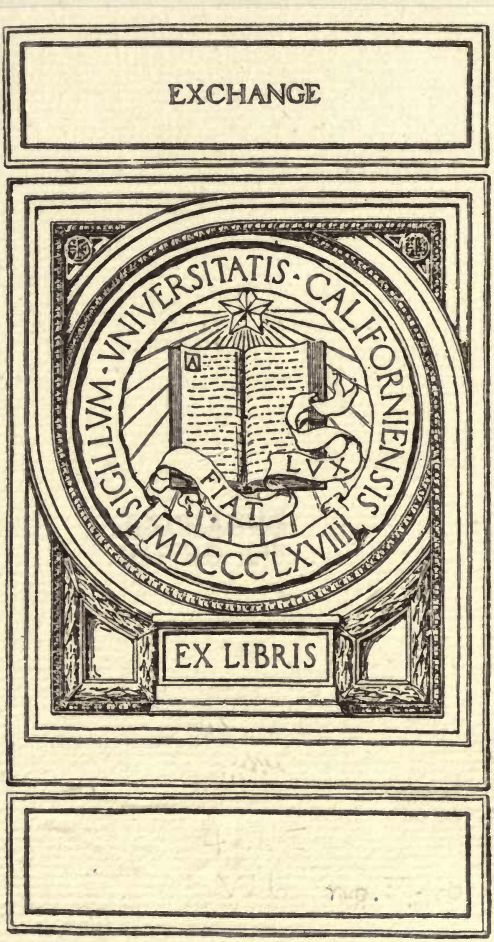

KEEP THE MAP.

The Experiment Station will publish bulletins from time to time dealing with the management of the different types mapped, so that some way should be found by each person receiving a copy of this report to keep the map permanently. If the map is folded in such a way as to have the part you are interested in of a convenient size, and then have a simple frame with glass made to hold it, it can be kept indefinitely. Since some of the colors fade after being exposed to strong light for a long time, it would be a good plan to have a protecting flap of dark cloth over the map when not in use.

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

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A. R. WHITSON, In Charge, Division of Soils.

SOIL SURVEY IN COOPERATION WITH THE COLLEGE OF AGRICULTURE,
H. L. RUSSELL, DEAN.

BULLETIN NO XL SOIL SERIES NO. 10

SOIL SURVEY

OF

LA CROSSE COUNTY

WISCONSIN

BY

A. R. WHITSON, W. J. GEIB, AND T. J. DUNNEWALD,

OF THE

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

AND

CLARENCE LOUNSBURY,

OF THE

UNITED STATES DEPARTMENT OF AGRICULTURE

SURVEY CONDUCTED IN COOPERATION WITH THE UNITED STATES
DEPARTMENT OF AGRICULTURE, BUREAU OF SOILS,
MILTON WHITNEY, CHIEF.
CURTIS F. MARBUT, IN CHARGE, SOIL SURVEY

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INTRODUCTION

Before the greatest success in agriculture can be reached, it is necessary that the farmer should have a thorough knowledge of the soil upon his own farm. A soil may be well adapted to one crop, and poorly adapted to another crop. Clover will produce a vigorous growth and profitable yields on the average loam soil which contains lime and is in a sweet condition; but on a sandy soil which is sour, or in an acid condition, clover will not make a satisfactory growth. We may say, therefore, that failure is certain to be invited when such important facts are disregarded, or overlooked. The degree of success which it is possible to win on any farm is in direct proportion to the practical knowledge possessed by the farmer concerning the soil and its adaptation to crops. A thorough knowledge of the soil is as essential to the farmer as a knowledge of merchandise and business methods is to the merchant.

The State of Wisconsin, working in coöperation with the United States Department of Agriculture, is making a careful study of soils and agricultural conditions throughout Wisconsin, and is preparing soil maps and soil reports of all counties in the State. A soil map shows the location and extent of the different kinds of soil. Tracts of 10 acres and over are mapped, but often areas of even smaller extent are shown. The soil map is prepared by trained men, who go over a county thoroughly, and examine the soil by making a sufficient number of borings to a depth of 36 inches to keep account of all variations. A report is also made, to accompany and explain the map, and this is based upon a careful study of the soils within the region surveyed, and upon such other features as have a direct bearing upon the agriculture of the area.

It is the object of this survey to make an inventory of the soils of the State, and to be of practical help to farmers by locating and describing the different soils, by determining their physical character and chemical composition, and by offering suggestions for their management, based upon the work of the Soil Survey within the area, covered in the report, and upon the results of field tests made by the Experiment Station.

Soil fertility depends upon two factors: first, upon the physical characteristics of the soil, such as water holding capacity, workability, etc., and second, upon the chemical composition of the material composing the soil. The chemical composition depends upon the mode of origin of the soil, and the source of material from which the soil is derived.

Water holding capacity, and other physical properties of soil all depend chiefly upon *texture,* which refers to the size of the individual soil grains, or particles. A coarse sandy soil, for example, will not retain moisture so long as a loam soil, or clay loam, because the finer the soil grains, the greater will be the total soil-grain surface area to which moisture may adhere. Texture is determined in the field by rubbing the soil between the thumb and fingers, and with experience one soon becomes expert at judging the size of soil grains. This field judgment is verified in the laboratory by a *mechanical analysis,* which is made by a simple method of separating soil grains into different groups, of which there are seven. These are known as clay, silt, very fine sand, fine sand, medium sand, coarse sand, and fine gravel.

A chemical analysis is also made of the soil to determine the amounts of various essential plant-food elements which are present. A chemical analysis shows whether the soil contains a large store of plant food, or only a small quantity, and it indicates which kinds of plant food will probably be needed first. The amount of organic matter in the soil is also determined, and tests are made to show conditions relative to soil acidity.

SOIL CLASSIFICATION.

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.

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 25% 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.

Soils may be grouped in another way. 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 graduation 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 sand and gravel. The Plainfield series includes light colored soils in regions where no limestone is present, and where the material occurs as outwash plains or stream terraces. The soils in this series also have a wide range in texture. The name used for a soil series usually indicates the locality where that particular series was first recognized and mapped by the Soil Survey.

By uniting the name of the *soil class,* which refers to texture, with the name of the *soil series,* which refers chiefly to origin, we get the *soil type,* which is the basis or unit of classifying and mapping soils. A *soil type,* thus, is a soil which is 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 LA CROSSE COUNTY, WISCONSIN.

CHAPTER I.

GENERAL DESCRIPTION OF THE AREA.

La Crosse County is located in west-central Wisconsin and has an area of approximately 481 square miles, or 307,840 acres. It is bounded on the north by Trempealeau, Jackson, and Monroe Counties, the greater part of the Trempealeau County boundary being formed by the Black River; on the east by Monroe County; on the south by Vernon County; and on the west by the Mississippi River. Since the western and a part of the northern boundaries are formed by streams, the county is somewhat irregular in shape.

The topography of La Crosse County consists of a thoroughly dissected plain, and from a geological standpoint it has reached an early mature stage of development. The surface of the area naturally falls into two broad divisions—the valleys and the uplands. The most prominent topographic feature is the line of bluffs extending across the area from north to south, and having an average elevation above the Mississippi River of about 500 feet. To the west of these bluffs lies the Valley of the Mississippi. At La Crosse the floor of this valley has an elevation above sea level of 681 feet. Fully one half of the valley lies within the present flood plain, while the remainder is occupied by two and sometimes three distinct terraces ranging from 20 to 70 feet in elevation above the river. The highest of these terraces is rolling owing to the action of the wind on the light sandy soil, while the lower terraces are level or only gently

undulating. To the east from this main line of bluffs the surface consists of a series of ridges varying in elevation from 200 to 500 feet above the streams which traverse the region. Practically all of the larger ridges rise to about the same elevation above sea level, and form the remnants of the original upland plain. The area of the original upland surface, however, is quite limited and is confined to the main water shed ridges, with long narrow arms extending into subordinate water sheds, often advancing to within a short distance of the main streams. Between these narrow remnants of the original surface lie broad, rolling basins, and along the axial belt of these basins lie the valley of the streams whose erosion has shaped them. From these valleys the country rises in rounded swells, gently at first, but becoming steeper at their boundaries until it ends abruptly at the foot of the steep slope marking the edge of the initial surface block.

The tops of the ridges which are undulating to gently rolling, and the more gentle slopes of the rolling basins, constitute the most extensive, highly improved class of farming land in the county. Along the streams traversing the upland region alluvial bottoms and terraces are often found. These valleys are referred to locally as "coulees" and in these the land is usually well improved and highly productive. The surface of the valleys is level to undulating with a gentle slope from the stream to the rough, broken land of the valley walls.

With the exception of the flood plains of the largest streams, the county as a whole is naturally well drained. The Black River, which forms the northwestern boundary for about 15 miles, receives the waters from Fleming Creek and a number of smaller streams which drain the northern part of the county. The La Crosse River traverses the county from east to west and receives the waters from Burns, Dutch, Fish, and Bostwick Creeks, and a number of other streams, draining the central and eastern parts of the county. Mormon Creek drains the southern and Coon Creek the southeastern sections. All of these streams empty into the Mississippi River.

La Crosse County was formed in 1851, and its present limits were established in 1857. It was formerly a part of Crawford

County. Farming operations were started in 1844 at a point under the bluffs between Mormon and State Road Coulées,[1] though traders had been operating throughout this section of the country for a number of years previously. In 1848 a company of Mormons settled in Mormon Coulée, and settlement began in the upland portion of the county between 1850 and 1855. Most of the early settlers were Americans, who came from the Eastern States. The county is now well settled, and the population, which in 1910 numbered 42,850, is quite evenly distributed.

La Crosse, with a population of 31,000, is the county seat and the largest city in the county and constitutes an important railroad and industrial center. It is situated on the Mississippi at the mouth of the La Crosse River, in the western part of the county. Onalaska, West Salem, Bangor, and Midway are smaller railroad towns.

While there are three important railroad lines in the county, the upland country is so rough that the roadbeds have followed the valleys of the Mississippi and La Crosse Rivers, and as a result some parts of the county are not conveniently accessible to the railroads.

The Mississippi River affords a water route for shipping, and while not extensively utilized at present, the possibilities of its use account for lower freight rates than could be secured if there were no water connections.

The main dirt roads throughout the upland portion of the county are usually kept in good condition, as the predominating soil material naturally makes a good roadbed, but hills are numerous and the grades are often steep, so that heavy hauling is difficult. Some of the main roads in the valley leading into La Crosse are crowned with crushed rock and are kept in excellent condition. Throughout the sandy portion of the county, where foreign material has not been applied, the roads are naturally sandy. All parts of the county are supplied with rural free-delivery service and telephones are common. La Crosse and the smaller towns within the county afford a market for large quantities of farm produce. Minneapolis is but 137 miles and Chi-

cago 283 miles from La Crosse, with excellent train service over two lines to St. Paul and Minneapolis and over three lines to Chicago.

SOILS.

La Crosse County lies within the unglaciated portion of Wisconsin and in its geological formation, soil conditions, and topography it is representative of a very large area in the southwestern part of the State. The topography throughout this region is comparatively old and was well developed before the materials constituting the majority of the present soils were laid down.

Throughout the greater part of the county, the uppermost rock consists of the lower Magnesian limestone. This occurs on the tops of the hills and ridges throughout the upland. The formation is thinner, shows more erosion, and is less continuous in the northern than in the southern part of the county. It outcrops along the upper slopes and forms a large part of the Rough stony land type. Directly under this formation lies the Potsdam sandstone, which outcrops on many of the lower slopes and forms the uppermost rock over a large area in the northern part of the county, where the limestone formation has been eroded. The outcrops of this rock also form a small part of the Rough stony land type.

The surface material from which the soils of La Crosse County have been derived, has been classified by the Soil Survey into 5 soil series and 16 soil types.*

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* The steep phase of the Knox silt loam as described in this report includes what was originally mapped by the Bureau of Soils as Knox silt loam, rolling phase.

The Knox fine sand as described by the Bureau of Soils has been included with Boone fine sand.

The Waukesha silt loam described in this report includes what was mapped by the Bureau of Soils as La Crosse silt loam, and Sioux silt loam.

The Waukesha fine sandy loam includes what was originally mapped as La Crosse fine sandy loam, and Sioux fine sandy loam.

The Waukesha sandy loam includes what was originally mapped as La Crosse sandy loam.

The Waukesha gravelly sandy loam includes what was previously mapped by the Bureau of Soils as Sioux gravelly sandy loam.

Plainfield sand includes what was originally mapped as Sioux sand.

The surface of nearly all of the upland is covered to a depth of 10 feet or more with a mantle of silty material, the greater part of which is much like loess. It is extremely silty at the surface, the clay content gradually increasing with depth, and in cuts a laminated structure is often observed. At one time the entire area seems to have been covered with this material, which has been removed by erosion in places, especially where the deposit was thin, as appears to have been the case in the northern part of the county. The soil derived from this material, which is the most extensively developed in the county, has been classified as Knox silt loam, and Knox silt loam, steep phase.

The Waukesha series includes the dark colored terrace soils which occur within the valleys of the streams which border or traverse the area. These terraces are all above the present flood plain and the heavy member of the series includes some of the finest agricultural land in the county. The types mapped as belonging to this series are the Waukesha silt loam, fine sandy loam, sandy loam, and gravelly sandy loam.

On many of the lower slopes the Potsdam sandstone outcrops from beneath the lower Magnesian limestone. In the northern part of the county the limestone has been entirely removed over a considerable area, and where the sandstone is thus exposed it has disintegrated and weathered into a sandy material from which the Boone series of soils is derived. Two types, the Boone fine sand and the Boone fine sandy loam, have been recognized and mapped as belonging to this series.

Narrow strips of bottom land, some of which are above the present flood plain, occur along the smaller streams of the county, especially throughout the uplands. The soil material is dark in color and gives rise to two types in the Wabash series, the loam and the silt loam.

Along the La Crosse River there are limited areas of sand within the present flood plain which are being reworked somewhat by floods. This material has been classed as Riverwash.

There are large areas along the Mississippi and Black Rivers and smaller patches along the La Crosse River which are subject to periodical overflow and in which the soil material is so mixed that a division into types would be impossible. The land

is too wet to be cultivated, except in a few places, and can not be reclaimed except by expensive diking. These areas have been classed as Meadow.

A few low-lying areas occur, in which the soil material consists of vegetable matter in varying stages of decomposition. These have been mapped with one color as Peat.

The material occupying the steep, rocky slopes of the upland, where the slope is too steep to be cultivated or too stony or rocky to have any agricultural value, has been classified as Rough, stony land, and is considered as non-agricultural land.

The following table gives the actual and relative extent of the various soil types mapped:

Area of different soils.

Soil.	Acres.	Per cent.
Knox silt loam	66,605	44.0
Steep phase	69,200	
Rough stony land	31,936	10.4
Meadow	31,360	10.2
Waukesha silt loam	20,031	
Coarse phase	4,160	7.9
Heavy phase	384	
Boone fine sand	16,192	5.2
Wabash loam	14,464	4.7
Boone fine sandy loam	14,400	4.7
Wabash silt loam	14,272	4.6
Plainfield sand	14,144	4.6
Waukesha fine sandy loam	7,616	2.5
Plainfield sandy loam	2,624	.9
Peat	2,176	.7
Waukesha sandy loam	1,856	.6
Riverwash	960	.3
Waukesha gravelly sandy loam	256	.1
Total	307,840	

CHAPTER II.

LIGHT COLORED UPLAND SOILS.

KNOX SILT LOAM.

Description.—The surface soil of Knox silt loam consists of a grayish-brown, friable silt loam, extending to an average depth of 10 inches. When dry it has a floury feel. It is low in organic matter, which in part accounts for its light color. The subsoil is a yellowish-brown silt loam, heavier than the surface soil, in which the clay content gradually increases, until at a depth of 16 to 24 inches the material becomes a silty clay loam. The subsoil has a compact structure and extends to an average depth of 12 feet, though in many places it is considerably deeper than this, while in others it is much shallower. Both soil and subsoil are free from stones, gravel, or other coarse material. On account of the heavy subsoil and the uniformly silty character of the soil, the type is commonly referred to throughout the area as a clay.

On account of its texture, structure, heavy subsoil, freedom from stones, and its low content of organic matter it is especially subject to severe erosion where the slopes are steep. Because of this condition, and the resulting differences in agricultural value, the portions of the type which are sufficiently steep to make special methods of cultivation and cropping necessary, have been separated from the typical soil and indicated on the soil map as the Knox silt loam, steep phase. A detailed description of the steep phase follows the description of the typical soil.

Extent and distribution.—Knox silt loam is the most important type in the county and is confined to the upland portion of the area. It is well distributed throughout the survey outside of the valleys of the Mississippi and La Crosse Rivers. The larg-

est, unbroken tracts occur in the southern half of the county where the ridges are broader than elsewhere, frequently reaching a width of one mile. In the northern portion of the survey the steep phase is much more extensive than the typical soil. The ridges on which the typical soil occurs here are irregular, and narrow, seldom being more than ½ mile in width. While the type usually occurs on the tops of ridges, it is sometimes also found along the lower slopes with a strip of Rough stony land or some of the steep phase intervening.

Topography and drainage.—The surface of the typical soil as it occurs on the tops of ridges varies from nearly level to undulating or gently rolling and even rolling in places. On some of the broad ridge tops where the surface is nearly level the natural drainage is deficient over small tracts, and tile drains could be used to advantage in such places. By far the greater proportion of the type, however, has very good natural drainage. Along the margin of the ridges where the typical soil grades off into the steep phase, and also over the most uneven portions of the type, there is some danger from erosion and while this is not so serious as on the steep phase, it must be considered as a factor in the management of the soil. On the lower slopes where the typical soil is sometimes found, deep ditches have frequently been cut by rushing water from the higher steep land. This converges at various points, and during heavy rains considerable damage may be done in a few minutes to fields on the lower slopes, if drainage channels have not been provided.

Origin.—The material forming Knox silt loam has many of the characteristics of loess and is usually considered as being of loessial origin. There seems to be no doubt but that a considerable proportion of the material was deposited by wind action, but in a number of places where the elevation ranges from 1,100 to 1,350 feet above sea level and where Lower Magnesian limestone forms the underlying rock it is quite apparent that the lower portion of the soil section at least is residual from this rock, and consists of brown or reddish-brown clay. In other places below these elevations it appears that the soil may have been derived in part from the weathering and decomposition of

VIEW SHOWING CHARACTERISTIC TOPOGRAPHY OF KNOX SILT LOAM.

This type occupies over 42 per cent of La Crosse County and is the most extensive and important soil in the area. It is well adapted to general farming and dairying.

a shaly phase of the Potsdam sandstone. The soil differs slightly from the typical Knox silt loam in Iowa, Illinois, and Missouri by having a heavier subsoil and a somewhat darker color with less yellow than is found in the states named. Litmus paper tests in the field indicate that the surface soil is slightly acid, and this condition is verified by acidity tests made in the laboratory.

Native vegetation.—The type was originally covered with hardwood timber consisting chiefly of bur and black oak, elm, maple, hickory and butternut. Practically all of the timber has been removed except on some of the more rolling places, but even here the timber left standing has but little value save for fuel.

*Present agricultural development.**—The crops commonly grown on this type are corn, oats, barley, wheat, clover, and timothy. Corn yields on the average from 35 to 40 bushels per acre, and as high as 60 bushels have been secured. The yield of oats varies from 25 to 50 bushels per acre. Wheat was at one time the leading crop, but at present only a comparatively small acreage is grown each year. It averages 25 bushels per acre, and yields of 30 to 35 bushels are not uncommon. Hay yields from 1 to 1½ tons per acre. Sometimes there is difficulty in getting a stand of red clover because of winter freezing. In such places it is usually possible to get a catch of alsike clover. Alfalfa is not grown to any extent. Potatoes are grown chiefly for home use, though near La Crosse some are grown for market. If the ground is carefully prepared and the crop properly cultivated yields of 200 bushels per acre can be secured. This, however, is somewhat above the average for the type.

Some tobacco is grown in the southeastern part of the county on the Knox silt loam adjoining the Viroqua tobacco district, but the crop is not receiving the attention it did in former years. Cucumbers, melons, peas, beans, strawberries, etc., are grown in a small way as garden crops, and small quantities are marketed, but the trucking industry has not been developed to any extent on the Knox silt loam. Apples and berries are grown for home use.

The most extensively followed rotation on this type is as follows: Corn for one or two years, followed by oats or barley

* For chemical composition and improvement of this soil see page 23.

one year; then rye or wheat for one year, followed by clover and timothy for two or three years; after which the land is again planted to corn. It is recognized that the Knox silt loam is better adapted to small grains than to corn. The yield of both the small grains and corn are somewhat lower than on the Wabash, and Waukesha silt loams, but the quality of the grain is better.

Dairying is the chief type of farming followed on this soil, and hog raising is also an important industry. The crops grown are generally selected with the idea of supporting these industries. The manure secured from the stock is usually applied to the corn crop, and no commercial fertilizers are in common use.

In order to obtain the best results with this soil, it should be tilled only under proper moisture conditions. If handled when too wet it is likely to puddle, and some difficulty may be experienced in pulverizing the clods which subsequently form. Where the clay is near the surface on the tops of narrow ridges and on some of the steep slopes cultivation is more difficult than on the tops of the broad ridges, where the silty covering is deeper. If the type is cultivated under the most favorable moisture conditions a good seed bed can be secured with but little difficulty. Because of the low organic-matter content the type is less loamy than some of the other silt loams, especially the Wabash, and a little more difficult to handle.

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

Mechanical analyses of Knox silt loam.

Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Soil	0.1	0.6	0.5	1.2	5.3	80.8	11.6
Subsoil	.0	.1	.1	.6	5.4	72.2	21.4

KNOX SILT LOAM, STEEP PHASE.

Description.—In general physical character and appearance of the soil this phase is essentially like the typical soil. It is as a whole somewhat lighter in color, and a little lighter in texture. Its principal variation from the type is in its topography. Because of this its agricultural use and possibilities are not the same in all respects as the type, and it is subject to a wider range in variation than the typical soil. On many of the steep slopes the surface soil has been removed by erosion and the heavy subsoil exposed. Along the lower slopes there has frequently been an accumulation of wash from the higher land, and in such places the surface soil is much deeper than typical.

Extent and distribution.—The steep phase is somewhat more extensive than the typical soil. In the northern part of the county north of the La Crosse River it is the predominating type, and is well distributed throughout the upland section. The typical soil here occurs as narrow ridge tops which form the remnants of the original elevated plain. In many places erosion has advanced to such a stage that the elevated plain-like surface has been dissected so that all of the soil falls into the steep phase. To the south of the La Crosse River the steep phase is much more limited in extent, and is usually confined below the upland plateau level. The ridges in this section are broad, and more numerous than in the northern part of the county. The areas of the steep phase are therefore broken up into smaller tracts, and the phase is of considerable less extent than the typical soil.

Topography and drainage.—The topography of the steep phase is much more uneven than is that of the typical soil, and consists of areas which are hilly, steep or broken. The surface is always sufficiently steep so that there is serious danger of damage being done by erosion, and because of the character of the surface cultivated crops cannot be successfully grown except by following special methods to prevent erosion. Owing to the uneven surface features the natural drainage of the steep phase is good. Occasionally, on slopes where springs originate from the Potsdam sandstone, there may be small areas of wet

land. The greater proportion of the land is so steep that too large a percentage of the rainfall runs off, so that crops often suffer from lack of moisture. The rapid escape of the water frequently cuts deep ravines on the steep slopes, especially where the surface is not protected by a forest growth or by some crop which thoroughly covers and protects the soil.

Origin.—The steep phase has practically the same origin as the typical soil, except that there is a smaller proportion underlain by residual material from limestone. Most of the phase is underlain by Potsdam sandstone and it has doubtless been derived in part from the weathering and decomposition of a shaly phase of this formation. The soil has the texture and structure of loess, however, and it is probable that much of it was deposited by the action of the wind. Litmus paper tests in the field indicate that this soil is slightly acid, but as a whole the phase does not appear to be quite as strongly acid as the typical soil.

Native vegetation.—The original timber growth consisted chiefly of oak, hickory, maple, elm and some butternut. A considerable proportion of this soil has been cleared, and practically all of the best merchantable timber has been removed. There is more timber on this soil at present, however, than on any of the other types with the exception of Meadow. Where the slopes are very steep no attempt has been made to clear the land. Where most of the timber has been removed a second growth of hazel brush, popple, etc., often springs up.

Present agricultural development.—The steepest areas of this soil are used for pasture and woodlots. The remainder of the area is in cultivation. The crops grown on the steep phase are the same as on the typical soil, but the proportions differ somewhat. There is a much smaller percentage of intertilled crops, and a large proportion of grazing land. There is also a smaller proportion of small grain, but as a crop of grain protects the soil from washing more than corn, the acreage in grains is greater than that devoted to corn. The yields secured are slightly lower than those received on the typical soil, and all farming operations are more difficult, so that it costs more to produce a bushel of corn, oats or barley on the steep phase than it does on the typical soil. Dairying is the leading branch of

farming followed, and the phase is well adapted to this industry as it supplies a large amount of good grazing.

Were it not for the uneven surface the soil would be no more difficult to cultivate than typical Knox silt loam. As it is, however, special care must be taken in plowing and also in the after cultivation to prevent erosion. Plowing is usually done with the contour of the hill, and sodded strips are sometimes left to check the flow of water down the slope where the surface is steep enough to require it. In some cases the paths of the drainage water down the slope may be left in sod, and cultivaction may then be carried on between these shallow sod ditches. In the majority of cases, however, not enough attention is given to selecting the methods of cultivation and cropping best adapted to this class of land, and as a result more or less damage results each year from erosion. The methods of cropping and cultivation best adapted to this class of land are discussed on the following pages.

CHEMICAL COMPOSITION AND IMPROVEMENT OF KNOX SILT LOAM.

Chemical analyses of Knox silt loam indicate that it contains, on the average, about 900 pounds of phosphorus in the surface 8 inches of an acre, about 35,000 pounds of potassium, and 2,700 pounds of nitrogen. These analyses are on soils taken from fields which have had the average history of farms in Iowa county. The virgin soil of that section contains considerably more phosphorus, but the years of cropping to small grains which occurred previous to the present decade have removed important quantities of that element. From now on it will be necessary for farmers on this type of soil to consider carefully the means of retaining and increasing the phosphorus content of their soils. The total potassium is sufficient to meet any demands, but its availability will depend upon the supply of actively decomposing organic matter; and the improvement of this type as a whole calls chiefly for the addition of green manuring crops in the system of rotation followed, unless, indeed, unusually large amounts of barnyard manure are available through intensive stock farming. The underlying rocks are chiefly limestone, and where fields are on the lower slopes of hills, they are rarely acid, since lime is brought to them from

the rocks lying under the higher portions of the hills. On the ridges, however, more or less acidity has developed, and each farmer should make the test for acidity* on each field, especially with reference to the growth of clover and alfalfa. Where an acid condition is found to exist, from 1,200 to 2,000 pounds of ground limestone per acre should be applied.

The question of preventing erosion is one which should be carefully considered by all farmers on Knox silt loam. It is a difficult matter to check erosion and repair the damage when once it has made considerable headway, but there are a number of ways by which washing may be prevented, or at least reduced to the minimum. On the tops of ridges and on gentle slopes, cultivated crops may be grown in rotation with other crops in the usual way; but when the slope becomes so steep that the bare ground would wash to any extent, fields should be used for hay or pasture as much of the time as practicable. Where the slope is so steep that modern farm machinery cannot be used, no cultivated crops should be grown, but the fields should be kept as permanent pastures. If such slopes are in timber they should be allowed to remain so. In some instances it would doubtless be advisable to reforest some of the steep slopes which have been cleared.

Where it is found necessary to cultivate steep land, the plow should follow the contour of the hill, and narrow strips of sod should alternate with the cultivated strips. In some places

* As a number of the soils in this County are in an acid condition and would be greatly benefited by the application of some form of lime, every farmer should know how to test his soil for acidity. Bulletin 230 of the Wisconsin Experiment Station on "Soil Acidity and Liming" gives the following method which can be readily applied." A very simple and reliable method to detect soil acidity is by the use of the blue litmus paper, which can be secured of any good druggist. Take a handful of moist soil and form it into a ball. Break the ball into halves and place a piece of blue litmus paper in the center of one of the halves, and cover over with the other half. After 5 minutes break the ball, and if the paper is pink in spots or over the whole end, the soil is acid." "Soil acidity is also usually indicated by the growth of certain weeds, such as sheep sorrel, horse-tail rush, corn spurry, and wood horse-tail."

The Truog test for soil acidity is a new method recently perfected by which a more accurate determination than is possible with litmus paper, can be made in the field in a few minutes time. Detailed information concerning this test may be secured by writing the Soils Department, U. of W., Madison, Wisconsin

strips of sod may be left running with the slope at points where most of the run off water flows. Erosion at such places will thus be held in check while the remainder of the field is being put into a grain crop and reseeded.

Care should be exercised in selecting crop rotations best suited to this soil. Where there is no danger from erosion the following rotation will be found to give good results. Small grain may be grown for one or two years and seeded to clover. The first crop should be cut for hay and the second plowed under as a green manuring crop. When sufficient organic matter has become incorporated in the soil, the seeding should be mixed timothy and clover, and the field cut for hay for two years. Stable manure should then be applied to the field before being plowed for corn. The manure may be supplemented by 600 to 800 pounds of rock phosphate, and the two may be applied at the same time. Subsequent application of half this amount of rock phosphate once during each rotation will doubtless be sufficient. Where the slopes are steep, intertilled crops should not be grown, corn should be eliminated from the rotation, and grain should not be grown any longer than is necessary to get the fields reseeded. As long as there is a good stand of grass on the slopes they should not be plowed. When ground limestone is to be used it may be applied at any convenient season, since in this form it is very slowly soluble and will not be carried away by the drainage waters.

The dairy industry could well be developed to a higher degree on this type. More silos should be constructed, and more attention given to the growing of alfalfa.

CHAPTER III.

GROUP OF DARK COLORED, ALLUVIAL SOILS.

WAUKESHA SILT LOAM.

Description.—The surface soil of Waukesha silt loam consists of a black silt loam to an average depth of 12 inches, having a very smooth feel and containing a high percentage of organic matter, which imparts a loamy character to the material. The subsoil is a chocolate-brown silt loam, which grades at from 16 to 20 inches into a yellowish-brown, compact silty clay loam. Occasionally the subsoil is drab or mottled. On the higher slopes and tops of knolls the soil is lighter in color than elsewhere, often being brown or dark brown, and the texture is heavier, owing to the fact that a portion of the silty covering has been removed by erosion. Frequently in such places the subsoil is exposed over small areas. In places the dark surface soil extends to a depth of 18 to 20 inches. At West Salem sand is encountered at 3 to 4 feet. Two phases of this type were recognized and mapped. They are known as the coarse phase, and the heavy phase. A description of each phase follows the description of the typical soil.

Extent and distribution.—Waukesha silt loam is second in agricultural importance among the types of the county. The largest area is found in Hamilton Township. Beginning about 2 miles east of Bangor, this soil extends east along the south side of La Crosse River to a point about 2 miles southwest of West Salem, where it swings south, extending up the valley of Bostwick Creek for a distance of 6 miles. At West Salem the type is well developed, being 1½ miles in width. On the north side of La Crosse River the soil is found in Hoyer, McKinley, and Jordson Coulées, Adams Valley, and in a number of smaller valleys. There is an important and quite extensive

VIEW NEAR WEST SALEM SHOWING CHARACTERISTIC LEVEL SURFACE, AND HIGHLY IMPROVED DAIRY FARM ON WAUKESHA SILT LOAM.

This type occurs as a black terrace formation. It is an excellent corn soil, and is well adapted to general farming and dairying.

tract in Lewis Valley, in the vicinity of Stevenstown. Smaller patches are found along Mormon, Halfway, and a few smaller creeks throughout the upland portion of the county. Near New Amsterdam in the valley of the Mississippi River there is another area of this soil covering somewhat over one square mile. The total area of the type is approximately 25,000 acres or about 8 percent of the entire county.

Topography and drainage.—Where typically developed, as in the vicinity of West Salem, the surface is level to very gently undulating. The black soil of the level terraces frequently extends up the adjoining slopes, and sometimes over small knolls. A part of the type as found in Lewis Valley and in the triangle formed by the La Crosse River and Bostwick Creek in sections 9 and 16, is quite sloping and gently rolling in places. Throughout almost the entire extent of this soil its highest margin borders the Knox silt loam. On the higher slopes and the tops of knolls the two types grade into each other so gradually that the soil boundary is often an arbitrary one. Where the surface is gently rolling or sloping the material has here been included with the Waukesha silt loam on account of its small extent, but in subsequent mapping where areas of importance are found this variation will be classed as a separate soil. The natural drainage over the greater portion of the type as mapped is fairly good, but where the surface is level, and the soil section deep tile drains would be beneficial. No portion of the soil is subject to overflow. None of the slopes are sufficiently steep to be affected by erosion.

Origin.—Waukesha silt loam seems to be both alluvial and colluvial in origin, the greater part of it occurring on what seems to be a terrace. In the vicinity of West Salem this terrace is over a mile wide, and at a depth of 3 feet or more layers of sand are encountered in places, indicating that the material, at this point at least, is alluvial. The terraces are distinct at a number of places, but along the border of the type which joins the Knox silt loam this soil extends up the slopes for a considerable distance, and even over some fair-sized knolls. In such places the origin is probably similar to that of the Knox silt loam, though being somewhat lower it has at some time been

more poorly drained, which condition favored the accumulation of organic matter in the presence of moisture resulting in the dark color characteristic of the type. Some of the slopes are partly colluvial.

The material forming this type was doubtless originally derived from the loess-like mantle which covers much of the surrounding upland country. Litmus paper tests indicate that the soil is acid and in need of lime.

Native vegetation.—Originally Waukesha silt loam supported a sparse growth of oak timber, and intervening treeless areas were spoken of as "oak openings." It thus appears that a semi-prairie condition prevailed. At present there is no timber except the trees which have been set out about the farm buildings.

*Present agricultural development.**—A larger proportion of this type is under cultivation than of any other in the county, and as a whole it is considered the best general farming soil. Practically all of the type can be cultivated. This type and the Wabash silt loam are the best corn soils in the county. Other crops commonly grown are oats, barley, hay, alfalfa, sugar beets, and some wheat. Corn makes an excellent growth, acquires a healthy green color, and yields from 60 to 80 bushels. While only a small quantity of wheat is grown, yields of 30 to 35 bushels are frequently obtained. The small grains do well, but the quality is not as good as that produced on the Knox silt loam of the upland. During wet years the growth of straw is likely to be so rank that lodging results. The hay crop consists of clover and timothy, yields of 1 to 2 tons per acre being secured. But little trouble is ever experienced in getting a catch of clover. When wheat is grown it is sometimes seeded with this crop, though seeding may be with oats or barley as a nurse crop. Alfalfa is grown to some extent, usually with fair success. Sugar beets are successful on this soil and yields of 15 to 20 tons per acre are secured. The sugar content is not as high as that of beets grown on soil having a lower organic-matter content, but the tonnage is greater and the net returns show a margin in

* For chemical composition and improvement of this type of soil see page 34.

favor of the black soils of this character. Potatoes are grown for home use, yields of 150 bushels per acre being secured.

Owing to the high percentage of organic matter present and the silty character of the soil, cultivation is comparatively easy and no difficulty is experienced in securing an excellent tilth.

Some of the finest farms in the county are located on this type of soil, and in general the methods of farming followed are above the average. One rotation of crops quite commonly followed is corn for one or two years, then small grain for about two years—or three years if wheat is grown—and then clover or clover and timothy mixed. After this the field may be pastured for a year or two before being again plowed for corn. Dairying is the most extensive type of farming followed, and the soil is well adapted to this industry. The silo is in common use. Hog raising is also carried on to a considerable extent in conjunction with dairying. Bush berries, small fruits, and strawberries are grown successfully on the higher slopes and knolls, though not to a very great extent.

WAUKESHA SILT LOAM, COARSE PHASE.

Description.—The surface soil of Waukesha silt loam, coarse phase, is a light-brown or grayish silt loam, extending to a depth of 10 inches and containing a higher percentage of fine and very fine sand than is found in the other silt loams of the area. The subsoil consists of a light-brown, yellowish, or sometimes chalk-colored, rather compact silt loam, somewhat heavier than the surface soil and extending to a depth of 24 to 30 inches, where a fine sand is frequently encountered. The type as a whole is variable, and the underlying sand appears at the surface and in a few small areas. The area north of Bangor, on the east side of the road, is quite sandy. In the lower valley of the La Crosse River the soil is a typical silt loam, being locally referred to as a clay, and is similar to the type mapped in Iowa County as Lintonia silt loam. The areas between Bangor and West Salem usually have sandy material at a depth of 30 to 36 inches. This soil is comparatively easy to cultivate, especially where a large quantity of fine sand is incorporated with

it, and a good seed bed can be secured with a minimum amount of labor.

Extent and distribution.—This soil is of comparatively small extent in La Crosse County. The largest area occurs on the north side of the La Crosse River between Bangor and Neshonoc, extending up the valley of Burns Creek. Smaller patches are found farther down the valley of the La Crosse River in Mormon Coulée and in the valley of a few of the smaller creeks throughout the upland.

Topography and drainage.—The type occurs as a terrace formation, and the surface is level, very gently undulating, or having a slight slope toward the stream along which it may be found. In a few places there are low, narrow bars or ridges of fine sand around which the silty material was deposited. On account of the bed of sand underlying this type the natural drainage is good except where the soil section is deeper than the average and in such places tile drains would be beneficial.

Origin.—The material forming this soil is largely of alluvial origin, the sand forming the subsoil having been deposited earlier and by more rapidly moving water than the silt forming the surface soil. Some of the gentle slopes along the margin of the type are doubtless of colluvial origin. Litmus paper tests indicate that an acid condition has developed over this soil.

Native vegetation.—The original timber growth consists chiefly of oaks, with occasional small "openings," as in the case of the typical soil.

*Present agricultural development.**—The type constitutes a good general farming soil, and a large proportion of it is under cultivation and highly developed. In productiveness it is somewhat inferior to the typical soil. The usual crops grown are corn, oats, barley, hay, and some wheat. Corn averages 50 bushels, oats 40 bushels, and barley 35 bushels, and hay from 1 to 2 tons per acre. The crop rotations and methods of farming followed are the same as on the typical soil. Dairying is the leading industry.

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* For the chemical composition and improvement of this soil see page 34.

WAUKESHA SILT LOAM, HEAVY PHASE.*

The surface soil of the heavy phase of Waukesha silt loam consists of a dark-brown, dark-gray, or black heavy silt loam or clay loam, extending to a depth of 12 inches. The subsoil is a brown, putty-like clay, over 3 feet in depth. The type is referred to locally as "gumbo." The soil is heavy and is more difficult to handle than the silt loams of the survey.

Most of this phase is found in two small areas, one on each side of the La Crosse River, east and southeast from Onalaska. The total area of the phase is less than one square mile.

The surface is level, and on account of the heavy soil and subsoil the natural drainage is deficient, and tile drains are needed. While its position is low, it is not subject to overflow.

The material forming this soil is of alluvial origin, but was deposited in waters which were moving very slowly. The type now appears as a terrace bordering the La Crosse River.

In agricultural value it is very similar to the typical soil, but it is somewhat more difficult to cultivate.

WABASH SILT LOAM.

Description.—The surface soil of Wabash silt loam is a black silt loam, having a smooth feel and containing a high percentage of organic matter. This is underlain at 14 inches by a heavy, compact silt loam subsoil. A silty clay loam is encountered at about 2 feet. In color the material may be yellow, yellowish-brown, or drab, with frequent mottlings in the deep subsoil, especially where the drainage is deficient.

Where this type is encountered at the mouth of a valley the surface soil frequently extends to a depth of 16 to 18 inches. In some localities the color of the surface soil is dark brown instead of black. Over large areas, especially where the type adjoins outcrops of sandstone, the subsoil may grade into a heavy fine sandy loam at from 26 to 30 inches.

Extent and distribution.—Wabash silt loam is an important soil from an agricultural standpoint and covers a total area of

* For chemical composition and improvement see page 34.

14,272 acres. The largest area is found in the valley of Fleming Creek, in the vicinity of Mindoro. Other areas of fair size occur in the valley of Burns Creek, in Burns Township, along Bostwick Creek, in Barre Township, immediately to the northwest of Midway, and as small, narrow strips along many of the smaller streams throughout the upland region.

Topography and drainage.—The surface is level to slightly undulating and usually has a gentle slope upward from the stream, which insures fair drainage. Drainage conditions over most of the type could be improved by the installation of tile drains. While part of the type is subject to overflow, the danger is not great, and it is seldom that crops are severely damaged.

Origin.—The type is of alluvial origin and consists largely of silt carried down from the loess-covered hills. The dark color is due to the accumulation of organic matter in the presence of moisture. It occurs chiefly as first-bottom land, though in a few instances it occupies benches considerably above the present flood plain of the streams.

Native vegetation.—The original growth consists chiefly of willows and marsh grass in the lowest places and soft maple, elm, and a few oaks on the higher, better drained places.

*Present agricultural development.**—By far the greater part of the type is under cultivation and highly developed. It is one of the most productive soils in the county and gives good yields of all the farm crops grown upon it. It is better adapted to corn than any of the other types, with the possible exception of Waukesha silt loam, which it very much resembles, average yields of 60 bushels per acre being secured. Oats yield 40 to 50 bushels, barley 35 bushels, and hay 1 to 2 tons per acre. The quality of the grain produced on this type is a little below that grown on the Knox silt loam. During dry seasons the grain stands up well, but with an excess of moisture the straw is likely to lodge. Sugar beets are grown upon this type and yields of 20 tons per acre are frequently obtained. Potatoes do not do as well as on the ridge land, yielding not over 150 bushels per acre.

The rotation most commonly used consists of corn for one or

* For chemical composition and improvement of Wabash silt loam see page 34.

two years, followed by oats or barley, or both, for one year, after which the land is seeded down and cut for hay, usually for two years. As there are but few farms composed entirely of this type, and since it is inextensive, no definite system has been worked out for this particular soil.

The Wabash silt loam often shows marked acidity, especially on the better-drained fields. Being naturally a very fertile type, it has been over-cropped on some of the well-drained areas, and this condition, together with the fact that it has a large content of organic matter, would tend to promote acidity in the dryer portions. This acid condition, however, does not materially interfere with the production of large crops, since the productivity of the type as a whole is still high.

WABASH LOAM.

Description.—The surface soil of Wabash loam is a dark-brown loam from 14 to 18 inches deep, containing varying quantities of silt, fine sand, and very fine sand. Over a greater part of the type the subsoil is a black or dark-brown silt loam. The type is subject to considerable variation. In some places the silt is present in sufficient quantities to make the type a silt loam, while in others the fine sand predominates. On some of the higher slopes of the valleys the surface is brown in color, while in some of the low-lying areas it is black. In some of the more poorly drained areas the subsoil material is drab or slightly mottled. Lenses and beds of sand are frequently encountered. Some stony areas are found adjoining steep slopes where rushing currents have carried down rocks from the ledges above. On account of the limited extent of these variations, they could not be separated. While the type represents a condition rather than material of uniform texture, it is more nearly a loam than any other class of soil, and has, therefore, been mapped under this head.

Extent and distribution.—The type is of limited extent, occupying a total area of approximately 4 square miles. It occurs in the narrow valleys along the upper course of the streams throughout the rough upland country. The most extensive developments are found along Dutch, Coon, Bostwick, and Mormon

Creeks in the southern part of the county, and along Fleming Creek in the northern part. Small patches occur along a number of small streams throughout the county.

Topography and drainage.—The surface of the type is level in the valley floor, with slopes extending up from the margin of the valley to the higher land of the hills. Some of the type is very low and marshy, while much of it is subject to annual overflow. With the exception of the highest margin of the slope bordering the rough stony land or the Knox silt loam, the drainage of the type is naturally poor.

Origin.—In origin Wabash loam is alluvial and colluvial. The black subsoil is undoubtedly largely of alluvial origin, the valley floors having become covered with a lighter colored material by the increase of the wash from the steep slopes after the settling of the country and the removal of much of the timber. A large quantity of this wash is composed of silt from the loessial material and some of it is sand from the exposures of the Potsdam sandstone on many of the steep slopes.

Native vegetation.—The original forest growth on this type consisted chiefly of willows and marsh grass in the lowest places and soft maple, elm, and a few oaks on the higher, better drained slopes.

Present agricultural development.—On account of its poorly drained condition and the occurrence of sloughs, only a small part of this type is under cultivation. Most of it is used for pasture, and some wild hay is cut from the marshy places. Although much of the type is not arable, it is valuable for stock raising because of the good pasture it affords and the abundant supply of water from the streams. On some of the better drained margins of the type, or where the danger from overflow is not great, small areas are being cultivated and the yields obtained compare favorably with those from the Wabash silt loam.

CHEMICAL COMPOSITION AND IMPROVEMENT OF WAUKESHA SILT LOAM, WABASH SILT LOAM, AND WABASH LOAM.

Chemical analyses of the soils in this group indicate that in most cases they are well supplied with all of the essential plant food elements. The total amount of phosphorus in the surface

8 inches is approximately 1500 pounds per acre, except in the coarse phase of Waukesha silt loam and Wabash loam, where the amount is about 1000 pounds per acre. The total amount of potassium is approximately 35,000 pounds per acre 8 inches. The amount of nitrogen is variable, there being 5,000 pounds or over in all of the soils except the coarse phase of Waukesha silt loam, and Wabash loam, where the amount is about 2500 pounds per acre in the surface 8 inches. The texture of the last two types named, and especially the Wabash loam, is variable, which accounts largely for the variation in the chemical composition. With the exception of small areas, the soils of this group usually show varying degrees of acidity, and before such crops as clover and alfalfa will give best results over a period of years this condition should be corrected by the use of 1500 to 2000 pounds of ground limestone per acre.

Most of the soils of this group are somewhat deficient in drainage*, and before the best results can be obtained tile drains should be installed in a number of places. In most cases there is sufficient fall so that the various areas could be drained with but little difficulty. The coarse phase of Waukesha silt loam has a somewhat uneven surface and is not in need of drainage.

In case of low yields on well drained areas it would be well to try the use of rock phosphate at the rate of 600 to 800 pounds per acre. It is thought that rock phosphate might be profitably applied, especially on the course phase of Waukesha silt loam, since this soil is somewhat deficient in phosphorus. There is a liberal supply of potassium in all of the soils, but its availability will depend largely upon the amount of actively decomposing organic matter in the soils. It is thought that by following well selected crop rotations, by being thorough in the cultivation of the soil, and by returning to the soil all of the manure produced upon the farms, that the fertility will be maintained, and no commercial fertilizers required.

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* See Bulletin Wisconsin Experiment Station No. 229 on "The Right Drain for the Right Place."

CHAPTER IV.

GROUP OF SANDY LOAM SOILS.

PLAINFIELD SANDY LOAM.

Description.—The surface soil of Plainfield sandy loam has an average depth of 10 inches and is dark brown in color, due to the organic matter that has accumulated in it. The subsoil is a sandy loam having a somewhat lighter-brown color than the soil, becoming progressively lighter with depth to a yellow or whitish color at 30 inches. It becomes lighter in texture in the deeper subsoil, being practically a pure sand at 36 inches. In the vicinity of Burr Oak the soil is lighter in color, contains less organic matter in the surface, and is somewhat finer in texture than in the other areas. It is also rather low in fertility. In exposed places there is a tendency for the sand to drift more or less.

Extent and distribution.—The type is of limited extent and occurs only in the northern part of the county, in the valley of Black River. There are two main areas, one near Burr Oak, the other in the northern part of Holland Township.

Topography and drainage.—The surface of the type is nearly level. Along the southern margin, however, the soil extends up the gentle colluvial foot slopes of the upland for a short distance, giving such places a slightly sloping topography. On account of the loose, open character of the subsoil the natural drainage is good and the soil is inclined to be droughty.

Origin.—The Plainfield sandy loam is alluvial origin, with the exception of the narrow fringes of colluvial material adjacent to the boundaries with the other types. Litmus paper tests indicate that an acid condition has developed over this type.

Native vegetation.—The native tree growth consisted chiefly of bur, black, and white oak. Practically all of the type is now cleared and under cultivation.

*Present agricultural development.**—While nearly all of this soil is under cultivation it is not highly improved. In the methods of farming followed, yields obtained, etc., it corresponds closely with the Waukesha sandy loam. The chief difference between the types is that the Plainfield sandy loam contains a smaller amount of organic matter in the surface soil and has a somewhat lighter color than the Waukesha sandy loam. Under favorable conditions corn frequently yields 50 bushels, oats 35 bushels, barley 30 bushels, rye 22 bushels, and potatoes about 150 to 200 bushels per acre. Average yields, however, are considerably lower. This soil is well adapted to truck crops but on account of the distance to shipping points this industry has not been developed.

WAUKESHA SANDY LOAM.

Description.—The surface soil of Waukesha sandy loam has an average depth of 10 inches and consists of a dark-brown medium sandy loam. The dark color of the soil is due to the organic matter present, which together with the silt and clay, accounts for the loamy character of the material. The subsoil is a sandy loam having a somewhat lighter brown color than the soil and gradually becoming still lighter in both color and texture until at 30 inches the material consists of a yellow or whitish sand. This light-colored sand is very clean, containing almost no silt or clay. In the vicinity of Bangor the texture of the soil is finer than typical.

Extent and distribution.—Waukesha sandy loam occupies a total area of less than 3 square miles and is confined to the valley of La Crosse River and its tributaries. One area extends from Bangor eastward through Rockland into Monroe County and a few small areas occur north of Bangor.

Topography and drainage.—The greater portion of the type is level, but along the margin where the soil borders the higher land the surface may have a gentle slope, and in a few places it is even gently rolling. Because of the sandy nature of the soil and subsoil the natural drainage is good, but the type is not droughty.

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* For chemical composition and improvement of Plainfield sandy loam see page 42.

Origin.—In origin the type is largely alluvial, and the greater part of it occurs as a terrace formation. Along the upper margin, where this type borders the residual sandy types, some residual material from the Potsdam sandstone is incorporated with it. Where it borders the silt types some of the silt from the higher slopes has been mixed with it. The type lies from 10 to 25 feet above the level of streams. Litmus paper tests indicate that the soil is acid.

Native vegetation.—The original timber growth consisted chiefly of bur, black, and white oak. Most of the type has been cleared and is now under cultivation. Sand bur is common on this soil.

*Present agricultural development.**—All of the general farm crops common to the locality are grown on Waukesha sandy loam with fair success. Some prefer this soil to the heavier types, since it is easier to cultivate, is early, and responds readily to good treatment. Under favorable conditions corn yields 50 bushels, oats 35 bushels, barley 30 bushels, rye 22 bushels, and potatoes 150 bushels per acre. Hay does not give very satisfactory yields. Trucking has not been extensively developed, although it is carried on to some extent. There is a wide range in the relative productivity of different areas of this type, probably owing to different methods of farming. The areas along Black River are less productive than those along the La Crosse River, although the texture of the soil is essentially the same.

The following table shows the results of mechanical analyses of samples of the soil and subsoil of Waukesha sandy loam:

Mechanical analyses of Waukesha Sandy Loam.

Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Soil	0.3	9.2	27.3	38.2	3.4	14.3	7.1
Subsoil	.1	11.2	30.1	36.6	4.3	12.1	5.5

* For chemical composition and improvement of this soil see page 42.

VIEW SHOWING LEVEL TO UNDULATING SURFACE OF WAUKESHA FINE SANDY LOAM AS IT OCCURS TO THE SOUTHEAST OF ONALASKA.

This is a dark colored fine sandy loam soil which occurs chiefly as a terrace. Most of the type is devoted to general farming, but it is better adapted to trucking. This industry

WAUKESHA FINE SANDY LOAM.

Description.—The surface soil of Waukesha fine sandy loam consists of a dark-brown fine sandy loam. The material is somewhat compact and has an average depth of 10 inches. The subsoil is a fine sandy loam, somewhat lighter in color than the surface soil, which grades into a yellow fine sand at 30 inches. In local areas the surface may consist of a fine sand, and the subsoil may also be a yellow fine sand over small areas. Ridges or low dunes are encountered in a few places. On account of the extremely sandy nature of the soil no difficulty is experienced in preparing a good seed bed.

Extent and distribution.—Waukesha fine sandy loam covers a total area in this survey of nearly 8,000 acres, or about 2.5 per cent of the county. A little more than half of this soil is found in the valley of the La Crosse River. The largest area occurs both east and west of Bangor, bordering the Meadow land on both sides of the River for a distance of several miles. Another area of some importance is found 2 miles southeast from Onalaska where the La Crosse and Mississippi Valleys join. The remainder of the type lies within the Mississippi Valley, mostly in the northern part of the county, though some small areas occur as far south as La Crosse.

Topography and drainage.—The topography of the type is level, with the exception of a few places made uneven by the action of wind in forming small sand dunes. The natural drainage is fair, except in the very low areas where the type adjoins the Meadow land. In these places the water table frequently approaches the surface and the soil is flooded at times.

In origin the type is alluvial, and a considerable part of it occurs as a terrace between the Meadow land and the Waukesha silt loam and other soils of the terraces. It has an elevation of from 4 to 10 feet above the Meadow. The areas on Brices Prairie and southeast of Onalaska are somewhat higher than this.

Native vegetation.—On the low, wet portions of the type there were some willows, soft maple, etc., while on the highest and dryer portions there was a scattering growth of oak.

*Present agricultural development.**—The greater part of the type is under cultivation and produces fair returns. Truck crops, including peas, cabbage, rhubard, sweet corn and potatoes, are grown, especially on the areas within hauling distance of La Crosse. Yields of 200 bushels of potatoes per acre are frequently obtained, although this is above the average. On the area between Bangor and West Salem some wheat of good quality is grown. General farming is also carried on upon this soil and the tendency seems to be to extend this industry. A number of farmers southeast of Onalaska report the reduction of acreage devoted to trucking, with a concurrent development of dairying. Yields of corn and small grain are somewhat lower than on the silt loam soils.

The following table shows the average results of mechanical analyses of samples of the soil and subsoil of Waukesha fine sandy loam:

Mechanical analyses of Waukesha fine sandy loam.

Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Soil	0.1	0.7	4.5	57.7	15.5	15.7	5.5
Subsoil	.0	.7	4.8	62.3	15.3	12.9	4.0

BOONE FINE SANDY LOAM.

Description.—The surface soil of Boone fine sandy loam is a brown or light-brown fine sandy loam, extending to an average depth of 8 inches and containing considerable silt, which makes the material somewhat compact in places. The subsoil consists of a light-brown fine sandy loam, becoming yellow with increased depth, and extending to about 30 inches, where a yellow fine sand is encountered. Over small areas the subsoil approaches a sandy clay, while in other places the underlying sand bed may be encountered at unusually shallow depths. Where the type

* For chemical composition and improvement of this soil see page 42.

borders Boone fine sand it is lighter in texture and grades almost imperceptibly into the lighter soil, and where it borders Knox silt loam the soil contains a high percentage of silt. The type may be considered a gradation from the purely residual sand, on the one hand, to the purely loessial silty material on the other.

Extent and distribution.—The most extensive development of Boone fine sandy loam is in the northern part of the county, which it crosses in an irregular belt, overlooking the valley of the Black River and varying in width from one-fourth of a mile to 2 miles. An area of this type occurs in the eastern part of the county, in Burns Township, and another east of Bangor. A number of small patches are scattered throughout various parts of the upland country, generally occupying the lower slopes of the ridges. The total area covered by this type is 14,400 acres or 4.7 per cent of the county.

Topography and drainage.—The topography of most of the type is rolling to somewhat hilly, though the surface in a few localities is nearly level. It is found on the steep lower slopes of bluffs and on long gentle slopes at the ends of secondary lobes of sandstone which project downward from the higher limestone bluffs and ridges. On account of the sandy nature of the soil and its uneven topography, the natural drainage is good, and in a number of places excessive. During dry seasons practically the whole type suffers from lack of moisture. Erosion is active on a number of the slopes which are not timbered.

Origin.—Boone fine sandy loam is chiefly of residual origin, having been formed from the disintegration of the Potsdam sandstone, which it overlies throughout its extent. On the steep slopes the underlying rock is encountered at shallow depths and frequently outcrops. Where the rock outcrop is pronounced the type is classed with Rough stony land. The silty material incorporated with the soil has undoubtedly been transported from the higher lying slopes, which are occupied by silty, loessial material.

Native vegetation.—The original timber growth consisted chiefly of white, bur, and black oak. Many of the steep slopes are still in timber, though all of the best trees have been removed.

Present agricultural development.—Boone fine sandy loam is extensively cultivated. The heavier phase is a fairly good soil and satisfactory yields are secured, but where the type approaches the Boone fine sand, conditions are not so favorable and yields are lower. All of the crops common to the region are grown. During favorable seasons corn yields 30 bushels, oats and barley from 20 to 25 bushels, rye from 15 to 20 bushels, and hay about 1 ton per acre, but during dry seasons yields are often considerably lower. Except on the heavy phase, hay does not do well. Dairying is not as extensively developed as on the Knox silt loam, and as most of the type is located at a considerable distance from shipping points, truck crops are not being grown.

The following table shows the average results of mechanical analyses of samples of the soil and subsoil of Boone fine sandy loam:

Mechanical analyses of Boone fine sandy loam.

Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Soil	0.2	5.9	13.5	54.9	5.8	14.7	5.1
Subsoil	.2	6.3	14.9	54.2	5.7	13.0	5.2

CHEMICAL COMPOSITION AND IMPROVEMENT OF THE SANDY LOAM SOILS OF LA CROSSE COUNTY.

The chemical analyses of the soils of this group indicate that they are somewhat deficient in practically all the essential plant food elements. They are intermediate in chemical composition, as well as in texture and agricultural value, between the light colored, heavy upland soils on the one hand, and the extremely light sand soils on the other. The total amount of phosphorus in the surface 8 inches averages from 700 to 800 pounds per acre, while the total supply of potassium, which is quite variable, aver-

ages approximately 2,000 pounds per acre to the surface 8 inches. The supply of nitrogen is also variable, and will average from about 1200 to 1600 pounds per acre in the surface 8 inches. The Waukesha soils are dark colored, contain more organic matter, and are therefore somewhat higher in their nitrogen content than the other types which are light colored. Varying degrees of acidity have developed on these soils, and before the best results can be obtained with such crops as clover and alfalfa it will be advisable to apply ground limestone at the rate of from 1500 to 2000 pounds per acre.

In the improvement of these soils an effort should be made to increase the supply of organic matter and the amount of humus forming material. This may be accomplished by growing green manuring crops, of which legumes are best. The supply of stable manure is usually limited so that other sources of mineral plant food must be drawn upon. The phosphorus may be supplied as ground rock phosphate, and applications of 1000 pounds per acre will usually be sufficient, with subsequent applications of about half this amount, once during each rotation. The potassium may be supplied in the form of the muriate or sulphate, and 150 pounds per acre will be sufficient. By the use of these commercial fertilizers and lime there should be no difficulty in getting clover or alfalfa started, and when once these crops can be grown successfully the greatest difficulties have been overcome in building up the fertility of the soil.

A rotation which gives good results on sandy soils consists of small grain, followed by clover, the first crop to be cut for hay and the second plowed under. The following year a cultivated crop consisting of corn or potatoes may be grown. When the organic matter content has been materially increased, or when there is a supply of stable manure, the second crop of clover may also be cut for hay or left for seed.

The soils of this group are well adapted to trucking crops, and it would seem that this industry could be profitably extended, especially within hauling distance of shipping points, and where produce could be sold directly to consumers in the towns of the area.

The method of improvement outlined for this group of sandy loam soils is practically the same as is suggested for the sand types. It will be found, however, that because of the larger amount of fine material which these soils contain, and on account of their higher content of mineral plant food, they will respond more quickly to careful management than will the sand types. It will also be less difficult to maintain their productivity when once these soils have been developed to their highest efficiency.

VIEW SHOWING LEVEL TO GENTLY UNDULATING SURFACE OF PLAINFIELD SAND.

This is a terrace soil and is found within the valleys of the Mississippi and Black Rivers. Most of the type is under cultivation but it has a low agricultural value, and requires careful management.

CHAPTER V.

GROUP OF SAND SOILS.

PLAINFIELD SAND.

Description.—The surface soil of Plainfield sand is composed of a dark-brown, somewhat loose and incoherent, medium sand, having an average depth of 14 inches. The subsoil consists of a brown sand of medium texture, which is lighter in color than the surface soil and extends to a depth of 24 to 30 inches, where a yellow sand is often encountered. The material is loose and incoherent. The soil and subsoil of a large part of the type contains an appreciable amount of coarse material. In some small areas the type could be classed as a coarse sand. The subsoil frequently grades into coarse sand and fine gravel at 20 to 30 inches. The sand grains are rounded, and rounded pebbles frequently occur in both soil and subsoil. On Brices Prairie the texture of the type is variable, and both soil and subsoil contain gravel. At North La Crosse and on toward Onalaska and on French Island the sand is coarser than typical. In a few low places the soil is slightly loamy.

Extent and distribution.—Plainfield sand is confined entirely to the valley of the Mississippi River, where it occupies a terrace from 10 to 20 feet above the level of the river. The city of La Crosse is situated on a terrace of this soil. The type also comprises a part of French Island. An area of 2 miles in extent lies to the southwest of Midway and another occurs in the western part of Holland Township.

Topography and drainage.—The surface of the type is level, with occasional undulating or billowy areas. In a few places the remnants of higher terraces form small elevated plateaus. Old sloughs have cut through in places, leaving an irregular, uneven surface. On account of the loose, open character of the

soil and subsoil, the drainage is excessive, and the type suffers from drought during a part of almost every growing season.

Native vegetation.—A large part of the type was originally a prairie. The city of La Crosse is situated on Prairie La Crosse. French Island and the portion of Brices Prairie occupied by this type were originally almost treeless. On some areas there was a growth of scrubby oaks.

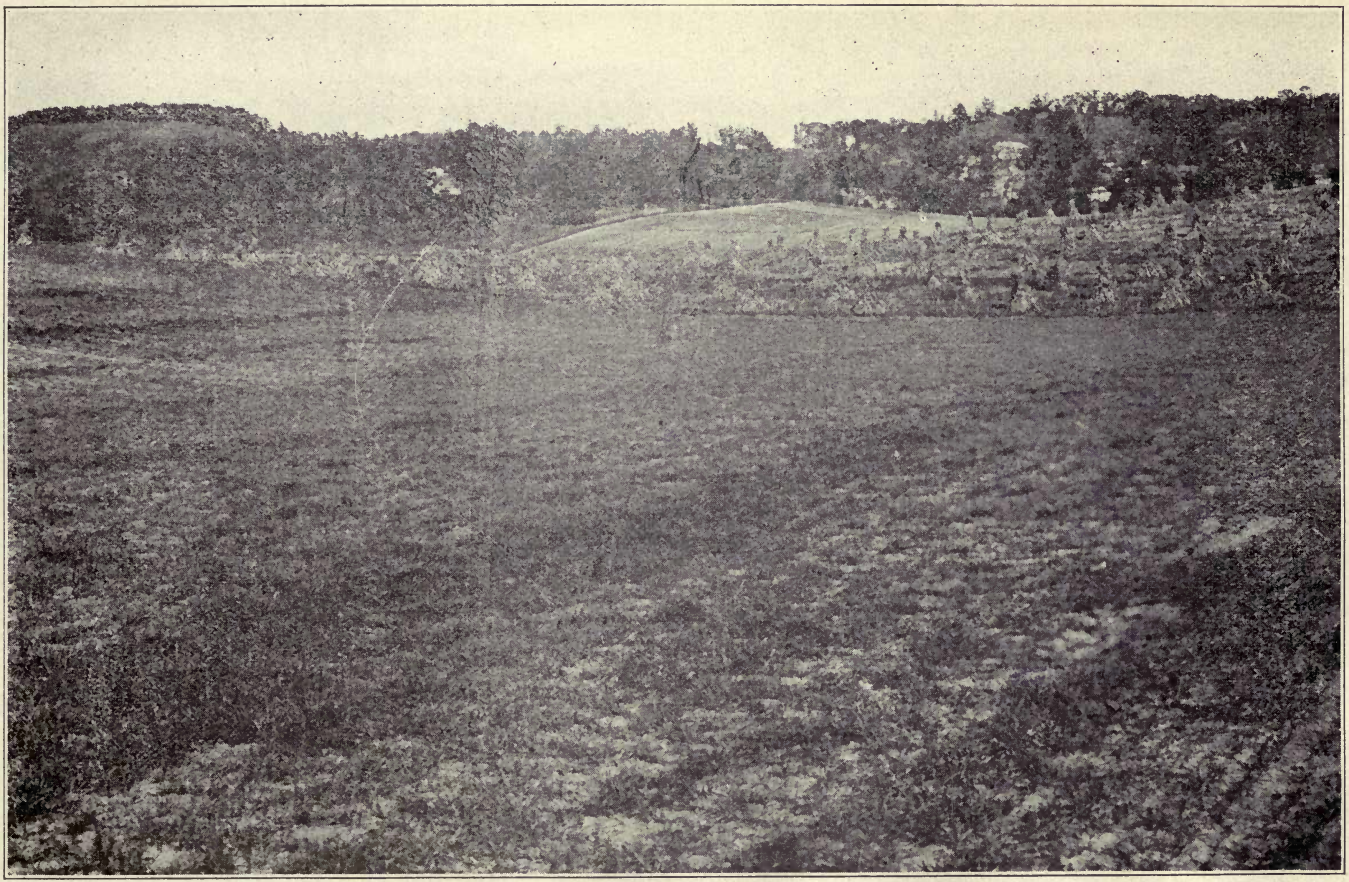
*Present agricultural development.**—Taken as a whole Plainfield sand is considered a poor soil. A large part of the type is under cultivation, but the farm buildings and improvements are poor and indicate a condition far from prosperous, while many houses are vacant. Some truck crops are grown near La Crosse, but owing to its coarse texture and loose, open structure, the soil is so droughty that yields are unsatisfactory. Even during favorable years corn seldom yields over 20 bushels and rye over 15 bushels per acre. Oats and hay can not be grown successfully, except under very careful management. Most of the hay is cut from the sloughs, which also furnish pasture, the land being too wet to be cultivated. The present methods of farming do not tend to increase the productivity of the soil. Dairying is carried on to a limited extent, but as hay and corn do not yield well, the industry is not as successful as on heavier soils.

The following table shows the results of mechanical analyses of samples of the soil and subsoil of Plainfield sand:

Mechanical analyses of Plainfield sand.

Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Soil	0.0	20.8	41.7	26.7	2.7	3.9	3.8
Subsoil	.0	20.5	45.0	27.4	3.0	1.8	2.0

*For chemical composition and improvement of this soil see page 49.



VIEW SHOWING SURFACE FEATURES OF BOONE FINE SAND AND AS IT OCCURS IN THE VICINITY OF ONALASKA.

This is a light colored sandy soil, the surfaces of which, in the vicinity of Onalaska, has been influenced by wind action. All of this soil requires careful management before profitable crops can be secured. Rock outcrop and bluffs of Knox silt loam in the background.

BOONE FINE SAND.

Description.—The surface soil of Boone fine said consists of a brown, loose, incoherent fine sand extending to an average depth of 10 inches. The subsoil is a light-brown, loose and incoherent fine sand, which becomes lighter in color with depth until at 24 to 36 inches it is a yellow or light-yellow fine sand. In some instances the underlying rock is encountered at 3 feet, although it usually lies at a depth beyond the reach of the auger, except on the steeper slopes and tops of ridges.

A variation from the above description is found where the type occurs in the vicinity of Onalaska. The texture will average a little finer, and the soil section is much deeper in this region than for the type as a whole, the depth to bed rock probably exceeding 40 feet.

The soil is so loose and open that it can be cultivated without difficulty and with very light stock and tools. Owing to its low content of organic matter and its loose character and surface soil is subject to more or less wind action.

Extent and distribution.—Boone fine sand extends in broken areas entirely across the northern end of the county, where it occupies the slopes along the Black River, and frequently reaches a width of 2 miles. A small area is also found directly south of Rockland, on the county line. Within the Mississippi River Valley there are two areas. One of these extends north from Onalaska to Midway, and the other begins about a mile north of Midway and extends to New Amsterdam.

Topography and drainage.—The topography of most of the type varies from level to gently rolling, and a part of it occupies slopes with varying degrees of steepness, on which the underlying rock often outcrops. Where the latter condition prevails to any extent the material has been classed as Rough stony land. Here and there throughout the type are knolls and ridges, some of which reach an elevation of 100 feet above the surounding soil. Within the Mississippi River Valley this type has a surface which is rolling to billowy. The slopes are usually long, and even, and no rock outcrops occur.

Origin.—The typical Boone fine sand is of residual origin,

having been derived from the disintegration of the Potsdam sandstone. The portion of the type within the Mississippi River Valley occurs as an elevated terrace from 60 to 80 feet above the flood plain. At Onalaska and north for some distance the slope toward the river is very abrupt. Where the terrace borders the upland there is a depression which apparently marks an old stream channel. The sand drifts freely over bare fields, resulting in considerable damage to growing crops. Sections in the knolls or dunes show stratification, and the lines are parallel with the curve of the slopes, indicating that the material has been wind blown. The material was doubtless influenced by the action of water and originally laid down by the river when the streams were higher than at present. The parent material was doubtless largely sandstone and the soil is non-calcareous. While differing somewhat from typical Boone fine said, this phase has practically the same agricultural value, and was therefore included with the Boone series. Litmus paper tests indicate that an acid condition has developed over practically all of this type of soil.

Native vegetation.—The original timber growth consisted chiefly of white, bur, and black oak. Many of the steep slopes are still in timber, though all of the best trees have been removed.

Present agricultural development.—Boone fine sand is a soil of low agricultural value, and, with few exceptions, the crops which are being grown at the present time are not producing satisfactory returns. Because of its low value for general farm crops a large proportion of the type is unimproved, and some areas which were once cultivated have been abandoned. Corn and rye are grown more extensively than other crops. When the rainfall is well distributed corn frequently yields from 20 to 25 bushels per acre, and rye from 15 to 20 bushels per acre, but the average is considerably lower than these figures. Oats and barley are not grown to any extent. Some potatoes are grown, but seldom on a commercial scale. Clover does not do well, except in low places where there is a fair amount of moisture, and in such localities satisfactory yields are sometimes secured. This class of land affords some grazing, especially during the spring and early summer, but as the soil is droughty, there is very little grazing late in the summer. On a few marshy

places included within the type some hay and pasture may be secured. Over the type as a whole the trucking industry has not received serious consideration, because much of this soil is located a long distance from shipping points. Within the Mississippi River Valley, however, the type is well located in relation to local markets and shipping facilities, and the trucking industry has been developed to a limited extent. A canning factory located at Onalaska handles large amounts of peas, and cabbage. Cucumbers do fairly well, but they are not grown extensively on this soil.

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

Mechanical analyses of Boone fine sand.

Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Soil	0.1	4.8	16.6	55.8	8.6	9.3	4.3
Subsoil	.2	4.9	17.0	58.4	8.6	6.6	4.4

CHEMICAL COMPOSITION AND IMPROVEMENT* OF PLAINFIELD SAND, AND BOONE FINE SAND.

In chemical composition these markedly sandy soils show considerable less of practically all of the important plant food elements than do the upland silt loam soils of this county. The total phosphorus in the surface 8 inches averages from 700 to 800 pounds per acre, while the amount of potassium is approximately 1,600 pounds in the surface 8 inches per acre. The amount of potassium in soil as found near Onalaska is somewhat higher than the average for the group. The total mount of orgnic matter in these sand soils is about one half of that in the Knox silt loam, and less thanone-third of that in the upland prairie soils of the southern and southwestern parts of the State.

*See Bulletin 204 Wisconsin Experiment Station on "Ways of Improving Our Sandy Soils."

Since Potsdam sandstone is the chief source of essentially all of these soils, they are low in lime carbonate, except in a few places where the sand occurs at a lower level than the beds of limestone, and thus receives a small amount of lime carbonate in the water from the higher slopes. The surface soil of all these types is acid, and will require lime. While these soils are deficient in all of the important elements, they have certain advantages for special crops, and it is possible to profitably supplement their natural supply of plant food material by the use of fertilizers. By all systems of farming on such land should be planed in such a way as either to conserve their natural fertility, or supply it by the use of commecial fertilizers.

The most important differences between these sandy types of soils and heavier classes, such as silt loams and clay loams, however, are not of a chemical nature, but of a physical nature, having to do with their water holding capacity, drainage, tillage, etc. Suggestions for the improvement of these types are based upon field experiments, chemical and mechanical analyses, and upon studies and observations covering a variety of sandy soils.

In the management of these sandy soils it should be kept in mind that they are naturally low in organic matter and in the mineral elements required, the water holding capacity is poor and the soil is acid. As all of the types in this group are in an acid condition they would be greatly benefited by the application of lime.

When the amount of organic matter or humus forming material in the soil is increased, the water holding capacity is also increased. The humus forming material can best be increased by applying stable manure and by plowing under legumes as green manure. Of the legumes red and mammoth clover are perhaps better adapted to sandy soils than any of the others, but neither of these nor alfalfa will make the most satisfactory growth until the acid condition is corrected. The mineral elements required may be supplied by the use of commercial fertilizers.

When a soil can be made to produce a fair crop of clover, without an excessive expenditure, that soil can be successfully and profitably improved. It is therefore important that the first

efforts in building up a soil should be directed toward the establishing of conditions which will be favorable for the growth of clover.

From experiments conducted it seems advisable to sow clover without a nurse crop, where the fertility of the soil is very low, since it will then have all of the moisture in the sand for its own growth. There is also some danger of the young plants being damaged by the hot sun when the nurse crop is removed. The field intended for clover should be plowed in the fall, or as early as possible in the spring, and a top dressing of ground limestone applied at the rate of 2,000 pounds per acre. The field should be harrowed at short intervals to kill all weeds, and this harrowing should be kept up until about the middle of May. Fifteen pounds of seed per acre should be sown and covered to a depth of 1½ to 2 inches. The seeding should be followed by a roller to compact the soil around the seed, and the roller should be followed by a light harrow to roughen and loosen the immediate surface to check evaporation and blowing of sand by the wind. Where it can be secured a top dressing of well rotted manure should be applied before the last harrowing. If manure is not available about 300 pounds of acid phosphate or ground steamed bone-meal and 100 pounds of muriate of potash should be applied at the time of seeding to clover. If only a small amount of manure is available it may be supplemented by ground rock phosphate, and this can be sprinkled over the manure in the spreader and applied at the same time.

Peat may often be used to advantage as a fertilizer if peat marshes are close at hand. It contains a high percentage of nitrogen, but should be supplemented by potash and phosphate fertilizers, as it is deficient in these elements.

Late in the summer it may be necessary to clip the weeds which are sure to come. The cutting bar should be run high and the clipping left on the field as a mulch. The second year the first crop should be cut for hay and the second crop plowed under as green manure to prepare the land for a cultivated crop. After the first application, ground limestone should be applied at the rate of about 1,000 pounds per acre once during every rotation. The amount of commercial fertilizers containing phos-

phorus and potash which should be subsequently applied will depend on the crops to be grown and especially on the amount of manure produced on the farm.

Alfalfa may be successfully grown on portions of these types of soil, when properly managed. The preparation of the soil and manner and time of seeding is practically the same as for clover, except that the soil should be inoculated with earth from an old alfalfa field or from a patch of sweet clover. About 20 pounds of seed per acre should be sown, and the first year the crop should be treated the same as clover. The second year it may be cut at least three times.

If the clover or alfalfa should fail for any reason, a crop of spring vetch or tare, soybeans, cowpeas, yellow lupine, or serradella may be grown as a green manuring crop and plowed under.

In selecting a rotation of crops to follow on the sandy soils it should be kept in mind that the soil is low in organic matter, and that this must be supplied either by applying manure or by plowing under green manuring crops. When the soil has been built up to a fair stage of fertility, a nurse crop may be used in seeding clover and alfalfa to better advantage than when the soil is very poor; and it is frequently desirable to seed with rye or oats. This system is considered by many to be more desirable, since an extra crop can be secured.

A three, four, or five year rotation may be followed. If but little stock is kept, a three year rotation may be practiced, consisting of one year of a cultivated crop as potatoes or corn, one year rye or oats seeded to clover, and one year clover—the first crop to be cut for hay and the second to be plowed under for green manure. When the fertility of the type is well established, the second crop may be allowed to seed. Good yields have been secured where the soil is well managed. If manure is scarce, acid phosphate and potash may be applied. If more stock is kept the rotation may be extended one year, using the clover field for pasture one season before plowing down the sod. The manure may then be applied to the sod in the winter or early spring of the year the field is pastured. This will increase the growth of clover and benefit the succeeding crop. In a five

year rotation alfalfa may be introduced, but this requires that considerable stock be kept, since none of the alfalfa should be sold. The field should be left in alfalfa for three years with two years given to cultivated crops and grain. Manure should be applied to the cultivated crop and also to the first year of alfalfa. This system is very desirable except that it does not provide any pasture. To overcome this the farm may be divided and both the four and the five year rotation practiced. Alfalfa may also be grown by itself and kept on the same field year after year, in which case its place in the rotation should be filled by clover. When the alfalfa begins to run out, the field should be reseeded.

In the cultivation of the sandy soils fall plowing for rye, and spring plowing for all other crops, is the usual practice. The seed bed should be prepared to a depth of at least 8 inches and organic matter should be worked in deeply as well as near the surface to increase the water-holding capacity and to induce a deeper development of the roots. When the land is plowed in the spring it is often advisable to pack the soil with a roller, but this should be followed by a light harrow to secure a mulch on the surface. Where the fields are exposed, and the soil is blown by the wind, an effort should be made to prevent damage from this source. The most effective plan is to lay out the land in long narrow fields so as to have crops that cover the ground in the early spring, such as clover and rye, alternate with the cultivated ground.

With the successful growing of clover and possibly alfalfa, the dairy industry may be developed to a much greater extent than at present. By plowing under a crop of clover every few years and by following a definite rotation and approved methods, the yields of potatoes will be greatly increased; and this crop may well be depended upon as one of the chief sources of income for the sandy soils of the area. Beans, peas, sweet corn, etc., could be profitably grown to a much greater extent, and the trucking industry should be extended where arrangements can be made for marketing. The soil warms up early and is well suited to cucumbers, strawberries, and all quick maturing vegetables.

CHAPTER VI.

GROUP OF MISCELLANEOUS SOILS.

WAUKESHA GRAVELLY SANDY LOAM.

Description.—The surface soil of Waukesha gravelly sandy loam consists of a dark-brown, gritty, or sandy, loam, the sand being of the coarser grades. There is enough clay present to make the material slightly sticky when wet. The subsoil is encountered at 12 to 18 inches, and consists of fine, rounded gravel, about the size of corn kernels. This material extends to a depth of 4 to 6 feet. The gravel subsoil is uniformly developed throughout the type, and owing to its presence a droughty condition prevails during dry periods.

Extent and distribution.—Waukesha gravelly sandy loam is of very limited extent, occupying less than half of one square mile. The soil is found on Brices Prairie, about 2 miles west and a little north of Midway.

Topography and drainage.—The surface is level to gently undulating, and on account of the loose gravelly subsoil the natural drainage is excessive.

Origin.—In origin the type is alluvial. It occupies a terrace within the valley of the Mississippi River, elevated about 15 feet above the present flood plan of the river, and has been worked by currents which were swifter than those which deposited the finer material composing other soil types.

Native vegetation.—The Waukesha gravelly loam occurs as a prairie, and the original growth was chiefly prairie grasses.

Present agricultural development.—During favorable years corn yields 50 to 60 bushels, oats about 40 bushels, and hay from 1 to 1½ tons per acre. During dry seasons the yields are considerably lower.

Method of improvement.—Because of its limited extent no chemical analyses were made of this soil. The surface soil, however, is known to be acid, and before clover or alfalfa can be successfully grown this condition should be corrected by the application of 1,500 to 2,000 pounds of ground limestone per acre. As the type is droughty, this condition may be improved somewhat by plowing under green manuring crops, and thus increasing the amount of organic matter in the soil. With a large amount of actively decomposing vegetable matter in the soil it is probable that there will be sufficient available phosphorus and potassium for the growing of general farm crops.

PEAT.*

The material classified under Peat consists of vegetable matter in varying stages of decomposition, the greater part of it being in a fibrous condition. It extends to a depth beyond the reach of the auger and is known to be 10 feet deep in places. The marshes are underlain by sand. There is only a small amount of this type in the county, and it occurs in scattered areas. The largest area is about 1½ square miles in extent and lies between Onalaska and Midway. The material here is very fibrous. This marsh was always treeless, but is covered with a dense growth of marsh grass, which can be cut for hay over part of the area when it is dry enough to support a team. The southern part, next to the Black River, is so low that ditching would not benefit it greatly. Farther north, near Midway, where the elevation is a few feet higher, ditching would lower the water table and improve the condition of the marsh. The whole area is subject to overflow from the slough north of Brices Prairie.

The area 3 miles southwest of Mindoro has 1 foot of reddish material on the surface resembling bog iron ore. The subsoil below 18 to 24 inches is a bluish clay, somewhat mottled. In the marsh east of Bangor the material is quite thoroughly decomposed and is more mucky, except in a number of places where it appears to consist largely of decayed logs, which are easily pene-

* See Bulletin 205 Wisconsin Experiment Station on "The Development of Marsh Soils."

trated by the soil auger. This material has a reddish color. A few other areas of smaller extent occur in the valley of the La Crosse River, chiefly in old sloughs.

The only use made of the Peat marshes is for cutting wild hay, but frequently it is so wet that horses can not be used without danger. In some localities the Peat could be drained and used for cultivated crops, but no extensive drainage projects have been undertaken.

In chemical composition Peat is very low in the mineral plant food elements phosphorus and potassium, and these elements must be supplied before good yields can be secured from year to year. The amount of nitrogen is extremely large, and therefore no fertilizers should be applied which contain nitrogen.

After drainage has been thoroughly established phosphorus should be applied in the form of rock phosphate at the rate of about 1,000 pounds per acre, followed by applications of about half this amount once during each rotation. The potassium may be used in the form of muriate or sulphate, and 150 pounds per acre will usually be sufficient. If the surface of the Peat has been burnt over there may be sufficient available potassium in the ash to supply several crops. When thoroughly drained and properly handled Peat will produce profitable yields of most of the general farm crops, such as corn, potatoes, timothy, alsike clover, and small grain, and in addition a number of special crops can be grown.

MEADOW.

Description and location.—The material classified as Meadow is so variable in texture that a division into separate types would be impossible on the scale of a mile to an inch. It lies entirely within the flood plains of the Mississippi, La Crosse, and Black Rivers.

The flood plain of the Mississippi, which varies in width from 2 to 3 miles, is divided into two parts by the sandy prairie at La Crosse. That part of the Meadow south of La Crosse is mostly a grayish, mottled, sandy clay. It includes small knolls and ridges of sand, some of which are cultivated. Where the surface soil is a clay or sandy clay it extends to a depth of from 10

to 30 inches, and is underlain by a sand which grades into coarse gravel at from 3 to 6 feet. The flat knolls usually consists of a dark-brown medium to fine sand, underlain at 18 to 34 inches by a lighter colored, coarser sand.

The area west and north of French Island is somewhat similar, though superior, to that south of La Crosse. The soil here is also underlain by sand, and some areas have been cultivated during favorable seasons. The proportion of the type which has been farmed, however, is very small.

Topography and drainage.—The surface of Meadow is level except for the low ridges of sand and the old channels which have been cut through it by flood waters. All of the type except the highest of the sand bars are inundated several times each year, and even the ridges are flooded when the river is extremely high. Inundation occurs both in the spring and the fall, and depends upon the precipitation about the headwaters of the Mississippi.

Origin.—The material composing the Meadow type is entirely of alluvial origin, having been carried down by the streams and deposited in times of overflow. The difference in the texture of the soil is accounted for by the swiftness of the current by which it was deposited, the slower currents having permitted the finer particles to settle to the bottom, while from the more rapid currents only the coarser particles were deposited.

Native vegetation.—The timber growth consists of willows, birch, elm, soft maple, and a few scattered oaks. Some areas support only a few bushes and a growth of wild grass. Rushes and marsh grass usually cover the heavy soil, and where the grass is not cut for hay a thick growth of tall weeds occurs.

Present agricultural development.—The crops grown on the sandy knolls consist of corn, rye, potatoes, a few melons, and some other truck. As a rule, the yields are not satisfactory and the danger from flooding makes farming an uncertain proposition. Only a very small proportion of this class of land is cleared, and present conditions do not encourage the higher development of the Meadow lands.

Methods of improvement.—The only way in which the type as a whole could be developed would be by the construction of

levees and the establishment of a system of drainage ditches. Even then it would be difficult to carry off excess storm water, since the land would be lower than the flood level of the river. Pumping plants could be installed to lift the drainage water over the levees, and along this line of development there are possibilities well worth considering. The greatest problems involved in such an undertaking are engineering, rather than soil problems.

ROUGH STONY LAND.

Rough stony land includes steep, rocky areas and land otherwise unfit for cultivation. It may be considered non-agricultural and is of value only for the small amount of timber and grazing which it supplies. This type occupies a large part of the steep walls bordering the valleys and coulees and forms a border between the valley bottoms and the high lands of the ridges. The type is developed as narrow bands many miles in extent, winding in and out of the valleys and coves, but always confined to the steepest slopes. A part of the type occurs as narrow ridges, upon which areas of soil too small to be mapped are sometimes encountered.

The type is well distributed throughout the upland portion of the county. The rock consists of sandstone and limestone. In the southern part of the county the lower Magnesian limestone forms the surface rock and this is underlain by the Potsdam sandstone. On many of the slopes both formations outcrop. In the northern areas much of the limestone has been removed, leaving more extensive sandstone outcrops.

The timber growth on the Rough stony land consists of white and red oak, hickory, and a few birch and elm trees. The best of the timber has been removed and the remainder should be left to protect the slopes from washing.

Over some of the slopes there is a shallow covering of soil which is utilized for pasture. In the southern part of the county this soil consists largely of silt, with some sand from the Potsdam sandstone. In the northern part a larger proportion of the soil material is of a sandy nature.

The presence of Rough stony land reduces the value of better land and renders the fields on the ridges less accessible. It makes hauling to market difficult, as many of the roads from the valleys to the upland cross steep strips of the type.

RIVERWASH.

The material mapped as Riverwash consists of white or grayish sand of medium to fine texture, more than 3 feet in depth.

This type is found along the La Crosse River in three areas between La Crosse and West Salem. It is of recent alluvial origin, and is being added to or moved about by high waters from year to year. The topography is level, with numerous ditches cut by flood waters. The type lies at about the same level as Meadow, and is naturally poorly drained, although during dry seasons the water in the stream is low and the soil dries out so that the surface will drift where not covered with vegetation.

On the area nearest West Salem fair crops of corn are frequently grown. Only a small proportion of the type is cultivated, however, and its agricultural value is very low.

CHAPTER VII.

GENERAL AGRICULTURE OF LA CROSSE COUNTY.

Until about 1890, the growing of grains constituted the chief type of agriculture in La Crosse County, with wheat as the principal crop. Owing to the decline in the price of grains, however, and to the fact that constant cropping to such crops would in time deplete the soil of its fertility, their production was curtailed and a gradual change has taken place in the cropping system and cultural methods of the county, until at the present time the principal type of agriculture consists of general farming, with dairying as the main feature. In conjunction with this hog raising is carried on to a considerable extent, and in some sections of the county trucking has been developed to supply local demands.

The crops which are most extensively grown at present, in order of acreage, are hay, oats, corn, barley, rye, wheat, and potatoes. In addition to these, such crops as buckwheat, alfalfa, sugar beets, peas, and some other truck crops are grown to a limited extent.

According to the Thirteenth Census reports there was more land devoted to hay production, including the wild marsh grasses, in La Crosse County during 1909 than to any other crop. A yield of 60,423 tons were secured from 30,465 acres, or an average of nearly 2 tons per acre, 60 per cent of which was mixed timothy and clover. Over four times as much timothy as clover is grown. About 14 per cent of the hay crop consists of grass cut from the swamps and marshes. The production of alfalfa is comparatively small. Timothy and clover are usually seeded with oats, barley, or wheat as a nurse crop, though a good stand may be secured without the use of a nurse crop, provided care is taken in the preparation of the seed bed and

the seeding is done at the proper time. Frequent cultivation should be given the field late enough in the season to insure the killing of most of the weeds which might choke out the young plants. Most of the hay is fed to stock on the farms, though some is sold each year.

The acreage devoted to oats is second only to that of hay. From 28,504 acres a yield of 911,685 bushels was secured in 1909, or an average of 31.9 bushels per acre. The yields secured on the Wabash and Waukesha silt loams are larger than those from other types, but during wet years there is likely to be a rank growth of straw, which frequently lodges, and the grain is not of as high quality as that grown upon the Knox silt loam of the uplands. Some of the oat crop is sold, but most of it is fed to stock.

Corn production ranks next in importance. From 19,810 acres a yield of 621,425 bushels of corn was secured in 1909, giving an average of 31.31 bushels per acre. The Wabash and Waukesha silt loams are better adapted to this crop than any of the other types, and yields of 50 to 60 bushels per acre are common, while considerably larger yields are sometimes reported. As the dairy industry increases the acreage devoted to corn also becomes greater each year. Silos are numerous and much of the corn is cut and preserved for stock feeding during the winter months. A large part of the crop is allowed to mature, to be used as feed for hogs, beef cattle, and dairy cows. More attention is being paid now than formerly to the selection and breeding of the varieties of corn best suited to local conditions in this part of the State. Practically all of the corn produced is used on the farms within the county.

Considerable barley is still grown, although the acreage devoted to this crop is gradually decreasing. A yield of 333,538 bushels was secured from 11,329 acres in 1909, or an average of 29.4 bushels per acre. As in the case of oats, a better quality of grain is produced on the upland soils than on the black types of the lower lands and river terraces. A large proportion of this crop is sold, though some is used for feed.

Rye is an important crop on the sandy types of the county, and while the yields on the light soils are low it does better on

such land than any of the other grain crops. From 5,944 acres a yield of 65,797 bushels, or an average of 11 bushels per acre, was secured in 1909. In addition to the grain produced, the rye crop also furnishes a late fall and early spring pasture.

Wheat, which was at one time the leading crop in this county, is now only of minor importance. In 1909 a yield of 39,633 bushels was produced from 1,928 acres, averaging 20.5 bushels per acre. About one-third of the production consisted of spring wheat. The yield of winter wheat averages about 3 bushels more per acre than spring wheat. On the best soils of the area, such as the Wabash, Waukesha, and Knox silt loams, satisfactory yields are still secured, but other lines of farming have been found to be more profitable and more certain to maintain the productivity of the soil.

Irish potatoes are grown commercially to a small extent, principally on the ridges east of La Crosse. From 1,790 acres 242,130 bushels, or an average of 135.2 bushels per acre, were secured in 1909. Yields of 200 bushels per acre are not uncommon. Potatoes are also grown for market on some of the sandy types. Most of these are early varieties, while on the heavier soil of the ridges the late potatoes are more common.

Sugar beets are grown in the vicinity of Bangor and West Salem, chiefly on Waukesha and Wabash silt loams. The beets are shipped to the factory at Janesville, which cooperates with the farmers by furnishing labor to do the hand cultivating and thinning, while the landowners provide the horse cultivation. Yields of 20 tons per acre are secured, although this is above the average. The beets bring an average price of $5 per ton.

Peas are grown for canning, being hauled to the factories at Onalaska and West Salem. The acreage devoted to this crop is gradually being increased. Waukesha and Wabash silt loam types are well suited to peas, but the crop would probably do better on Knox silt loam. The dark-colored soils are rich in organic matter and produce a vigorous and sometimes rank growth, while the light Knox silt loam contains less organic matter and would produce a smaller vine but a good quality of peas.

Within a radius of 5 to 10 miles of La Crosse truck crops and small fruits are grown extensively for local markets. The

truck crops, include early and late potatoes, cabbage, melons, radishes, celery, beets, sweet corn, peas, beans, and rhubarb.

Large quantities of stable manure are hauled from La Crosse and used in growing these crops.

The fruit industry has not been developed in La Crosse County to any extent. Apple culture has received very little attention, although over a large number of slopes throughout the upland portion of the county the conditions are favorable to the successful development of this industry on a commercial scale. Of the small fruits blackberries, raspberries, and strawberries are being grown on the higher slopes of Waukesha silt loam, on some of the slopes of Knox silt loam, and on some of the sandy types. The growing of small fruits and berries has been developed on a commercial scale in the vicinity of Sparta, on the adjoining slopes bordering the county, and there is no reason why equal success should not be attained along the valley of the La Crosse River, where the silt from the upland has become mixed with the residual sand of the lower slope terraces, since the conditions in these two areas are practically identical.

Tobacco was formerly grown, principally in the southeastern section of the county adjoining the Viroqua tobacco district, but very little of this crop is now produced.

Dairying in conjunction with hog raising is the most extensive and important agricultural industry now carried on within the county, although it is not as highly developed here as in the southeastern part of the State. When the Thirteenth Census was taken there were 20,046 dairy cows and 26,518 swine in the county.

Dairying is confined chiefly to the upland portion of the county and to the silt-loam areas in the La Crosse River Valley. Throughout the upland region there is a succession of slopes which are better suited to the development of dairying than to any other type of farming, some of them being too steep for the production of crops, but providing a large area of excellent grazing land. The more level ridge tops and the gentle slopes provide sufficient land for the growing of corn and other cultivated crops. The cattle are principally Holsteins, Jerseys, and Guernseys, with some shorthorns and native-grade cows. Dairy

products are sold mainly in the form of butter and cheese. There are 8 creameries and 6 cheese factories in the county. The output of butter made far exceeds that of cheese. The cream is usually separated on the farm and hauled to the creamery by the farmer or by collectors who operate definite routes. Large quantities of milk and cream are delivered daily to the residents of La Crosse and the smaller towns throughout the county.

Hog raising, in conjunction with dairying, constitutes an important feature of the agriculture of La Crosse County. The largest number of hogs are raised on Waukesha and Wabash silt loams, these types being better adapted to the production of corn than any of the other soils. The principal breeds are Poland China, Duroc Jersey, Berkshire, and some Chester Whites.

Some beef cattle are raised in the county, although this industry is not extensively developed. More steers and calves are probably shipped from West Salem than from any other point in the county.

While the rougher areas are well adapted to the raising of sheep, there were at the time of the Thirteenth Census only 9,268 sheep in the county. Since there is a large total area of steep, rocky land which can not well be cultivated, but which furnishes good grazing, it would seem that sheep raising could be profitably extended.

The adaptation of the soils to certain crops is recognized to some extent within the area surveyed. It is considered that Wabash, and Waukesha silt loams are better suited to corn than is Knox silt loam, and that Knox silt loam produces a better quality of wheat, oats, or barley than either Wabash or Waukesha silt loams. The sandy types are considered better adapted to rye than to any of the other grain crops grown in the county. The crop rotation most commonly followed consists of corn, oats, barley, and hay.

The question of securing farm labor is sometimes a difficult one. The average wage for a single man is about $25 per month, with board and laundry work included. It is often stipulated that the farmer shall keep the hired man's driving horse. It is sometimes difficult to find men who are willing to milk. In addition to the regular wages, married men are usually supplied

with a house, fuel, a garden patch, etc., in addition to their monthly wages.

About 89.9 per cent of the land in La Crosse County is in farms. The average size of the farms is 153 acres, 54 per cent of which is reported as improved. Of the farms, 75.9 per cent are operated by their owners, and 53.5 per cent of these are free from debt. In most cases where land is rented the cash system is followed. During the period from 1900 to 1910 the value of farm lands in La Crosse County increased 48.3 per cent.

Farm improvements throughout the area vary with the character of the soil upon which they are located. On all of the heavier types agriculture is well developed, the farmers are prosperous, and the farm buildings are substantial and well cared for. On the sandy soils, especially the Boone fine sand, Knox fine sand, and Boone fine sandy loam, agriculture is not so highly developed, the soil being less productive, and, in general, the farm buildings and improvements are inferior to those on the heavier soils. Frequently farms on the poorer soils are abandoned, and the buildings soon become dilapidated.

While agriculture is well developed over the greater part of the county, there are a number of lines along which improvements could be made. Specific suggestions are given in connection with the descriptions of individual soil types as to the best methods for bringing them to a higher state of productivity. In general, however, it may be said that much of the land is better suited to dairying than to any other type of agriculture, and where such is the case this industry should be given more attention. Hog raising may be carried on to a greater extent in connection with dairying. The growing of alfalfa should also receive careful attention and an effort made to produce this crop on every dairy farm. By inoculating, liming, and manuring the soil a good stand can be secured when the seed bed has been properly prepared and good seed sown.

The slopes throughout the upland portion of the county comprise good orchard sites, and the fruit industry, especially the culture of apples, could be developed on a commercial scale. While it is generally recognized that the soil and climatic condi-

tions are favorable for apple growing, this industry has not received the attention it deserves. The growing of small fruits, such as strawberries, raspberries, currants, etc., should be extended.

In the vicinity of La Crosse and along the railroads the trucking industry could be profitably enlarged. The growing of sugar beets and of special crops, such as peas for canning, cucumbers for pickling, and cabbages, could also be extended with profit. The selecting, breeding, and growing of different varieties of the various farm crops for seed could be developed into a profitable industry.

Among the weed pests common to the region, quack grass and Canada thistle are the worst with which the farmer has to contend. In general the methods of farming followed by the leading farmers on the heavier soils are fairly well adapted to present conditions. The soil of the heavier types is usually plowed deep and receives ample tillage. Manure spreaders are in common use. Most of the progressive farmers have silos and more are being built each year. Over the sandy areas, however, the methods of farming could be generally improved.

CHAPTER VIII.

CLIMATE.[1]

"Among the factors which influence the agriculture of a state none is more important than climate. The class of crops which can be grown is largely determined by the length of the growing season, and the amount and distribution of the rainfall." Any one of these factors may determine the type of farming which can be followed to best advantage.

"The distribution of rainfall over Wisconsin is remarkably uniform, the average yearly precipitation having a range of from 28 to 34 inches, while the mean for the state as a whole is 31 inches. This is a slightly heavier rainfall than is received by eastern England, northern France, most of Germany, Sweden, and the Dundee Valley. As compared with other portions of this country, Wisconsin has a total rainfall equaling that of central Oklahoma and Kansas, northern Iowa, Michigan, Northwestern New York, or the Puget Sound Basin of Washington. But owing to its northerly location, the lessened evaporation probably makes the precipitation as effective as that of Arkansas, Illinois, or Virginia."

The local distribution of rainfall varies, however, from year to year, some sections receiving more rain one year, and other sections more in other years. The variation is caused largely by the movement of cyclonic storms. The average rainfall for the entire state during the driest year was 21.4 inches, and for the wettest year 37 inches.

"Of equal importance, in agriculture, to the total rainfall, is its seasonal distribution, and in this respect Wisconsin is un-

[1] This chapter has been taken largely from Wisconsin Bulletin 223 on The Climate of Wisconsin and its Relation to Agriculture. This bulletin should be consulted if more information is desired concerning climate. All quotations indicated are taken from this bulletin.

usually fortunate, since about half of the total rainfall comes in May, June, July, and August, and nearly 70 per cent from April to September, inclusive. June has the heaviest rainfall, averaging 4.1 inches, while July averages 4 inches and May 3.9 inches. The precipitation during the winter, on the other hand, is slight; December, January, and February each averaging from 1 to 1.5 inches of rain and melted snow. The average rainfall for the state during winter is 3.9 inches, during spring 8.3 inches, during summer 11.4 inches and during autumn 7.4 inches. Most of the rainfall occurs just preceding and during the period of plant growth, thus being received by the crop at the most effective time. Wisconsin receives during the growing season, April to September, inclusive, an average of 21 inches of precipitation, which is as much rain as that received during the same months by eastern Texas, Illinois, Ohio, or eastern New York. The small winter precipitation in Wisconsin, mostly in the form of snow, on the other hand, causes virtually no leaching of fertility from the soil, or erosion.''

Another phase of rainfall distribution of great importance is its variation within a period of a few weeks. Frequently periods of drought and periods of unusually heavy rainfall occur, continuing for one to four weeks and occasionally longer. Observations taken at Madison by the Weather Bureau over a period of 30 years from 1882 to 1911, inclusive, show that there are on the average three ten day periods during each growing season when the amount of rainfall is so slight that crops on a reasonably heavy soil (Miami silt loam) actually suffer from the lack of moisture. In La Crosse County where silt loam is the predominating soil type conditions would doubtless be very similar.

The western portion of La Crosse County lies within the ''Mississippi Valley'', which is one of eight climatic provinces in Wisconsin. ''This is a rather deep depression, the warm influence of the lower altitude being apparent from Dubuque to Grantsburg. This narrow valley is the warmest portion of the state, and is characterized by hot summers and much cooler and drier winters than the Michigan shore. The mean summer temperature, averages about 71° and is similar to that of New Jersey and southeastern Pennsylvania, Ohio, or southern California.

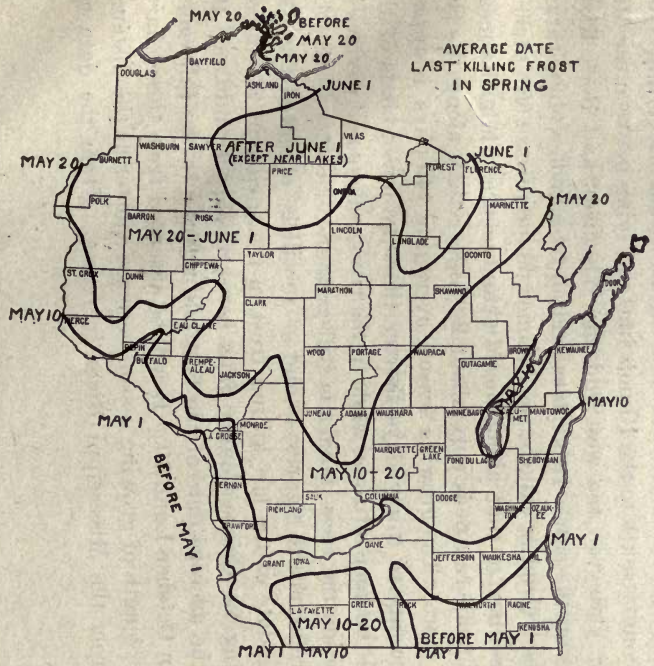


FIGURE 1. LAST KILLING FROST IN SPRING.

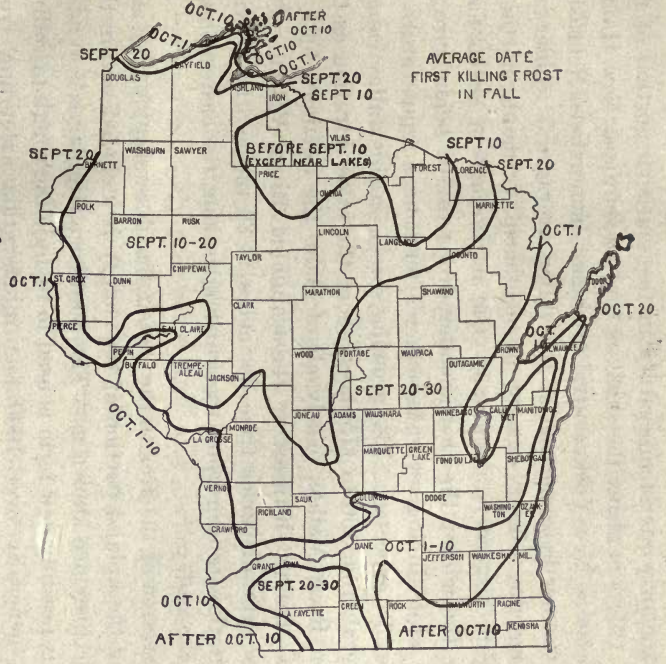


FIGURE 2. FIRST KILLING FROST IN FALL.

These maps have been prepared from the original monthly reports of the observers of the U. S. Weather Bureau for the past 12 years, supplemented by private records.

The mean winter temperature in the southern portion of the valley (21°) is about the same as that of southern New Hampshire, eastern New York, central Michigan, or northern Nebraska, while the northern portion of the valley averages 5° colder, resembling the winter climate of northern Vermont, northern Michigan, or eastern Montana. On an average of seven days during the winter the thermometer drops to 10° below zero or lower; while during several summer afternoons a temperature of 95° may be expected. The growing season in this valley ranges in general from 150 to 175 days, about the same duration as the Hudson River Valley, nearly all of Ohio, the northern half of Illinois, western Kansas, or the Columbia River Valley. The average rainfall varies from 30 inches to 33 inches, the heavier precipitation falling upon the hill lands along the eastern margin of the valley."

The section of the area to the east of the Mississippi Valley and forming the upland portion of the county is included within the climatic province known as "The Southern Highlands".

"This possibly new term is used to include the rough to rolling region, generally over 1000 feet in elevation extending from Clark county south to the Illinois line and lying between the Mississippi Valley on the west and the Wisconsin and Rock River Valleys on the east. It is characterized by a cooler temperature than the adjoining valleys, the summer temperature (66° to 69°) being similar to that along the Michigan shore, while the mean winter temperature is only about 2° higher than along the Superior shore. The growing season, averaging 145 days, is apparently twenty to thirty days shorter than the lower lands of the state in the same latitude, while in the river valleys and ravines in this section the frost danger is still greater."

By reference to figures — and — it will be observed that the average date of the last killing frost in the spring in the region including La Crosse County falls between May 1 and May 10, while the average date of the first killing frost in the fall comes between October 1 and 10. It will be observed from these charts that the length of growing season becomes shorter as the distance back from the Mississippi River increases. From the data on

these two charts the approximate length of the growing season for any portion of the State can be readily determined.

The following table gives the record of the Weather Bureau Station at the city of La Crosse. The station is located on the first terrace above the River and has an elevation above sea level of 681 feet. While these records will apply to practically all of the county within the Mississippi Valley, they should not be taken as being correct for the upland portion of the area. From these records it will be seen that at La Crosse the mean annual temperature is 46°, with a maximum of 104° and a minimum of —43°. This gives a total range of 147°, which is greater than is recorded for points in the eastern part of the State, where the influence of Lake Michigan is felt. The extremes indicated are seldom recorded, although during the winter months the temperature frequently goes below zero, and during the hottest part of the summer it occasionally reaches 95°. The winters are severe and the snowfall is heavy, the average being 39.9 inches. The summers are comparatively short, but the growth of all vegetation is rapid.

The mean annual precipitation of 30.9 inches is well distributed throughout the growing season. During the months of May, June, July, August, and September the mean for each month is over 3 inches. Thunderstorms are of frequent occurrence and are sometimes accompanied by high winds and hail. Destructive storms, however, are of rare occurrence. The prevailing winds are from the south and their average velocity is 7.2 miles per hour.

Records extending over a period of 37 years indicate that the average date of the first killing frost in the fall at La Crosse is October 1 and that of the last killing frost in the spring April 30. This gives an average growing season of about 142 days free from killing frosts.

The following table gives the normal monthly, seasonal, and annual temperature and precipitation, as recorded at La Crosse:

Normal monthly, seasonal, and annual temperature and precipitation at La Crosse.

Month.	Temperature			Precipitation.			
	Mean	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	° F.	° F.	° F.	Inches.	Inches.	Inches.	Inches.
December ...	23	61	—26	1.4	1.3	0.3	7.7
January	16	57	—43	1.1	.2	1.5	9.6
February ..	19	65	—34	1.1	1.4	1.3	8.9
Winter ...	19	.....	.....	3.6	2.9	3.1	26.2
March	31	78	—23	1.6	.3	1.0	7.5
April	48	87	10	2.4	1.9	1.4	1.6
May	60	96	29	3.5	.5	3.1	.0
Spring	46	.....	.....	7.5	2.7	5.5	9.1
June	69	98	33	4.4	1.0	2.8	.0
July	73	104	46	4.1	1.8	8.9	.0
August	71	101	39	3.3	2.2	5.0	.0
Summer ..	71	.....	.....	11.8	5.0	16.7	.0
September ..	62	97	24	4.0	4.4	10.9	.0
October	50	88	6	2.5	1.6	7.6	.2
November ..	34	72	—21	1.5	.8	1.2	4.4
Fall	49	.....	.....	8.0	6.8	19.7	4.6
Year	46	104	—43	30.9	17.4	45.0	39.9

SUMMARY

La Crosse County is located in the western part of Wisconsin, and comprises an area of 481 square miles, or 307,840 acres. It may be divided broadly into two divisions, the valleys and the uplands. The Mississippi River borders the county on the west; the La Crosse River traverses it from east to west, and the Black River forms a part of the north and northwestern boundary. Along all of these rivers there are valleys, varying in width from 1 to 5 miles, within which distinctly formed terraces are developed, the highest being about 70 feet above the Mississippi River. The topography of the valleys is level to undulating, the highest terraces having a rolling surface due to wind action. The upland country consists of a series of ridges with an elevation of 200 to 500 feet above the streams which traverse the region. The slopes are usually steep and rocky. On the ridge tops and gentle slopes are found the most extensive areas of highly developed soil in the area.

La Crosse, the county seat, is situated on a sand flat in the valley of the Mississippi River at an elevation of 681 feet above sea level.

Farming operations were begun in 1844. The county attained its present limits in 1857. It is traversed by three railroad systems and one short-line railway, and these, together with the opportunity for shipping afforded by the river, afford excellent transportation facilities. La Crosse is 137 miles from Minneapolis and 283 miles from Chicago.

La Crosse County lies within the unglaciated portion of the State and the soils have been derived from the mantle of loess which covers a large part of the area, from the disintegration of the underlying rocks and from the material washed down from

the slopes, transported by the rivers, and deposited as terrace formations.

Including Rough stony land, River wash, Peat, and Meadow, 16 types of soil have been recognized and mapped in the county.

Knox silt loam, with its steep phase, is the most extensive type and is found throughout the upland portion of the county, occupying the tops of hills and ridges and extending down the slopes. It is a good general farming soil and dairying is carried on quite extensively. It produces a better quality of grain than any of the other types in the area.

The Waukesha series includes the dark colored terrace soils of the area which are found chiefly along the Mississippi and La Crosse Rivers. The heavy types are dark brown to black in color, very productive, and highly developed. The sandy types are lighter in color and have a lower agricultural value. The types mapped as belonging to the Waukesha series are Waukesha silt loam, with a coarse phase and a heavy phase, Waukesha fine sandy loam, sandy loam, and gravelly sandy loam.

The Plainfield series includes the light colored terrace soils which are found chiefly in the valleys of the Mississippi and Black Rivers. The soils resemble the soils of the Waukesha series except that they are light in color and contain a smaller amount of organic matter. The types mapped as belonging to the Plainfield series are the Plainfield sand and sandy loam.

The Boone series includes soils which have been derived from the disintegration of the Potsdam sandstone. They are light colored upland soils and because of the high sand content and rather loose, open structure of the subsoil their agricultural value is rather low. Two types the fine sandy loam and the fine sand were mapped.

The Wabash series consists of alluvial material within the present flood plain, and occurs as narrow, low-lying strips chiefly along the streams which traverse the upland region. The soils are black or dark brown, and when drained are very productive. Two types, the loam and the silt loam, were mapped.

Rough stony land includes the steep, rocky slopes throughout the upland portion of the area, which are generally non-agricul-

tural. Its chief value lies in the pasture which it affords and the timber which is found upon it.

Meadow consists of the low-lying land within the present flood plain of the Mississippi, Black, and La Crosse Rivers. It is subject to overflow, very poorly drained, undeveloped, and so complicated that no separation into types could be made on the scale used.

Peat includes the partially decomposed vegetable matter which occupies low, poorly drained areas, chiefly along streams. This material is very limited in extent and of but little importance in La Crosse County.

Riverwash consists of the sandy material which is flooded each year and moved about somewhat by each high water. Areas of this material are inextensive and of little value for cultivated crops.

Over the greater part of the county agriculture is well developed, and the well-kept farmsteads indicate the general prosperity of the farmers. The leading type of agriculture is general farming, with dairying as the main feature. The crops most extensively grown, in the order of their acreage, are hay, oats, corn, barley, rye, wheat, and potatoes. In addition to these, some alfalfa, sugar beets, peas, and truck crops are grown. Small fruits and berries are successfully produced to a small extent, but apple culture has not been developed commercially. There are only a few orchards in the area. It is recognized that the silty upland soils produce a better quality of grain, though smaller yields, than the dark-colored soils of the river terraces, the grain plants being likely to lodge on the latter soils, especially in wet years. These soils are better adapted to corn than any of the upland types. The most common rotation followed consists of corn, followed by a small-grain crop, such as oats, barley, wheat, or rye, for one, two, or sometimes three years, when the field is seeded to clover and timothy, to be cut for hay for two years, after which it is again plowed for corn. The steep slopes afford excellent pasture and are usually kept in grass to prevent erosion. Trucking could be more extensively developed and dairying could be profitably enlarged. Alfalfa should be tried by all dairy

farmers, and such crops as sugar beets, cabbage, peas for canning, and cucumbers for pickling, should be grown to a greater extent where conditions are favorable.

The mean annual temperature at La Crosse is 46° and the precipitation is 30.9 inches. The rainfall is well distributed. The average length of the growing season free from killing frosts is about 142 days.

KEEP THE MAP.

The Experiment Station will publish bulletins from time to time, dealing with the management of the different types mapped, so that some way should be found by each person receiving a copy of this report to keep the map permanently. If the map is folded in such a way as to have the part you are interested in of a convenient size, and then have a simple frame with glass made to hold it, it can be kept indefinitely. Since some of the colors fade after being exposed to strong light for a long time, it would be a good plan to have a protecting flap of dark cloth over the map when not in use.