upper 2 feet of upland soils is approximately 120,000 pounds per acre, whereas peat soils contain only about 3,000 pounds.

The large quantity of organic matter in peat soil increases the supply of nitrogen. This soil averages 2.5 per cent of nitrogen, whereas the upland silt loam soils contain about 0.12 per cent in the 8 inches nearest the surface.

The rational treatment of peat lands requires the use of fertilizers containing phosphorus and potassium. These elements are contained in comparatively small quantities in barnyard manure. Heavy applications of manure will secure good yields of crops on peat, but manure contains much nitrogen which is not needed on the peat. Therefore, when a farm includes upland soils as well as peat, the manure should be used on the upland soils, and commercial fertilizers containing phosphorus and potassium should be used on the peat land.

On deeper peat soil which is in a raw and acid condition, the use of lime in addition to commercial fertilizers may be profitable. On a few marshes the nitrogen in the organic matter does not become available to crops, because of the low soil temperature and the high degree of soil acidity. In such cases a light application of composted stable manure, to inoculate the soil with the proper organisms, is very helpful.

Crops recommended for peat are grasses for hay and

pasture, hardy root crops, rye, and oats. When the land is properly fertilized and limed, clover, alfalfa, and other legumes can be grown. On fairly well drained, decomposed marshland good pasture can be developed, as the compacting of the soil by livestock is very beneficial; and where the pasture is good and other conditions are favorable, certain parts of these marshes can be successfully utilized for dairying or stock raising. When peat land is cultivated, a heavy roller should be used to compact it. Certain special crops, such as cabbage, onions, carrots, buckwheat, and rape, are adapted to properly fertilized and well-drained peat land.[3]

In summarizing the prospects for the future agricultural development of peat land in this county, several conditions obtain with which it is necessary to comply before farming on this land can be permanently successful.

1. It is absolutely necessary that the land be sufficiently drained. Large outlet ditches, although necessary, are not in themselves sufficient, but must be supplemented by open laterals and tile drains.

2. Since this land is generally deficient in potash and phosphorus, these materials must be supplied in proper form and adequate quantities to insure permanent profitable production.

3. It must be recognized that danger from summer frosts makes such crops as corn and potatoes uncertain, and the crops to be grown must be suited not only to the soil, but also to the climatic conditions.

4. Those purchasing peat land for farming purposes must see their way clear not only to pay for the land but also to provide adequate drainage and fertilization, both of which call for further outlay of money.

Peat, Shallow Phase.—Areas of peat where the organic material is less than 18 inches thick are indicated separately on the soil map as peat, shallow phase. This phase of peat is described in the foregoing general discussion of peat soils.

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[3] For a more complete discussion of the management of marsh soils see the following bulletin: Bulletin 392. Fertilizers and Crops in Marsh Soils, 1927.

Rough Stony Land

Rough stony land in Green Lake County includes land which is so stony, rocky, steep, and broken that it can not be cultivated. Some of this land can be used for grazing, but much of it consists of rock outcrop on which but small patches of soil occur. Some of the areas are steep cliffs of outcropping rocks, and other tracts are entirely stones or rock. Some of the land is not very rough, but the rock is so near the surface as to render the land of little agricultural value. On a few areas the rock has a fair covering of soil, but the land is so steep that it is impossible to cultivate it, though it is used for grazing. Soil which occurs on rough stony land ranges from heavy to light in texture, depending upon the nature of the rock.

Limestone, sandstone, and granite are present in rough stony land of this county. The eastern part of the county is generally underlain by limestone and the western part by sandstone. Projecting through these formations are granite, gneiss and other crystalline outcrops in the vicinity of Utley, within the city limits of Berlin, and immediately south of Lake Puckaway.

The only agricultural value of rough stony land is in the little pasturage which it affords. In a few places cultivation is attempted, but it is carried on with difficulty and with unsatisfactory results. Where steep slopes are forested they should be allowed to remain so, and where timber has been removed, reforesting should be considered.

At Utley and Berlin, rock is quarried from the granitic outcrops. At Berlin a very good quality of rock is present, some of which is used for monuments. Building stone, paving stone, curbstone, and some road material are among the products of the quarries.

CHAPTER VI

GENERAL AGRICULTURE OF GREEN LAKE COUNTY

AGRICULTURE

The most common form of agriculture in Green Lake County is general farming, with dairying as its most important feature. In 1919 there were 26,688 cattle in the county. Of these, 22,593 were dairy cattle and the remainder were beef cattle. In 1927 there were 15,900 producing cows in the county and they produced on the average 5,100 pounds of milk each. The total milk production for the county in 1927 was 810,900 Cwt. In 1926 there were 7 cheese factories and 4 butter factories, 2 condenseries and 4 receiving stations in the county. There were produced in the county in 1927, 1,668,789 pounds of butter and 647,926 pounds of cheese. The condenseries used 13,302,780 pounds of milk, and there were delivered to the receiving stations 6,173,728 pounds of milk, in 1927.

A list published by the Wisconsin Livestock Breeders Association showed that in Green Lake County there are 210 breeders of cattle, listed as follows: Holstein breeders, 100; Guernsey breeders, 34; Shorthorn breeders, 40; Brown Swiss breeders, 20; Hereford breeders, 8; Jersey breeders, 4; Red Polled breeders, 4.

Other farmers are raising cattle; in fact, practically every farmer in the county raises some, but comparatively few make a business of raising purebred cattle or high standard grades for breeding purposes. The proportion of purebred livestock is gradually increasing. Raising beef cattle here is not so important an industry as dairying; but many farmers buy steers and fit them for market, and others sell as beef cattle part or all of the cattle they raise.

In 1927 there were 23,700 swine in the county and 9,400 sheep. Poultry numbered 210,000.

The chief crops are hay, oats, corn, rye, wheat, barley,

and potatoes; and the minor crops are peas, beans, sugar beets, hemp, flax, buckwheat, vegetables, and small fruits.

In 1927 there were 24,140 acres of tame hay in the county. Of this acreage 18,070 acres were made up of timothy and clover, and 4,240 acres were alfalfa. There was also 10,450 acres of wild hay cut mostly from the marshes of the county. It may be said that the acreage of alfalfa is gradually increasing.

The production of alfalfa is growing in favor, although it is difficult to obtain a good stand because the soil lacks lime and because of winter killing. The acreage in wild hay and marsh grasses for hay nearly equals the acreage of tame grasses, but this wild hay is coarse and decidedly inferior to clover and alfalfa. Clover and alfalfa grow best on Miami soils, but if lime and fertilizers are used, excellent crops may be raised on all the well-drained soils of the county. Hay is grown on all soils of the county, but does best on the heavier soils.

In 1927 there were 29,470 acres in oats, 29,970 acres in corn, 6,860 acres in barley and 6,580 acres in rye. That same year wheat covered an area of 2,320 acres of which 1,200 acres were winter wheat.

The acreage of potatoes that year was 1,940 acres, flax 1,056 acres, peas for canning 4,140 acres, clover seed 1,060 acres, and dry beans 750 acres.

Hemp grown for fiber is a comparatively new crop. It is shipped to hemp mills at Markesan, Fair Water, and Ripon. Hemp brought large profits immediately following the World War, but with the price of cotton reduced, the price of hemp also declined and the returns were less satisfactory. Hemp requires fertile soil for profitable yields, and at present it is grown mostly on Miami and Carrington silt loams. The erection of a mill for handling hemp is an item of considerable expense, but before the growers in any community can raise hemp on a large scale it is necessary that they should have access to a hemp mill.

It is recognized that different soils are adapted to different kinds of farming. Gravelly loam soils are in some places too rough for growing general farm crops, and farmers realize that such areas are best suited for pasture. It is well known that crops on lowlands are most susceptible

to frost. It is generally conceded that corn grows best on heavy Clyde silt loam, and adapts itself well to all the heavier, dark-colored soils, such as Carrington and Waukesha silt loams. On these dark soils which are high in organic matter, small grains are apt to lodge, and the quality of the grain is not so good as on the light-colored, heavy soils. Peas do best on Miami silt loam and Fox silt loam, and potatoes grow best on sandy and fine sandy loam soils. The sugar content of beets grown on Carrington silt loam, Waukesha silt loam, and Clyde silt loam is lower than that of beets grown on Miami silt loam and Fox silt loam, but the yield is sufficiently high to give better returns. The lighter-textured soils are best for truck crops.

Farm buildings and equipment differ greatly throughout the county. In sections in which occur such soils as Carrington silt loam and Miami silt loam, which include heavy soils, nearly all the farm buildings are large and substantial, and there are many silos. The work animals are draft horses of medium or heavy weight. Modern farm machinery is used, and tractors for plowing and other farm work are common. In sections where the soil is extremely sandy, the buildings, livestock, and machinery are inferior, and where the soils are loamy the farm equipment is of medium grade.

Threshing outfits travel about the country serving the farmers soon after harvest. Several cooperative threshing outfits are owned jointly by groups of farmers, especially where purebred grain is grown to be sold as seed grain.

The tendency throughout Green Lake County is toward better methods of cultivation, fertilization, and seed selection, and as a result, yields are increasing gradually. Where there are sandy soils underlain by sand, spring plowing is preferred to fall plowing. If such soils are covered during fall and early spring with a good growth, loss of plant-food elements by leaching and loss of finer sand particles by severe winds are prevented. Seeding rye in corn rows at the time of last cultivation or in potato fields at digging time prevents much loss of plant-food elements.

When farm work allows, the heavy soils, especially those in sod, are plowed in the fall. It is customary to apply stable manure to land which is to be plowed for corn, but

if the land has been plowed in the fall the manure is often hauled out during the winter and scattered over the plowed surface. When stubble land is plowed in late summer, manure is frequently applied before plowing. Fall plowing aids in conserving moisture, helps to improve the tilth, and where there is no danger from erosion it is a good practice to follow on heavy soils.

Throughout the county most farmers seed their land to grasses at least once every four or five years. The practice of using lime to correct acidity and to prepare land for clover and alfalfa, is becoming more common. Commercial fertilizers are also being introduced and, where properly applied, results are satisfactory.

LIME AND FERTILIZERS

On the prairies the topsoils are acid and the subsoils show some acidity to depths varying from 2 to 3 feet. The light-colored heavy upland soils are usually slightly acid at the surface, but the material of the gravelly layer in the subsoil contains carbonate of lime. The sandy soils are most in need of lime, and the soils least in need of lime are Clyde, Poygan, and Superior soils.

The degree of acidity is variable and each farmer may find a wide variation in soil acidity on his farm. Failure of clover and alfalfa to make a stand is a good indication of the need of lime. Such crops as alfalfa, sweet clover, peas, cabbage, onions, and lettuce have a high lime requirement; clover, garden beans, barley, hemp, turnips, and radishes have a medium lime requirement; and vetch, white clover, oats, rye, bluegrass, potatoes, sorghum, and some others have a low lime requirement. As a rule the heavy soils which are acid need more lime than the sandy ones which show the same degree of acidity.

Ground limestone is doubtless the most economical form of lime for Green Lake County. Lime should be applied before planting the crop which is to be benefited. It should be applied to plowed land and thoroughly worked in by harrowing. Either fall, winter, or spring applications may be made on heavy soils, but on light soils spring applications are preferable. The best way to apply lime is with

a lime spreader, but a manure spreader may be used by putting a thin layer of manure over the bottom of the spreader and then spreading the limestone evenly on top of it. Where several farmers are so situated that they can work together, a lime spreader may be purchased jointly for this purpose.

After making an initial application of 2 tons of ground limestone per acre it is not likely that another application will be needed for about four or six years. Subsequent applications should be determined by the needs of the crops and by acidity tests.

Most acid soils are deficient in available phosphorus, and the need of phosphorus may be so great that lime has little effect until phosphorus is added. In places the application of phosphate alone to an acid soil will result in larger increases in yield than the use of lime alone, and for this reason it is important that both deficiencies should be corrected to obtain the best results.

Ground limestone may be applied at rates ranging from 2,000 to 4,000 or more pounds an acre, whereas 75 to 400 pounds of phosphates and other fertilizers are usually applied for staple crops. A machine for distributing ground limestone should be provided with a double agitator so as to effect continuous feeding. End-gate spreaders which will distribute proper quantities of either fertilizer or ground limestone fairly well are available. When a fertilizer distributer is not available, acid phosphate or other fertilizer may be spread evenly over the load of manure in the manure spreader and distributed fairly well in this manner. The quantity of fertilizer to be spread over each spreader load must be calculated so that the right quantity will be applied to the soil. An old drill or seeder may also be used to distribute fertilizer, the grain drill following the fertilizer drill.

Potash fertilizers are often needed on low ground and on sandy soils.

Use of farm manure: The care and use of the manure produced is an important factor in the management of livestock farms. The principal advantage of farming with livestock is that the manure produced may be used to maintain profitable yields, so that comparatively little fertilizer

need be purchased. Much of the crop nutrients in manure is readily soluble in water, so that if the manure is exposed to much rain a considerable part of its soluble material is lost. It is important also to remember that a large part of the nutrient elements is in the liquid part of the manure, making it necessary to use bedding or other absorbents freely to prevent a considerable loss of the fertilizer value of the manure. This is particularly true of potassium, about 60 per cent of which is contained in the liquid part.

Ordinarily the best practice is to haul the manure directly to the fields. When manure must be kept in a pile for a time, the pile should be kept compact and moist. In this climate the use of shelter for manure is of doubtful importance, though where more rains occur, particularly in the winter, a shed roof is very helpful to conserve manure.

The rate and frequency with which manure is applied depends in part on the character of the soil. On lighter soils, frequent applications of small quantities prove most effective. An application of 5 or 6 loads an acre once in three years is desirable on the sandy loams, whereas from 8 to 12 or more loads once in four or five years may be used to advantage on the heavier soils.

Crop Rotations

Owing to the great variety of soils in Green Lake County, many kinds of crops may be grown to advantage. The kind of crop or of rotation to be followed on the sandy lands will not be suited to the black prairie lands or to the clay lands, and the system of farming followed on the marshlands will not give best results on the uplands.

It is generally recognized that it is advisable to follow a definite crop rotation, or at least to diversify crops, rather than to have the same crop growing on a certain field year after year. It seems to be easier to maintain fertility through diversification of crops than by practicing a one-crop system of farming.

Crop rotation helps to keep down weeds, aids in controlling plant diseases, serves to check insect pests, and helps to maintain soil fertility. A good system of cropping increases the humus supply in the soil, and also aids in the distribution of farm labor, rendering it more effective.

Among the factors which determine the kind of rotation to practice are (1) the type of soil, (2) the kind and acreage of crops a farmer wishes to grow, (3) the surface features of the land, and (4) soil fertility.

The following rotation is probably the best for most sandy soils: First year, clover with perhaps a light seeding of rye; second year, clover for hay, leaving the second crop to be turned under either in fall or spring; third year, corn or potatoes; fourth year, soy beans, which may be used for seed, for hay, and for green manure.

The following rotations are suggested for heavy soils: Five-year rotations—corn, small grain (with clover), clover, wheat (with clover), and clover. Four-year rotations—wheat, corn, oats (with clover), and clover; or corn, corn, oats (with clover), and clover. Three-year rotation—corn, oats (with clover), and clover.

It seems unnecessary to add organic matter to peat soil which in itself is practically all organic matter, yet it is recognized as a good practice, especially where potatoes, cabbage, sugar beets, and onions are grown. The use of proper fertilizers, combined with a corn rotation containing clover, or clover and timothy, is advisable. On farms consisting entirely of marshland it is as important to grow alfalfa and clover as it is on upland soils. With the use of a legume or hay crop in the rotation some small grain such as rye or oats must necessarily be grown, but they are considered less desirable crops for this kind of soil because of their tendency to lodge. If corn or some other cultivated crop is raised the first three years and the soil is treated with the proper mineral fertilizers during that time, small grain may be grown very successfully, provided less seed be sown than on upland soil. If the grain crop is too rank it would be well to cut it for hay in order to have the grass or clover seeding.

If a farmer has 30 acres of peat and desires to grow cabbage and sugar beets as cash crops, it is a good plan to divide the field into four strips and crop them to sugar beets, cabbage, grain, and hay, so that a four-year rotation of hay, sugar beets, cabbage, and grain, would be practiced on each strip. On a dairy farm, two or three corn crops may be grown in succession, to be followed by small grain, and then

seeded to alsike clover and timothy. The hay may be cut the first year and pastured the second. The rotation best suited to any peat marsh can best be determined by the conditions existing on that particular farm.

A three-year rotation is popular on many of the dairy farms. It consists of grain seeded to clover, and the clover followed by corn or some other cultivated crop. Much the larger part of the corn in this region is put into the silo to be fed to dairy animals, and the clover is cured for hay and fed to livestock. It is often possible to get two crops of medium red clover in one season, the second of which may be cut for hay, or may be pastured. This three-year rotation may be lengthened into a four-year rotation by the addition of timothy, so that hay may be cut two years instead of one year, or the land may be pastured the second year instead of cutting the timothy for hay.

Potato raising, when properly managed, is profitable. Although good crops may be grown on heavy soils, the sandy loams are especially well adapted to potato production. For best results, this crop should be grown in rotation with other crops, and should always follow a legume of some kind. Potatoes should not follow corn, and corn should not follow potatoes, as both crops draw heavily on the plant-food elements of the soil. In the rotations described, potatoes may be planted as one of the cultivated crops. It is better to apply manure to the clover crop rather than to potatoes, because potato scab is more common where potatoes are planted on freshly manured land. The three-year rotation just described is excellent for sections where potatoes are grown extensively, the potatoes taking the place of corn. As a rule, cropping to potatoes more frequently than once in three years is not recommended.

As indicated elsewhere, hemp growing is important in this county. Regarding the best crops to grow in rotation with hemp, the following may be said: Hemp* should not follow timothy meadow, bluegrass sod, nor pasture. Neither should hemp follow any small-grain crop, unless the soil is very well supplied with manure.

Hemp leaves the soil in excellent physical condition for

* See bulletin of the Wis. Exp. Sta. for more information on hemp growing.

any spring-sown small grain. It also leaves the land comparatively free from weeds, and consequently it is a good crop to precede sugar beets or canning peas, for these crops especially require a clean seed bed. The following rotations have given good results in growing hemp:

Four-year rotation — small-grain crop (seeded with clover); clover for hay and pasture (manured and fall plowed); corn, potatoes, or similar crop; and hemp (then back to small grain and clover). In this rotation many growers sow timothy with the clover. There is no objection to this if the land is not left in sod for more than a year.

Three-year rotation—small-grain crop (seeded to clover); clover (manured and fall plowed); hemp (then back to small grain and clover). In this rotation considerable attention should be given to using well-pulverized manure and to spreading it evenly. The clover sod should be worked thoroughly in the spring to insure a compact, smooth seed bed.

LIVESTOCK AND DAIRY STATISTICS

GREEN LAKE COUNTY

All cattle	25,100		1927
Producing cows	15,900		1927
Production per cow	5,100	lbs.	1927
Milk production	810,900	cwt.	1927
Creamery butter	1,668,789	lbs.	1927
Cheese	647,926	lbs.	1927
Condensed milk	13,302,780	lbs.	1927
Delivered to receiving sta. (milk)	6,173,728	lbs.	1925
Swine	23,700		1927
Sheep	9,400		1927
Horses and mules	5,600		1927
Poultry	210,000		
Cheese factories	7		1926
Butter factories	4		1926
Condenseries	2		1926
Receiving stations	4		1926

CLIMATE[1]

Practically all of Green Lake County lies within the Fox River drainage basin and forms part of the Fox and Wolf River Basin which is one of the eight climatic provinces in

[1] For more information on climate and its relation to agriculture see the following bulletin, on which this chapter is based: Whitson, A. R., and Baker, O. E. The Climate of Wisconsin and Its Relation to Agriculture. Wis. Agr. Expt. Sta. Bul. 223, 65 p., illus. 1912.

Wisconsin. The climate of this basin is influenced somewhat by lakes, but it possesses more of the characteristics of a land climate. The winters at Green Bay, Appleton, Pine River, Oshkosh, and Fond du Lac, with a mean temperature averaging 18.7 degrees F., are as warm as those at Dodgeville or Lancaster; and spring and summer are as

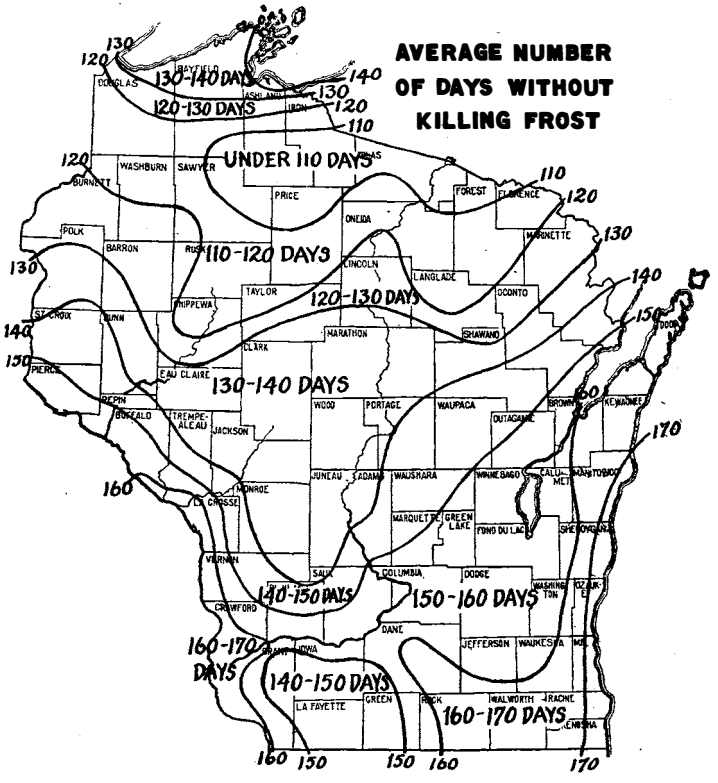

Fig. 2. Sketch map showing average number of days without killing frost.

cool as the average at Eau Claire and Osceola. The frost-free season which varies from 130 to 150 days, shows land influence, lasting about the same length of time as the frost-free season in Richland, Buffalo, and St. Croix Counties.

The mean annual temperature for Green Lake County is 44.9 degrees F. as recorded at the nearest Weather Bureau station at Grand River Locks in Marquette County. The maximum recorded temperature is 103 degrees and the

minimum—40 degrees. The average rainfall is 33.26 inches, which under normal conditions is well distributed throughout the growing season. April, May, June, July, August, and September, during which the crops make most of their growth and are most in need of a good supply of moisture, average 3.86 inches of rainfall. Although the range in temperature is wide, the extremely low and extremely high readings recorded are rare and the periods are of short duration. The winters are severe with an average snowfall of 43.1 inches. The winds are usually from the northwest.

The average date of the last killing frost in spring is May 5, and of the first in the fall, September 30, giving an average frost-free season of 147 days. The latest recorded frost in the spring occurred on May 23, and the earliest recorded frost in the fall on September 10.

The climatic conditions are representative of a large section in the east-central and central parts of the State, where agriculture is highly developed on all of the best soils and where extremes of climate do not prevent the growing of any general farm crops. Excellent water for household purposes and for stock is available throughout the county. This fact, together with healthful climatic conditions, a long growing season, and large areas of rich, productive soil, helps to make Green Lake County one of the desirable agricultural communities of Wisconsin.

The following table compiled from the records of the Weather Bureau station at Grand River Locks, Marquette County, gives the more important climatic data representative of this county:

NORMAL MONTHLY, SEASONAL, AND ANNUAL TEMPERATURE AND PRECIPITATION AT GRAND RIVER LOCKS, MARQUETTE COUNTY

(Elevation, 768 feet)

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1923)	Total amount for the wettest year (1906)	Snow, average depth
	°F	°F	°F	Inches	Inches	Inches	Inches
December	21.4	57	—24	1.20	1.61	2.22	10.1
January	14.5	48	—33	1.15	.79	3.11	11.4
February	17.6	53	—40	1.03	.76	1.40	9.0
Winter	17.8	57	—40	3.38	3.16	6.73	30.5
March	31.9	82	—26	1.87	1.79	2.59	5.2
April	45.8	85	14	2.58	2.74	1.35	2.6
May	56.8	91	26	4.69	1.27	4.62	.5
Spring	44.8	91	—26	9.14	5.80	8.56	8.3
June	66.4	99	34	4.33	2.02	9.47	.0
July	71.0	103	37	3.76	2.61	2.97	.0
August	68.2	98	31	3.77	1.28	6.30	.0
Summer	68.5	103	31	11.86	5.91	18.74	.0
September	61.0	98	23	4.05	3.78	4.15	.0
October	48.8	84	11	2.87	1.73	5.25	.9
November	35.7	72	—10	1.96	.80	4.07	3.4
Fall	48.5	98	—10	8.88	6.31	13.47	4.3
Year	44.9	103	—40	33.26	21.18	47.50	43.1

SUMMARY

Green Lake County is slightly southeast of the geographical center of Wisconsin. It has an area of 360 square miles, or 230,400 acres. The county is almost entirely within the Fox River drainage basin.

Most of the land is gently rolling, comprising level river terraces, flat marshland, gently rolling prairies, and some rolling and gently rolling clay lands and sandy loams. There is very little land too steep for cultivation.

The first settlement was made between 1830 and 1835, and the county was organized in 1858 from territory which was previously a part of Marquette County. The population in 1920 was 14,875. Green Lake is the county seat, and had a population of 456 in 1920. Berlin, with a population of 4,356, is the largest city.

Most of the county is well supplied with railroad facilities, but a few places are 9 miles by wagon road from a shipping station.

The eastern part of the county contains some of the finest prairie land in the State, but the western part contains large areas of sandy and marshy lands. The agricultural development on these different soils is markedly different, and there is a wide range in soil conditions and agricultural practices within the limits of this small county.

The soil-forming materials of Green Lake County originated from calcareous glacial drift, sandy glacial drift, water-laid materials, and from accumulated vegetable matter in varying stages of decomposition. The 31 soil types mapped are grouped into 12 series, not including peat and rough stony land.

The various soils are described in detail and their agricultural values are discussed. Some suggestions are offered for the improvement of these soils.