WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

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SOIL SURVEY IN COOPERATION WITH THE COLLEGE OF AGRICULTURE

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SOIL SURVEY

OF

BUFFALO COUNTY

WISCONSIN

BY

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OF THE

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

AND

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OF THE

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TABLE OF CONTENTS

CHAPTER VI.

CHAPTER VII.

CHAPTER VIII.

CHAPTER IX.

SUMMARY.

ILLUSTRATIONS

PLATES AND FIGURES.

MAP.

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, course sand, and fine gravel, and the following table gives the size of the soil particles of which each group or separate is composed.

TABLE SHOWING SIZE OF SOIL PARTICLES

	Millimeters
Fine gravel	2.000–1.000
Coarse sand	1.000– .500
Medium sand	.500– .250
Fine sand	.250– .100
Very fine sand	.100– .050
Silt	.050– .005
Clay	.005– .000

1 millimeter equals .03937 of an inch.

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 *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, where the parent rock was largely sandstone, 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 BUFFALO COUNTY, WISCONSIN

CHAPTER I.

GENERAL DESCRIPTION OF THE AREA.

Buffalo County, Wis., borders the Minnesota State line about midway between the south State line and Lake Superior. It is bounded on the north by Pepin and Eau Claire Counties and on

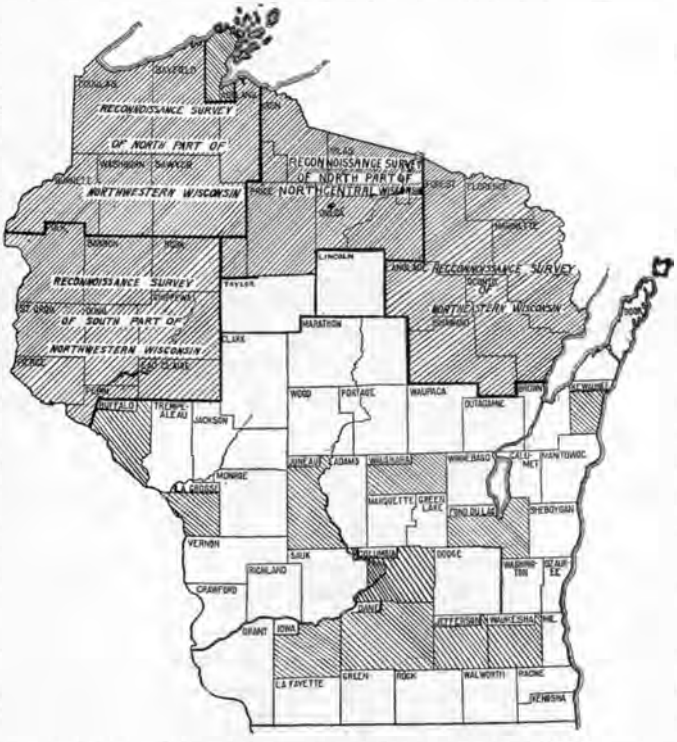


FIG. 1.—Sketch map showing area surveyed.

the east by Trempealeau County, the southern part of the eastern boundary line following the Trempealeau River. The south boundary line runs in a southeast and northwest direction, and

the county is separated from Wabasha and Winona Counties, Minn., by the Mississippi River. The northwestern part of the county is separated from Pepin County by the Chippewa River. The county is about 27 miles wide in the northern part and gradually tapers to a point at the southern extremity. It is about 38½ miles long, and has an area of 687 square miles, or 439,680 acres.

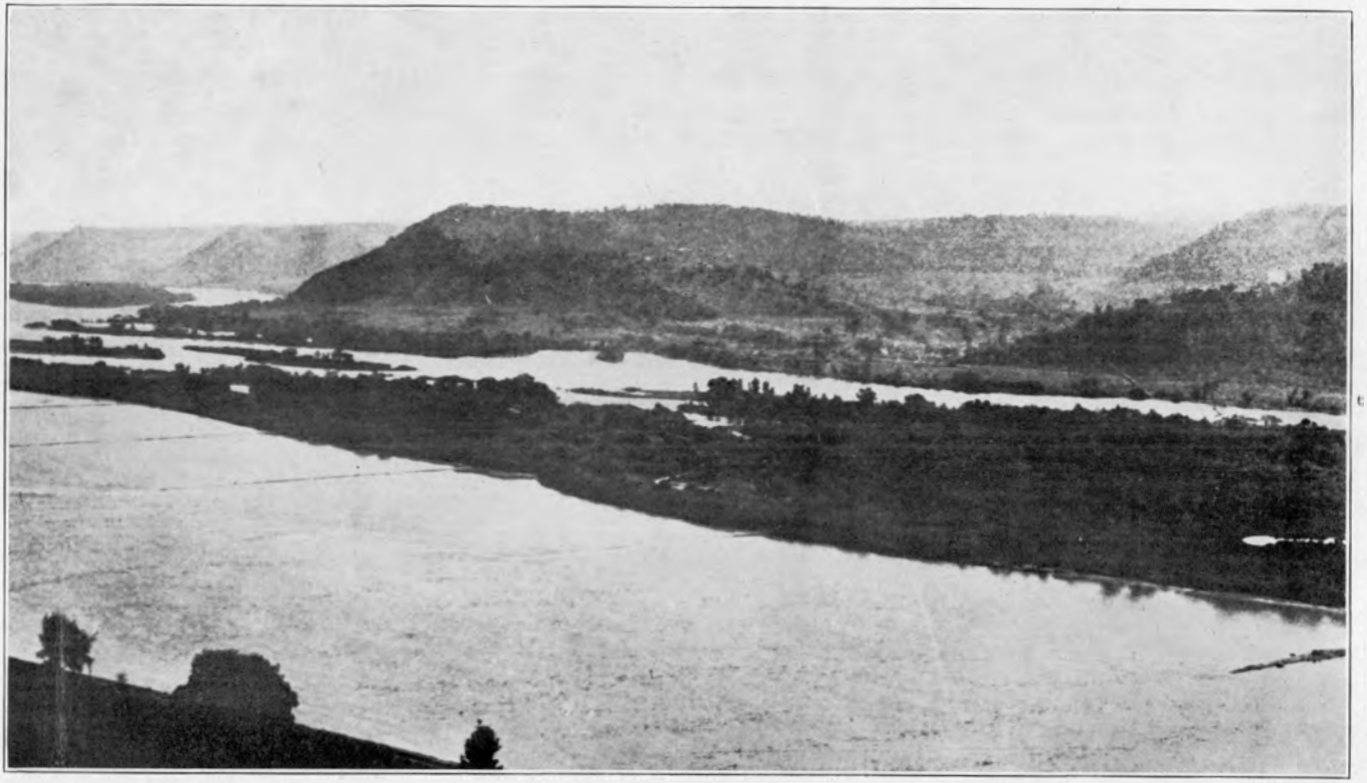
Topographically, Buffalo County consists of two plains, a lower and higher. The latter covers nine-tenths or more of the total area of the county, the former occurring only in the northeastern part as belts of lowland, one of them being followed by Buffalo River to Mondovi and continuing in about the same direction northwestward to the county line and beyond, and another, followed by Elk Creek. These are connected by a belt along Buffalo River south of Mondovi. This is a rolling and undulating plain lying about 300 feet below the level (1,100 feet) of the higher plain. It is the extreme western part of an extensive plain lying to the east, and has been formed on a soft sandstone of Paleozoic age. It is bounded by an escarpment terminating in a rather abrupt slope from the higher plain. The two branches of the lower plain are separated by an outlying remnant of the upper plain. The lower plain is the product of erosion in an advanced stage of development, and lies now at low relief.

The topography of the upper plain is hilly, due to complete dissection and it now stands in a stage of maturity.

According to the census of 1910, the population of Buffalo County is 16,006. The rural population is evenly distributed through the county.

Alma, with a population of 1,011, is the county seat. It is situated on the Mississippi River and has the advantage of both railroad and water transportation. Fountain City, with a population of 1,031, is also on the Mississippi River in the southern part of the county. Mondovi, with a population of 1,325, is the largest incorporated town in the county. It is situated on the Buffalo River, in the northeastern part of the county, and is the center of a prosperous agricultural community. Nelson and Cochrane are smaller places on the railroad, while Gilmanton, Montana and Waumandee are small villages off the railroads.

All the railway lines thus far built have kept to the valleys. There are thus considerable areas which are at some distance from shipping points. The Chicago, Burlington & Quincy Rail-



VIEW ALONG THE MISSISSIPPI RIVER.

In some places the bluffs come to the water's edge, while in other places the floodplain is several miles wide.

road, running from Chicago to Minneapolis and St. Paul, traverses the county, following close to the Mississippi River and passing through Fountain City, Cochrane, Alma, and Nelson. The Chicago, St. Paul, Minneapolis & Omaha Railway from Fairchild reaches into the northeastern corner of the county and terminates at Mondovi. A branch of the Chicago, Milwaukee & St. Paul Railway follows the Chippewa River to the Mississippi on the Buffalo County side, but is of little service to the county, since for most of its extent it lies within the flood plain of the Chippewa River, and is very difficult to reach. The extreme southern end of the county is crossed by a branch of the Chicago & North Western and also by the Green Bay & Western railroad. The distance from Alma to Minneapolis over the Chicago, Burlington & Quincy Railroad is 89 miles and to Chicago 353 miles. From Mondovi to Chicago over the North Western line the distance is 327 miles, and to Milwaukee 246 miles. The Mississippi River affords water transportation, but at present is used to a comparatively small extent.

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 hauling heavy loads is difficult. Throughout sandy portions of the county, where foreign material has not been applied, the roads are naturally sandy. All parts of the county are supplied with rural mail-delivery service, and telephones are common throughout the country districts.

Local towns provide a market for varying quantities of farm produce and supply shipping points from which produce is shipped to outside markets. Winona, Minn., just across the Mississippi River, constitutes a market for produce from the southern part of the county. Minneapolis, St. Paul, Chicago, and cities within the State receive produce from Buffalo County.

Buffalo County lies in the unglaciated part of Wisconsin and in its geologic formations, topography, and soil conditions is representative of a very large area in the southwestern and western part of the State. Three general physiographic divisions are easily recognizable: (1) The uplands proper, which are gently undulating to strongly rolling and in places even steep and rough in topography; (2) the terraces and level valley areas

occurring in the position of terraces; and (3) the overflow plains of the present streams.

The soils in the last two divisions have been derived to a very large extent, if not wholly, from the soils of the first division and represent wash material transported by the streams and deposited in their flood plains. The material of the first bottoms is of recent deposition and the process is still going on; but those in the terraces are much older, some probably dating back to glacial time or before, with the result that through weathering the surface has come to be more like that of the uplands than that of the first bottoms.

The upland soils are predominantly silty, as is the case throughout the unglaciated area of the State. The great extent of silty soils has led some to believe that a blanket of wind blown material originally overspread most of the region and that the soils are derived for the most part from this deposit and are residual from the underlying formations which in an undecomposed state are now usually found at a depth of less than 15 feet from the surface and outcrop in many places. The silty material is of a rather smooth texture and comparatively free of stone or other coarse material, but it is just such material as would be expected to result from the mature weathering of the country rock, consisting of fine and cherty limestones, shales, and sandstones.

Over a large part of the county the uppermost rock consists of the lower Magnesian limestone. Once the limestone was continuous as the surface formation, but as the result of erosion which has deeply dissected and worn away much of the old plain, it is now found only as remnants capping the higher hills and ridges and giving way in all the lower levels to the Potsdam sandstone, the immediately underlying formation. The limestone and a massive phase of the Potsdam sandstone outcrop along the upper slopes and give rise to steep stony slopes and cliffs. At lower levels the principal rock is a thin-bedded sandy shale or shaly sandstone with occasional layers of a heavier shale.

underlain by limestone, characterized in general by a brownish-gray to brown silty soil underlain by a yellowish brown or buff-colored silty clay loam subsoil, are classed in the Knox series. The soils of the slopes below the limestone lying mainly on the sandstone and shale layers and which have been made up in part or wholly of materials derived from the sandstone, have been in-

cluded in the Boone series. Where these slope soils are distinctly dark in color, they are included in the Bates series. The Boone series includes a fine sandy loam and a fine sand. The Bates series, of which the area is small, includes a silt loam and a fine sandy loam.

Distinct terraces are developed in the Mississippi Valley and also in the larger tributary valleys. The terraces in tributary valleys are occupied largely by soils which are predominantly silty, with comparatively little sand, while in the Mississippi Valley and Chippewa Valley the greater part of the material outside of the present flood plain is of a sandy nature. This terrace material is classed with three series—the Waukesha, which is black or dark brown; the Lintonia, which is light colored and not underlain by gravel or other coarse material; and the Plainfield, which is light colored and rests upon a substratum of sand and gravel. In the Waukesha series there are two types, the gravelly sandy loam and silt loam. In the Lintonia series three types are recognized—the Lintonia silt loam, fine sandy loam, and fine sand; and in the Plainfield series three types—sand, fine sand, and fine sandy loam.

In many of the smaller valleys tributary to the Mississippi and Chippewa Valleys the present flood plain consists of a dark-colored material, variable in texture and color, and poorly drained. This material has been carried down from the unglaciated higher lands, transported by streams and redeposited. Such material is classed with the Wabash series, and in the present survey one type—the Wabash loam—is recognized and mapped. The soil of the present flood planes of the Chippewa and Mississippi Rivers which, in addition to being poorly drained, is subject to overflow by these streams at intervals, has been classed with the Genesee series. This series includes a fine sandy loam, silt loam, and silty clay loam.

On the steep slopes throughout the upland part of the county there are extensive tracts where the outcrops of rock are so numerous or the surface so steep and broken that the land is of no agricutural value except for the little pasturage it affords. Such land has been classed as Rough Stony Land and may be considered as non-agricultural.

A few low-lying acres occur in which the material consists of vegetable matter in various stages of decomposition. Such tracts are mapped as Peat.

The following table gives the name and the actual and relative extent of each of the soils* mapped in Buffalo County.

Soil	Acres	Per cent
Knox silt loam	104,256	
Steep phase	105,216	47.6
Rough stony land	62,912	14.3
Wabash loam	36,480	8.3
Genesee soils	31,872	7.3
Boone fine sandy loam	20,200	
Rolling phase	1,984	6.7
Waukesha silt loam	19,520	4.4
Lintonia silt loam	7,168	1.6
Bates silt loam	7,168	1.6
Boone fine sand	6,656	1.5
Peat	6,400	1.5
Plainfield fine sandy loam	6,080	1.4
Lintonia fine sandy loam	3,904	.9
Plainfield fine sand	3,776	.9
Plainfield sand	3,776	.9
Bates fine sandy loam	1,344	.3
Waukesha gravelly sandy loam	1,088	.2
Lintonia silt loam	640	.1
Total	439,680	

* The soil classified in this report as Knox silt loam with its steep phase, includes what was mapped by the U. S. Bureau of Soils as Boone silt loam, with a rolling phase, and Union silt loam with a steep phase. The Waukesha silt loam and gravelly sandy loam were originally included in the La Crosse series. The Plainfield fine sandy loam and fine sand also include some soils previously mapped by the Bureau of Soils as belonging to the La Crosse series.

CHAPTER II.

LIGHT COLORED UPLAND SOILS.

KNOX SILT LOAM

Description.—The surface soil of the Knox silt loam to an average depth of 10 inches consists of a light-brown or grayish friable silt loam. When dry it has a smooth, floury feel. The amount of organic matter present in the soil is rather small, and this accounts, in part, for the light color. The subsoil consists of a yellowish-brown or buff-colored silt loam, which becomes heavier, more compact, and claylike with increased depth, until, at about 18 to 24 inches, it is a silty clay loam. The soil mantle extends to an average depth of probably 8 to 12 feet. The underlying rock was not reached with the soil auger except in local spots on a narrow ridge, at the edge of a bluff, or at the head of a ravine. Both soil and subsoil are practically free from stone, gravel, or other coarse material, although occasional fragments of chert are to be seen on the surface or in the subsoil close to the limestone rock. On account of the heavy subsoil and the uniformly silty character of the soil, the type is commonly referred to by farmers throughout the county as a clay.

The most important variation in this soil has been designated as the steep phase, on account of its steep slopes and rough, uneven topography. This phase is described in greater detail following the description of the typical soil.

Minor variations in the typical soil occur, chiefly on the narrow ridges, where the surface soil has sometimes been removed and the heavy subsoil exposed. In such places the depth to the underlying rock is also less than over the more extensive areas of this type and in some instances it can be reached with a 3-foot auger. On some of the lower slopes the wash from adjoining higher land has accumulated to a small extent, and the surface soil in such places is somewhat deeper than the average. On some slopes the soil is somewhat darker in color and contains more

organic matter than typical. While a number of such minor variations occur, this soil, taken as a whole, is remarkably uniform.

Extent and Distribution.—The Knox silt loam, with its steep phase, is one of the most important soil types in Buffalo County. It occurs in all parts of the county and occupies the limestone ridge tops of the entire upland portion of the survey. It lies at a higher level than any other type and includes all of the lands above the rough stony escarpments. It also covers many of the valley slopes descending to the level valley terrace soils.

Topography and Drainage.—The topography of the Knox silt loam as it occurs on the ridge tops may be classed, in most cases, as undulating to gently rolling. On the narrower ridges and at the heads of valleys it becomes more rolling and grades into the steep phase, while over portions of the broader ridges the surface is nearly level. That part of the typical soil occupying the lower slopes and lower outlying ridges is gently rolling, but often grades abruptly into the steep phaze or Rough Stony land.

On account of the fine texture and the peculiar structure of this soil a considerable proportion of the type is subject to erosion, and care must be exercised in selecting crop rotations and in the cultivation of all slopes, even though the slope is gentle. Some erosion will take place even on rather gentle slopes where intertilled crops are grown or where the ground is left bare and not cultivated for a considerable time. Wherever the slopes are so steep that intertilled crops can only be grown at intervals, or where no crops other than grass can be grown without danger of serious erosion, such slopes have been included with the steep phase.

Owing to the character of the topography, the natural surface drainage of the type is good, so that tile drains will doubtless never be necessary except possibly on some of the broader ridges, where the surface is more nearly level than elsewhere.

Origin.—The Knox silt loam has the uniform silty texture, the buff-colored subsoil, and other field characteristics of a loessial formation, though it is considered that part of the material has been derived from the underlying rock, the lower Magnesian limestone. The material forming this soil is sometimes found to be in a slightly acid condition. The subsoil is less acid than the soil, and frequently shows no acidity at all.

Native Vegetation.—The original timber growth on this type consisted chiefly of white, black, and bur oaks. Maple, poplar, hickory, white birch, and basswood are also commonly seen, and hazel brush is frequently abundant. Some of the older settlers state that most of the timber was originally on the ridges, and that many of the valleys were treeless, being burned over annually by the Indians, who used some of the land for grazing. Some of the wider valleys, with dark-colored slopes, were timbered sparsely with oak and were called "oak openings." Most of the timber which is now standing is confined to the steepest slopes and associated chiefly with the Rough stony land. Small wood lots are also seen on top of some of the narrow ridges.

Present Agricultural Development.—By far the greater part of the typical Knox silt loam is under cultivation and highly improved, while much of the steep phase is still in timber or pasture land. The leading type of agriculture followed consists of dairying in conjunction with general farming. As the growing of wheat, which was a very important industry 20 to 25 years ago, declined, the raising of live stock and the dairy industry gradually developed.

The principal crops grown at the present time and the average yields obtained are as follows: Corn, 40 to 45 bushels; oats, 35 to 45 bushels; barley, 30 to 35 bushels; wheat, 20 to 25 bushels; and hay, 2 to 2½ tons per acre. Oats are grown more extensively than any other grain crops. The acreage of barley is considerably smaller than that of oats and the acreage devoted to wheat is still less. The quality of the small grains grown on the Knox silt loam is excellent, and this soil is generally held to be a better grain soil than any of the other soils of Buffalo County. Corn, on the other hand, does not do so well on this type as on the darker colored soils of the Wabash or Waukesha series, though the crop is successfully grown wherever this soil occurs. Most of the grain and corn grown is fed to stock on the farms, though elevators at Alma, Fountain City, and Mondovi still ship much oats and barley and some wheat. Where the land is well farmed but little trouble is experienced in growing clover. When the snowfall is light the alternate freezing and thawing of the ground sometimes kills out clover. Pasturage, in general, is excellent, being scant only in very dry weather, or on shallow slopes or knolls exposed directly to the sun.

Buckwheat, rye, and sorghum are produced on this soil, but their acreage is never large. Alfalfa is successfully grown by a few farmers and the acreage will no doubt be gradually increased, as the crop provides excellent feed, which is of great value, especially to the dairy farmers. Potatoes are grown for home use on practically every farm, but seldom on a commercial scale. Tobacco is grown to a small extent, but the crop is not increasing in favor. Beans and peas are not extensively grown on this type, being confined chiefly to soils of lighter texture. Garden crops, such as strawberries, tomatoes, lettuce, radishes, and cucumbers, and bush berries all do well and are grown for home use, but seldom on a commercial scale.

The rotation of crops most commonly followed on the Knox silt loam consists of a small-grain crop, such as oats, barley, or wheat, with which clover and timothy are seeded, hay being cut for two years, after which the land is plowed for corn. A field may be pastured for a year, but on account of the large amount of steep land on most of the farms such land is used for pasture and the hay fields are not often grazed.

When the soil is cultivated under the proper moisture conditions but little difficulty is experienced in securing a good seed bed. If handled when too wet there is danger of puddling. Where the clay loam subsoil is near the surface or exposed on the narrow ridge tops, cultivation is more difficult than on the broad ridges where the surface soil has a good depth. Because of the rather low organic-matter content, the type is somewhat less loamy than some of the other silt loams. Practically the only fertilizer used on this soil is stable manure. A second crop of clover may be plowed under, but the practice of green manuring is not at all common. Fall plowing is practiced to some extent, and this is advisable where there is but little danger from erosion, but on slopes which are apt to wash it is better to plow in the spring.

While farming is well developed on this type and most farmers are prosperous, there is considerable room for improvement.

Land of this type has a considerable range in value, depending upon location, improvements, and the character of the surface. The best improved farms, conveniently located, and with a large proportion of their acreage on the broadest ridge tops, range in value from $75 to $100 an acre. Most farms include land of the steep phase of this type, and many include some Rough stony

land, which detract from their value. In some remote parts of the county, and where there is a large proportion of the steep land on the farms, values range from $30 to $60 an acre.

Knox Silt Loam, Steep Phase.—In general physical character and appearance the soil of the steep phase is essentially like the typical soil, the basis of separation being one of topography. As a whole the color and texture of the soil may be slightly lighter than the typical soil, and the average depth to rock is less. Because of its steep, broken character, this phase has a lower agricultural value than the typical soil.

The steep phase of the Knox silt loam occurs in all parts of the county intimately associated with the main type and frequently grading into it in such a way as to make the drawing of a definite boundary line difficult. It occupies steep slopes generally about the heads of small streams heading in the limestone areas above the Rough stony land. On these slopes, which form the more or less steep sides of the valleys, the silt soil is subject to erosion and careful methods are often necessary to prevent destructive ditch formations while these slopes are under cultivation. When the steep slopes are neither wooded, in pasture, nor covered by a growing crop to protect them, the soil washes badly and ditches are quickly and deeply cut into the hillsides. When erosion has once started in this way it is difficult to check, so that methods of prevention are very important.

The natural drainage of the steep phase is good, except in small areas along the slopes where springs and seeps may occur. The greater part of it is so rolling that too large a percentage of the rainfall runs off, and crops often suffer from lack of moisture.

The Knox silt loam, steep phase, has practically the same origin as the typical soil, though as a rule there is less depth to bedrock, and chert fragments occur on the surface and through the soil mass in greater abundance. As with the typical soil, it is partly residual from a cherty magnesian limestone and partly of loessial origin.

The original timber growth consisted of the same trees as on the typical soil, oak predominating. Most of the standing timber outside of the bottom lands is now found on this phase and on the Rough stony land with which it is associated, though a considerable proportion of the steep land is cleared and either in cultivation or pasture land.

The same crops are grown on the steep phaze as on the typical soil, but less corn and other intertilled crops are grown and more of the land is in grass and pasture than on the main type. The ordinary yields of all crops are somewhat lower. Because of the steep character of the surface the phase is more difficult to work than the typical soil. The steepest portions of the phase are now in timber or pasture land and the remainder is devoted to general farming.

Land values are subject to considerable variation. The phase usually forms only a portion of the farms, occurring in association with the typical soil and in some cases also with Rough stony land. It is estimated, however, that the value of this class of land alone would range from $25 to $50 an acre, depending upon the degree of slope and the area under cultivation, as well as upon the location and improvements.

Chemical Composition and Management.—Numerous analyses of the Knox silt loam indicate that it contains on the average about 900 pounds of phosphorus, 35,000 pounds of potassium and 2,700 pounds of nitrogen in the surface soil eight inches of an acre. Analysis of the timbered soil as compared with cultivated fields indicates that cropping reduced the content of phosphorus in the virgin soil to a considerable extent in some cases. The most severe drain on phosphorus was probably during the grain raising days of 30 or 40 years ago and the removal of this element of plant food is possibly not so rapid now under the dairy system of farming.

The total potassium is sufficient to meet the needs of crops for a long time to come, but the availability of the mineral for the use of plants can be greatly increased by having a supply of decomposing organic matter in the soil. The improvement of this soil as a whole calls for more organic matter and may be added in the form of green manuring crops turned under or as manure.

Many fields have become sour or acid on the surface through continued cropping, especially on the higher ridges, the soil in the valleys and on the slopes being supplied with lime dissolved by rain and flood water from the limestone which caps the ridges. Where trouble with clover or alfalfa is had, lime will be needed and such fields should be tested with blue litmus paper for acidity. Where the soil is acid a ton of finely ground limestone per

VIEW SHOWING LINTONIA SILT LOAM ON THE TERRACE JOINING THE STEEP SLOPES OF THE UPLAND.

On many of these steep slopes the soil is shallow, and the underlying rock frequently outcrops. Care should be taken to prevent erosion on such slopes when the timber is removed. The steepest slopes should be allowed to remain forested.

acre will be found to help clover, while for alfalfa 2 tons or more should be used.

The question of erosion is an important one on this type of soil and especially on that part designated as steep phase. In many cases the loss of organic matter and phosphorus from the soil by erosion is considerable, and often the fertility and yields on some fields could be greatly improved by proper attention being paid to the arrangements of the fields and crops and the protection of the fields from erosion.

When the slope becomes so steep that the bare ground washes to any extent, care should be used to keep that field in hay or pasture as much as possible or it should be laid out in alternate strips of cultivated crop and sod land if practicable. Where the slope is so steep that modern farm machinery cannot be used, cultivated crops should seldom if ever be grown. When timbered such slopes should remain so and be used for pasture only. Badly eroded slopes can be restored by proper cropping and management. For further data on erosion see Bulletin 272 of the Wisconsin Experiment Station.

Chemical analyses of Lintonia silt loam show it to contain on the average slightly more of the essential plant food elements than occur in Knox silt loam which it very much resembles in texture, structure, and color. Suggestions offered for the improvement and management of the Knox silt loam will also apply to this type of soil except as regards erosion. While this soil is eroded in some cases, the topography being level sheet erosion does not often occur, and methods for combatting gullies only are necessary.

Lintonia Silt Loam.

Description.—The surface soil of the Lintonia silt loam to an average depth of 10 inches consists of a brownish-gray, friable silt loam, which becomes lighter colored on drying and frequently has a whitish appearance. The amount of organic matter present in the surface soil is comparatively small, and this accounts in part for the light color of the material. A slight acid condition has developed in places in the surface soil, as indicated by the litmus-paper test. The subsoil consists of a yellowish-brown or buff-colored silt loam, which usually becomes somewhat heavier and more compact with depth, and at 24 to 30 inches may be

a silty clay loam. Below this depth there is often a considerable amount of fine and very fine sand, and this mixture extends to a depth of 3 feet or over and grades into stratified fine sand, with layers of gravel in the lower depths. The type is subject to some variation, and in Glencoe Township and the valley of Buffalo River the soil is somewhat darker than typical.

The soil quite closely resembles the Knox silt loam in texture and color, but differs from it in topography, origin, and the position which it occupies.

Extent and Distribution.—The most extensive areas of Lintonia silt loam are found in the Buffalo River Valley in the vicinity of Tell, where terraces of this soil have a width of from one-half to three-fourths of a mile, and these frequently extend back to tributary valleys for 1 mile to 3 miles. A number of areas also occur in Little Bear Creek Valley in the northwestern part of the county. Lower Big Waumandee creek valley and tributaries, and tributary valleys of the Trempealeau River in the southeastern part of the survey also contain quite extensive remnants of Lintonia silt loam terraces.

Topography and Drainage.—The surface of the Lintonia silt loam is usually level or nearly so, frequently having a gentle slope toward the stream channels along which it occurs. The type occurs as terraces, usually rather narrow, but extending along the streams for considerable distances. The part adjoining the upland rises slowly and frequently grades into the Knox silt loam so gradually that the boundary line must be arbitrarily placed. Near the Mississippi Valley the terraces of this soil have an elevation of 20 to 30 feet above the present flood plain, but as the distance back from the Mississippi River increases, the elevation of the terraces above the flood plain becomes less, and the difference finally is not over 4 or 5 feet. As this type is found chiefly at the foot of considerably higher lying slopes, which are often very steep, large quantities of water must pass over the terraces during heavy rains, and as a result deep ravines are frequently formed. Such gullies may become a source of great expense and loss to individual farms. The natural drainage of this type is usually good, but there are a few places where the surface is nearly level, and in places over such tracts tile drains could be installed to advantage.

Origin.—The material composing the Lintonia silt loam is largely of alluvial origin and was deposited during glacial

periods when the melting ice sheets greatly increased the volume of water flowing down the Mississippi River and many of its tributaries. The high water in the Mississippi River itself caused a backwater or partly ponded condition in the tributary streams. In these more or less quiet waters the finer particles now forming the soil were deposited. The coarser particles in the deep subsoil were deposited earlier, before the ponded condition prevailed and when the current was swifter. It is probable that a portion of the surface material, especially close to the foot of the bluffs, is partly colluvial, having been washed down the steep slopes from the Boone and Knox silt loam areas, which are always found at a higher elevation.

The gravel in the Lintonia terraces is of glacial origin. In the valley of Buffalo River such gravel is found as far up as Mondovi, though none is found in this valley more than a mile east of Mondovi. Such gravel, however, is found in the valley of Farrington Creek to the west of Mondovi.

Native Vegetation.—The original timber growth on the Lintonia silt loam consisted chiefly of oak, with some hickory and a few other species. Most of the timber has been removed. In the ravines there is now a second growth of sumac, hazel, and other brush.

*Present Agricultural Development.**—Practically all the type, except the more eroded areas, is put to some agricultural use, and most of it is cultivated regularly. The land where erosion is most active is kept in pasture most of the time, or the grass may be cut for hay. The crops generally grown and the yields obtained are: Corn, 45 to 50 bushels; oats, 25 to 40 bushels; barley, 30 to 35 bushels; and hay, 1½ to 2 tons per acre. Potatoes are grown on the type to a small extent for home use, but seldom on a commercial scale. The usual rotation consists of corn followed by a small grain, either oats or barley, or sometimes by one year of each of these crops, and then by clover and timothy mixed, seeded with the grain, the field being cut for hay one or two years, before returning to corn. The stable manure is usually applied to the sod to be plowed under for the corn crops. The methods of cultivation, fertilization, and treatment are practically the same as those practiced on the Knox silt

*For chemical composition and management see the discussion on composition of Knox silt loam on page 22.

loam. The soil is not difficult to cultivate, and where the areas are of sufficient size to form fields or the larger part of a farm, this terrace soil may be considered one of the most desirable types in the county.

Farms made up largely of soil of this type sell for $50 and $80 an acre, depending upon the location and improvements.

CHAPTER III.

DARK COLORED UPLAND SOILS.

WAUKESHA SILT LOAM.

Description.—The surface soil of the Waukesha silt loam to a depth of 12 to 18 inches consists of a dark-brown or black silt loam containing a high percentage of organic matter. Its high percentage of silt and organic matter gives the soil an extremely smooth feel. The subsoil consists of a brown or buff-colored silt loam, which gradually becomes heavier in texture and lighter in color and at 24 to 30 inches consists of a yellowish-brown, compact, heavy silt loam or silty clay loam. In local areas where the drainage is deficient the subsoil shows a slight mottling of light gray or drab. This heavy subsoil extends to a considerable depth and the soil section will probably average 7 to 8 feet in thickness. Below this heavy mantle are to be found stratified beds of sand. Along the Mississippi and Buffalo Rivers and Farrington Creek some glacial gravel may also be found with the sand.

Extent and Distribution.—The largest areas of this soil occur in Little and Big Waumandee Valleys, where it is most typically developed. In the vicinity of Anchorage the black soil occupies most of each valley for a distance of 6 or 7 miles. The area varies in width from one-fourth to three-fourths of a mile. A comparatively extensive area is mapped also at the mouth of Schultz and Newton Valleys west of Mondovi and in Farmington Valley northwest of Mondovi. Strips of this type about one-fourth mile in width and from 1 mile to 3 miles in length are found in a great many of the smaller tributary valleys scattered over the county.

Topography and Drainage.—The surface of the Waukesha silt loam is level or has a very gentle slope toward the streams along which it occurs. In places it occupies a distinct terrace and lies about 6 to 10 feet above the present flood plain of the stream, while in other places it occupies an entire valley floor through

which the stream has cut its channel, with the present water level from 3 to 10 feet below the surface of the type. Natural drainage over most of this type is fairly good. A few of the lower areas are subject to overflow during the heavy rains of spring, but by far the greater proportion is not subject to inundation. A considerable part of the type would be benefited by tile drains, though these have not been installed to any great extent. Because of the gentle slope or level character of the surface, there is no danger of erosion.

Origin.—The material composing the Waukesha silt loam is of alluvial origin and occurs in the valleys of many streams throughout the county. The upper section, consisting largely of silt, was deposited in comparatively quiet waters, but the beds of sand forming the lower section were deposited by more rapidly moving currents. The dark color of the soil is due to the large content of organic matter resulting from the growth and decay of rank vegetation in the presence of moisture.

Native Vegetation.—The native vegetation consists largely of grasses, with some timber, mainly oak, elm, and soft maple. The greater part of the merchantable timber has been removed.

*Present Agricultural Development.**—Practically all of the Waukesha silt loam can be cultivated, and the greater proportion of it is now in farms and well improved. It is one of the most highly valued soils of the county, and with the soils of the Bates series comprises the best corn land. The yields of corn range from 60 to 80 bushels per acre during favorable years, and the ordinary yields are larger than those from the other types in the county. The small grains do well, but the quality is not so good as that of grains grown on the Knox silt loam. Oats and barley each yield about 40 to 45 bushels per acre. An excessive quantity of straw is apt to be produced and these grains, especially oats, are likely to lodge. Clover and timothy do well and pasturage is always good.

A rotation frequently followed consists of corn followed by small grain for 1 or 2 years and then hay for 2 years. Corn is often grown on the same field for 2 or 3 years in succession, and on the whole not enough consideration is given to the rotating of crops. Because of the natural fertility of this soil farmers

*For chemical composition and management of this type of soil see page 33.

have abused it. Cropping has been heavy and in many cases no element of fertility has been returned to the soil.

The Waukesha silt loam is not difficult to handle under proper moisture conditions, but it can not be worked under so wide a range of moisture conditions as the Bates silt loam, which has better drainage. Where the soil is well drained alfalfa can be successfully grown.

Land of this character brings from $80 to $150 an acre, depending upon location and improvement.

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

MECHANICAL ANALYSES OF WAUKESHA 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	0.0	0.3	0.4	1.6	10.9	73.4	13.4
Subsoil	.0	.1	.2	.6	11.4	72.3	15.4

BATES SILT LOAM.

Description.—The surface soil of the Bates silt loam to an average depth of 12 to 14 inches consists of a heavy, black to dark-brown silt loam. The amount of organic matter in the surface soil is large, and the material has the smooth feel characteristic of silt. Litmus-paper tests indicate that the soil is in an acid condition. The subsoil consists of a heavy silt loam of a brown or chocolate-brown color, which gradually becomes lighter in color with depth. At 24 to 30 inches the material becomes a yellowish-brown, slightly sticky, heavy silt loam. Below this depth it frequently becomes lighter in texture and at 40 inches there is usually an appreciable amount of fine and very fine sand. On the higher slopes and tops of knolls the soil is lighter in color than elsewhere, and in such locations the surface material has been eroded, leaving the subsoil exposed. On some of the lower knolls underlain by sandstone the soil is thin and there is more or less coarser material mixed with it, giving it a somewhat sandy texture.

Extent and Distribution.—The Bates silt loam is of small extent, the largest areas occurring directly north of Mondovi, occupying the sloping land bordering Big Bear Creek Valley, along the North Fork of Elk Creek, and the valleys of Big Waumandee and Kammuler Creek. Other scattered areas of small extent occur in various parts of the survey.

Topography and Drainage.—The position which the type occupies is intermediate between the Waukesha silt loam of the terraces and the Knox silt loam of the highest parts of the country. It occupies gentle slopes and even rather rolling upland areas, but these are always parallel with the alluvial valleys and immediately bordering them. The type grades into Waukesha silt loam on the one hand and Knox silt loam on the other, so that there is quite a range in the color of the material. On account of the sloping surface, the natural drainage is excellent, while the slopes are seldom steep enough to cause any considerable damage from erosion.

Origin.—The silty material composing this type of soil is probably of residual origin from a shaly phase of the Potsdam formation or it may be partly loessial. It differs from the Boone silt loam principally in its higher organic-matter content.

Native Vegetation.—The type as a whole is generally known as "oak openings," having been originally timbered with scattered clumps of large oak trees, while the intervening spaces were in a semiprairie condition, supporting a more or less heavy growth of prairie grass.

*Present Agricultural Development.**—The Bates silt loam is one of the desirable types of soil in the county. Because of its great natural fertility, it frequently has been ill used, too little attention being given to crop rotation and fertilization. All the general crops grown in the region do well on this type, and the average yields of some of the crops are considerably higher than on most of the other soils. The soil is especially well adapted to corn, of which the ordinary yield is 50 to 60 bushels an acre. This type and the Waukesha silt loam are the two best corn soils in the county. Barley produces 30 to 35 bushels and oats 30 to 40 bushels per acre. Wheat is still grown to some extent and yields of 25 to 30 bushels per acre are not at all uncommon. The quality of the small grains is not so good as of those grown on the

*For chemical composition and management see page 33.

Knox silt loam. Clover and timothy produce 1½ to 2 tons per acre, and the pasturage is generally excellent. The rotation of crops most generally followed consists of corn, small grains, and hay. Of the small grains, oats is most commonly grown, though barley may also be grown in the rotation following the oats. A few small fields of alfalfa have been established on this soil. Where the acid condition is corrected and the soil inoculated this crop promises very well.

Dairying is the chief branch of farming followed, and hog raising is carried on quite extensively on many of the dairy farms. The buildings and other improvements on this soil are as a rule better than the average. Silos are in quite general use.

Farms located on land of this type have a selling price ranging from $75 to $100 an acre, depending upon improvements and nearness to markets.

Below are given the results of mechanical analyses of samples of the soil and subsoil of the Bates silt loam:

MECHANICAL ANALYSES OF BATES 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	0.0	0.4	0.4	1.4	13.2	68.5	15.9
Subsoil	.0	.2	.2	1.5	16.6	66.7	14.9

BATES FINE SANDY LOAM.

Description.—The surface soil of the Bates fine sandy loam to an average depth of 10 to 12 inches consists of a dark-brown to black fine sandy loam, which contains a large amount of organic matter. When dry the material has a dark-grayish appearance. Litmus-paper tests usually indicate an acid condition. The subsoil consists of a choclate-brown fine sandy loam or loam which becomes lighter in color with depth. At 22 to 24 inches it is frequently a heavy silty loam, and sometimes is quite clay-like in appearance. At 38 or 40 inches the material is usually a yellow fine sandy loam.

The soil is subject to some variation and over small areas ranges from a fine sandy loam to a loam in texture, although the greater proportion of the material is a fine sandy loam.

Extent and Distribution.—The Bates fine sandy loam is one of the minor types of the county, occupying only 2.1 square miles. Nearly all of this type is found on the slopes bordering the south side of the Buffalo River Valley east of Mondovi. Here it occurs as a narrow strip from one-fourth to one-half mile wide, paralleling the valley in an east and west direction for nearly 4 miles.

Topography and Drainage.—This type occupies the lower portion of a long, gently rolling, residual fine sandy loam slope which leads down to the valley from the limestone ridges 3 miles south. The surface of the type is gently undulating and nearly level in places, but usually has a gentle slope toward the river. In a few places it is gently rolling. Because of the texture of the soil and the gentle sloping surface, the natural drainage is good, and there is no serious danger from erosion.

Origin.—While the field work was in progress some doubt was felt as to whether or not this type was in part an old alluvial terrace formation, but because of the undulating to gently rolling surface and the fact that sandstone was found outcropping at its lower edge along the river bottom, the soil was mapped as an upland type and placed in the Bates series.

No evidence of stratification in the subsoil was found, although the soil section has an average depth to the underlying sandstone of 15 to 20 feet.

Native Vegetation.—The original growth of oak on this type was more evenly distributed than on the Bates silt loam, and it appears that no portion of the type was in the condition of prairie.

Present Agricultural Development.—Practically all of the type is now under cultivation, and it is considered a valuable soil. Dairying and hog raising is the leading type of farming, and this is carried on in conjunction with general farming. Corn produces 50 to 55 bushels, oats 35 to 40 bushels, barley about 25 bushels, and clover 1½ to 2 tons per acre. For a long period wheat was the most important crop grown on this soil and yields of 15 to 18 bushels per acre were obtained. The acreage of wheat at present is very small. This is a very good corn soil, ranking with the Bates and Waukesha silt loams in this respect. It is also well adapted to a number of truck crops, but trucking has not been developed to any extent. The soil is easy to cultivate. About the same methods are followed as on the silt loam.

Land of this type sells for $65 to $90 an acre, depending upon such factors as location and improvements.

CHEMICAL COMPOSITION AND MANAGEMENT OF DARK COLORED UPLAND SOILS

These dark colored soils are naturally the most fertile soils in the area. They are generally well supplied with the essential plant food elements and with organic matter which gives them their dark color. The total amount of phosphorus in the surface 8 inches is approximately 1,500 pounds per acre. The total potassium is 35,000 pounds, and the nitrogen from 4,500 to 5,500 pounds per acre 8 inches. Many fields on these soils which have been cropped for some time will in all probability be benefited by the use of a phosphorus fertilizer in addition to the use of manure.

These soils all show some acidity, although it varies with the location and past treatment of particular fields. Where clover and alfalfa do not do well the soil should be examined for acidity and if acid an application of 1,500 to 2,000 pounds of ground limestone per acre to the sour fields will be found beneficial.

Lying at lower levels than the upland soils, these soils often receive the run-off water from higher land, and level or low spots especially need drainage or special methods for taking care of storm water. In some cases tile drainage would be beneficial, in others surface ditches rightly placed would keep the land dry.

On account of their level topography and large content of organic matter, these soils are especially adapted to corn, hay, and other root crops. Grain crops often give large yields, but the quality is often not as good as on the lighter colored soils and oats and barley often lodge badly on these soils. This characteristic varies greatly with the character of the season. In case of low yields on well drained fields, the use of a phosphate fertilizer would hasten the maturity of crops.

CHAPTER IV.

LIGHT COLORED FINE SANDY LOAM SOILS.

BOONE FINE SANDY LOAM.

Description.—The surface soil of the Boone fine sandy loam to an average depth of 8 to 10 inches consists of a grayish-brown fine sandy loam, which in some places contains a considerable amount of medium sand. The amount of organic matter present is not large, but a slightly acid condition is found to exist over most of the type. The subsoil consists of a brown to yellowish-brown fine to medium sandy loam, which usually extends to a depth of over 3 feet.

Both soil and subsoil of this type are subject to considerable variation, though none of the variations are found of sufficient extent or importance to be mapped separately, except the more rolling tracts, which are usually shallow. This variation has been termed the rolling phase and shown separately on the soil map. In smaller sandy areas in the valleys of Bygolly and Little Bear Creeks the subsoil is a brown sandy loam, becoming lighter in color with depth and containing a few small bits of sandstone. Bordering Buffalo River in T. 24, R. 11, in the northern part of the county the soil is slightly finer and heavier than usual, varying from a fine sandy loam to a loam, and often grading into a compact sandy clay loam layer at 18 to 24 inches. This heavy material is again underlain by a yellow sand at 24 to 40 inches. The differences in texture are due in part to the presence of a shaly sandstone layer under the soil in places and also to the proximity of heavier and higher lying soils from which finer particles are often washed. Outcrops of sandstone are not uncommon, though they are not extensive and seldom interfere to any marked extent with cultivation. The depth to the underlying rock is variable, and while it averages considerably over 3 feet, there are places on the tops of ridges and on knolls where there may be as little as 2 or 3 inches of soil. There are also places

over gently rolling tracts where the soil has a depth of only 2 or 3 feet, but such areas are not extensive.

Extent and Distribution.—The Boone fine sandy loam is one of the important types in the county, though there are several which are more extensive. The largest area occurs in the northeastern part of the survey in Naples and Mondovi Townships, lying mostly south of the Buffalo River. A number of smaller tracts are found in the vicinity of Gilmanton along the slopes on the south side of Elk Creek and its two chief branches. Other small tracts are scattered throughout the northwestern corner of the county, and to a more limited extent through the southern part.

Topography and Drainage.—The surface of the Boone fine sandy loam, including the rolling phase, varies from undulating to rolling, and in places it becomes quite steep, though there are but few small areas where the surface is too steep to prevent the growing of the ordinary farm crops. Where the limestone cap remains with sandstone outcropping below, a rather steep, narrow belt of fine sandy loam following the contour is produced, as at the base of the river bluffs at Cochrane and Fountain City. Where the limestone covering is thinner, and where more of the sandstone is exposed, as in Little Bear Creek and Spring Creek Valleys and a few other places, long gently rolling or undulating slopes are found, being rather steep or rolling only near the limestone ridge. In the largest area in the northeastern part of the county, where the limestone capping has been entirely removed, the topography is nearly level in places. The surface rises with a gentle gradient up to long, gently rolling slopes, culminating in low, rolling, oak-timbered knolls, which slope away again to the next valley. The surface of this soil becomes rolling also and even rough in places along the southern edge of the area bordering the outliers of the limestone ridges which project into this type. South of Gilmanton, bordering Elk Creek Valley, is an irregular area of this type covering 3 or 4 square miles where the topography varies from gently rolling to rough and broken.

Because of the sandy nature of this type and its absorptive capacity it withstands erosion fairly well. On some of the steeper slopes, however, and over long, more gentle grades, where the run-off from an extensive area converges, there is some danger from erosion.

On account of the sandy character of the soil and the surface features, the natural drainage of this type is excellent. Where the soil is shallow and where the slopes are steep the type frequently suffers from lack of sufficient moisture, though as a whole it retains moisture fairly well.

Origin.—The original Boone fine sandy loam is largely residual, having been derived from the weathering of the Potsdam sandstone and from a shaly phase of this formation. On some of the slopes it is probable that some of the sandy material has been moved short distances down the slope by washing. Where there is silty material incorporated with the soil it is probable that a part of this has been washed down from higher lying silt loam types. Thus it will be seen that the type may also be partly of colluvial origin, though this phase is of minor importance. In a few places sand dunes have been formed, but these are also of small extent.

Native Vegetation.—The original timber growth consisted partly of black and scrub oak covering the shallow knolls and the lighter portions of the type. On the heavier portions there was some birch and maple. Sumac, hazel brush, poplar, and wild cherry form the second growth in uncultivated places.

*Present Agricultural Development.**—By far the greater proportion of the type is put to some form of agricultural use, and most of it is cultivated. The wooded portion is confined chiefly to the steeper slopes and shallow knolls, which are covered mainly with small oak. As is the case with the county as a whole, most of the type is devoted to general farming, with dairying as the most important branch. In connection with dairying quite a number of hogs are raised. The chief crops grown and the ordinary yields are as follows: Corn, 40 to 50 bushels; oats, 30 to 40 bushels; barley, 35 to 40 bushels; and hay from 1 to 2 tons per acre. Some rye is also grown and it gives fair yields. On some of the level portions of the type some farmers report an increasing difficulty in getting a good stand of clover. Others on the gently rolling phase report no trouble at all, none having been lost in the last seven or eight years. Some very fine stands of clover appear on some of the lighter portions of the type, even though the soil showed a slight indication of acidity in response to the litmus-paper test.

*For chemical composition and management see page 41.

When the county was first settled wheat was grown extensively on this soil, but very little is now produced. It is considered a fair corn soil, and the yields are practically the same as on the Boone silt loam. Potatoes can be grown successfully, though the acreage is not large.

The rotation of crops most commonly practiced consists of corn, followed by oats or barley, with which clover and timothy are seeded. Hay is cut for one or two years, and the field may be pastured for a year before being again plowed for corn. Cultivation of this soil is not difficult, and a lighter class of implements and stock can be used than on the silt loam type.

The selling price of land of this type is quite variable, depending upon location, character of the surface, texture of the soil, and improvements. In the area near Mondovi the gently sloping and nearly level portions of the type sell for $60 to $100 an acre. The rougher places which are more distantly removed from towns are held at $40 to $50 an acre. In Little Bear and Spring Creek Valleys the price of land of this class ranges from $25 to $50 an acre.

Boone Fine Sandy Loam, Rolling Phase.—The rolling phase of the Boone fine sandy loam is separated from the typical soil for two reasons. In the first place the topography is more rolling than the typical soil and in the second place the depth of the soil material to the underlying rock is less than the average for the type as a whole. Because of these two conditions the agricultural value of the phase is considerably lower than that of the typical soil. In fact a considerable proportion of the rolling phase has been left wooded because of its lower value.

In texture the rolling phase is a somewhat lighter fine sandy loam than the main portion of the type, and the depth to rock, which is mostly the Potsdam sandstone, ranges from 1 foot to 3 feet. A few rock outcrops occur, but these are not extensive. The surface of the phase is nowhere found to be so steep as the steep phase of the Knox silt loam, but may be described as consisting of rather low ridges with gentle slopes and as regions where the topography is gently rolling to rolling. Some of the narrow areas of this type found bordering Knox silt loam or Rough stony land have been included with the rolling phase.

The rolling phase has the same origin as the typical soil and the original vegetation is the same. Where this class of land has been cleared the yields are lower than usual for the type, the

soil is more subject to drought, and as a whole is less desirable for farming. That which is now in timber should be allowed to remain so, and where cultivated the most careful methods of soil management should be practiced in order that the productivity may be increased.

PLAINFIELD FINE SANDY LOAM.

Description.—The surface soil of the Plainfield fine sandy loam to an average depth of about 14 inches consists of a reddish-brown heavy fine sandy loam. At about 16 to 20 inches the color becomes a lighter reddish-brown fine sandy loam, and this grades into stratified yellow fine sand at from 24 to 36 inches. Gravel occurs in places in the subsoil of this type south of Mondovi. While this is about the normal for the type, there are a number of variations, and the texture may range from a heavy fine sandy loam to a medium, and in a few places a rather coarse loamy sand. Some variations in color also occur, these ranging from dark brown to nearly black in places. None of the variations, however, were of sufficient extent to be indicated on the soil map.

Extent and Distribution.—The largest and most important area of this type is a long terrace lying between the bluffs and the Mississippi River in the vicinity of Cochrane. This belt varies in width from one-half to a mile, parallels the river for a distance of 6 or 7 miles, and has an elevation above the flood plain of 5 to 20 feet. The texture and organic matter content of this area vary somewhat, it being more sandy and of a lighter color on the side bordering the river than next to the bluffs. The soil occurs also as a narrow belt occupying a terrace bordering the Buffalo River in the northeastern part of the county. A few smaller tracts are found in various stream valleys throughout the county.

Topography and Drainage.—The Plainfield fine sandy loam is a terrace soil and the surface is usually level or slopes gently toward the streams along which it occurs. There are a few places, however, where the surface is undulating or even gently rolling, though such tracts are of small extent. On the whole the type has good drainage, but there are a few places where the surface is lower than usual and in these there is an excess of moisture during part of the year. On the other hand, some of the

lighter textured higher places are apt to suffer at times from drought.

Origin.—This is largely an alluvial soil, the materials having been deposited by the streams when flowing at a much higher level than at present. It is noncalcareous and the type is now slightly acid.

Native Vegetation.—A forest, largely oak, with some elm and soft maple in the lower places, originally grew on this soil. The growth was rather open, with grass among the trees. Some portions of the type were originally in a semiprairie condition.

*Present Agricultural Development.**—By far the greater proportion of the Plainfield fine sandy loam is under cultivation. It is considered a good farming soil. The chief crop grown is corn, which yields 45 to 50 bushels an acre. Oats yield 35 to 40 bushels an acre and barley about 30 bushels. A small acreage of wheat is grown and yields of 20 to 25 bushels an acre are obtained. The yields given above are for the average development of the type. On the more sandy tracts they are somewhat lower, and on the areas of heavier texture they are higher than indicated. This is especially true of corn. Timothy and clover are grown and alfalfa has been tried, but not extensively. Potatoes do well on this class of soil, and it would seem that this crop could well be grown more extensively.

Land of this type sells for $35 to $40 an acre, depending upon location, improvements, etc.

LINTONIA FINE SANDY LOAM.

The surface soil of the Lintonia fine sandy loam consists of 10 inches of light-brown or grayish-brown fine sandy loam which contains only a comparatively small amount of organic matter and which is acid in some places. The subsoil is a yellowish-brown, compact fine sandy loam to a depth of 24 to 30 inches, where the texture and color usually become lighter. In a few instances a layer of compact clay loam was found at 24 inches. This lighter material, which would be classed as a loamy fine sand in most instances, extends to 36 or 40 inches or even deeper, where stratified fine sand is usually found. The terraces upon which this soil is found are often 25 to 30 feet high, and in such places this stratified material extends at least to this depth.

*For chemical composition and management see page 41.

The soil is somewhat variable in texture and in some places, especially on the higher elevations, the surface material is a loamy fine sand. In its texture the type is quite similar to the Boone fine sandy loam, and it is subject to about the same variations.

The Lintonia fine sandy loam is of limited extent and occupies only 6.1 square miles. The largest areas are those bordering the Buffalo River south of Mondovi and along the south side of Farrington Creek west of this place. There is also some of the type in Kammuler Valley north of Fountain City. Small tracts occur in various other places in the county.

The surface of this type is level or gently sloping toward the stream channel along which it occurs. The terrace which the type occupies has the same position and drainage conditions as the terraces of Lintonia silt loam, and this soil is subject to the same danger from erosion. The material composing the soil is also of the same origin, having been deposited when the waters were flowing at a much higher level than at present.

The original timber was chiefly scattered oak, but practically all of this has been removed, except where erosion has rendered the land unfit for cultivated crops.

The greater proportion of this type is under cultivation. It appears that the crop returns are somewhat better from the small areas of this soil in the small valleys than from the larger tracts found in the valley of the Buffalo River. Practically all of the crops common to the region are grown on this soil. Corn yields 30 to 50 bushels; oats, 25 to 40 bushels; barley, 25 to 30 bushels; and clover, 1 ton to 1½ tons an acre. While the soil was frequently found to be in an acid condition by the litmus-paper test, no difficulty was reported by the farmers in getting a stand of clover, except during dry years. Rye is grown, but not so extensively as oats or barley. Fairly good yields are obtained. During ordinary seasons good crops of corn and fair crops of hay are always had. When the rainfall is scanty, however, the soil suffers from the lack of moisture and crop yields are reduced to a greater extent than on soils of heavier texture.

The rotation most commonly followed consists of corn, small grain, and hay. Potatoes might be added to this list. The type is also well suited to small fruits, strawberries, and a number of truck crops.

CHEMICAL COMPOSITION AND MANAGEMENT OF LIGHT COLORED FINE SANDY LOAM SOILS.

The chemical analysis of the soils of this group shows them to be intermediate in chemical composition as well as in texture and value between the light colored heavy upland soils and the light sandy soil group. The total amount of phosphorus in the surface 8 inches is about 800 pounds per acre, of potassium about 20,000 pounds, and of nitrogen from 1200 to 1600 pounds.

Varying degrees of acidity are found on these soils and where best results are not obtained with clover and alfalfa, it will be advisable to apply 1500 to 2000 pounds of ground limestone per acre.

In improving these soils it is necessary first to see that the supply of organic matter is increased. This may be accomplished by growing green manuring crops of which the legumes are best—such as clover, the second crop of which should be plowed under before ripening. The supply of stable manure is often too limited and mineral fertilizers in addition to green manuring crops will be found to increase crops in such cases. Phosphorus in the form of acid phosphate applied at the rate of 300 pounds per acre once in 3 or 4 years will supply the plant food needed. By applying phosphorus and lime any trouble with clover or alfalfa should be overcome and when once these crops are successfully growing the greatest difficulty in building up soil has been overcome.

These soils are adapted to a variety of crops. Corn and small grains do very well but dry weather often injures crops such as grass and clover on these soils more than on the deeper and heavier soils. They are also adapted to potatoes and other truck and garden crops. A rotation which gives good results consists of small grain, followed by clover—the first crop for hay and the second plowed under. Next year corn or potatoes are grown. When the organic matter content has been sufficiently increased or when there is plenty of manure, the second clover crop can be cut for hay or ripened for seed.

CHAPTER V.

GROUP OF LIGHT COLORED FINE SANDS AND SANDS.

LINTONIA FINE SAND.

The surface soil of the Lintonia fine sand consists of a light-gray or yellowish loose fine sand extending to a depth of about 8 inches. This is underlain by a yellow loose fine sand which extends to a depth below the reach of the soil auger. In texture, structure, and color this type is quite similar to the Boone fine sand, but differs from that type in origin and topography. Like the Boone fine sand, it contains only a very small amount of organic matter and is in an acid condition.

The Lintonia fine sand is of very small extent and minor importance in the present survey. It covers only 1 square mile, the largest area occurring in the northeastern part of the county along the south side of the Buffalo River. It occupies a terrace position between the present flood plain and areas of Boone fine sand.

The surface of this type is nearly level to gently undulating, with a gradual slope toward the Buffalo River. On account of the loose structure the natural drainage is excessive and the soil is droughty. While the type occupies a position above the present flood plain, the elevation is never so great as that of the other types of this series, which also occur as terrace soils.

As indicated above, the type occupies a low terrace and the material composing it is of alluvial origin. Possibly a small amount of material has also been washed down from the higher land adjoining, but the proportion of the type that is of colluvial origin is small.

The original timber was chiefly oak, but the growth was rather scattering.

At present nearly all of the type is under cultivation, and most of the crops common to the region are grown. Yields are

low, however, and the soil can only be worked profitably under the best methods of soil management.*

BOONE FINE SAND

The surface soil of the Boone fine sand consists of a brown to yellowish-brown or grayish-brown fine to medium sand extending to an average depth of about 8 inches. This is underlain by a fine sand of a lighter yellow color than the surface, extending to a depth considerably below 3 feet. The amount of organic matter present is very low. There is some variation in the texture of both soil and subsoil and portions of the type might be classed as medium sand, but as the type is inextensive and as the fine sand seemed to predominate it was considered advisable to include all of the material in one type. In section 19 and vicinity in Manville Township the soil is slightly heavier than typical. A portion of it is also somewhat loamy, and as a result more productive than the typical soil.

The largest area of this soil, covering about 3½ or 4 square miles, occurs in Spring Creek Valley, in T. 24, R. 13. Most of the medium sand was found in this region. South of Mondovi and along the south side of the Buffalo River wind-blown areas occur. A few other patches of small extent are found associated with the Boone fine sandy loam in the northern part of the county.

The surface of this type varies from very gently undulating to gently rolling. There are a few low ridges and some low sand dunes, and where the type borders Rough stony land or other types occupying the steep slopes, the surface near the boundary frequently has considerable slope. On account of the surface features and the loose, open character of both soil and subsoil, the natural drainage is excessive and the type is droughty. None of the slopes is sufficiently steep to make the prevention of erosion an important factor in the management of this soil.

In origin the Boone fine sand is largely residual, having been derived from the weathering of Potsdam sandstone. There is but little organic matter present and such a small amount of silt and clay that the loose surface material is readily blown by the wind, and in a number of places low sand dunes have been

*For chemical composition and management see page 48.

formed. The material composing the type is in an acid condition, as indicated by the litmus-paper test.

The original timber growth on this type consisted chiefly of scattered scrubby oak. Coarse grasses and sand burs are also found growing on the type, though there are a number of places where the surface is bare of vegetation and the soil is now drifting.

On account of its loose, open character and the resulting droughty condition, its low content of organic matter, and the fact that it is subject to drifting in places, this soil has a low agricultural value. While most of it is cleared, there is a considerable proportion which is not farmed because of the small yields. Corn produces 20 bushels per acre where the rainfall is well distributed, but the crop if often a failure. Rye produces 8 to 12 bushels, and buckwheat 10 to 12 bushels an acre. Grass and clover are not successfully grown, and the coarse, wild grasses supply little pasturage. Potatoes are not grown extensively, and the yields are small. A portion of the type in section 19, Manville Township, is better than the average. Here corn frequently produces 30 bushels and buckwheat as much as 30 bushels an acre during favorable years.*

The selling price of most of the land of this type ranges from $10 to $15 an acre. The heavy phase, indicated above, has a somewhat higher value.

WAUKESHA GRAVELLY SANDY LOAM.

The type mapped as Waukesha gravelly sandy loam is of very small extent and of minor importance in the present survey. It occurs in two separate tracts which have a somewhat different texture. That just northwest of Cochrane has a surface soil which consists of 12 to 16 inches of black or dark-brown loam. This contains a considerable quantity of coarse, rounded sand particles, and in a number of places the surface soil is a sandy loam. There is usually sufficient clay present to make the soil sticky when wet. The subsoil consists of a yellowish sandy loam to about 24 to 30 inches, where rounded, rather fine gravel is encountered. This bed of stratified gravel and coarse sand is compact and difficult to penetrate with the soil auger.

*For chemical composition and management see page 48.

The second area is found on the terrace near Nelson. The texture of the soil here is somewhat more silty than that of the first mentioned area, though here also the soil varies to a coarse sandy loam, and in a few places a coarse loamy sand appears at the surface. This area is also underlain by stratified gravel. In a few localities this fine gravel outcrops, and there is considerable gravel scattered over the surface in such places. The surface soil is in an acid condition, as indicated by the litmus-paper test.

The surface of the type is level or very gently sloping. On account of the underlying sand and gravel beds the drainage is thorough, sometimes excessive, and, except where the covering over the gravel is deeper than usual, the type is inclined to be droughty during dry periods.

The type is a terrace soil situated well above the present flood plain. Portions of it appear to lie in an abandoned stream channel, later filled by sediment and now having the same elevation as the remainder of the terrace. In such places the gravel is as much as 4 feet below the surface.

The Waukesha gravelly sandy loam is a prairie soil, the native growth consisting chiefly of grasses.

At present the greater part of it is under cultivation, and during favorable years as much as 40 to 50 bushels of corn are grown per acre. Oats may yield 30 to 40 bushels and hay 1 ton to 1½ tons per acre. During dry seasons, however, the yields are considerably lower and crops frequently suffer greatly from lack of moisture.

PLAINFIELD FINE SAND

The surface soil of the Plainfield fine sand to an average depth of about 10 inches consists of a dark-gray to dark-brown fine sand having a loose structure and a comparatively low content of organic matter. Litmus-paper tests indicate that the soil is acid. The subsoil consists of a fine to medium sand, which becomes lighter in color and grades into stratified sand in the lower subsoil. There is some variation in the texture and some of the material included with this type could be classed as a medium sand if the areas were of sufficient extent.

The type is of small extent and of minor importance. The largest areas are found in Spring Creek and Little Bear Valleys.

The soil in Spring Creek Valley is somewhat coarser in texture than typical. In the vicinity of Waumandee there is also a small amount of this soil, and here the type is better than the average, having a finer texture and containing enough silt and clay to make it slightly loamy.

Generally the surface of the type is level or slopes gently toward the streams. In a few places there is a billowy topography, and small undulations are common. These are doubtless due to the action of the wind. On account of the loose, open structure of the material, the natural drainage is excessive. There are some portions of the type where erosion has cut rather deep channels, especially on the gently sloping terraces in Little Bear Valley.

Areas of this type occur within valleys of streams which head within the driftless region, and there is no glacial material, even in the stratified subsoil. The sand was doubtless derived from Potsdam sandstone and later carried down the slopes by the action of water and deposited by stream action when the volume of water was much greater than it is at present, and when the streams were running at a much higher level.

The original growth on the Plainfield fine sand consisted chiefly of a few scattering scrub oak and some prairie grass.

A relatively large proportion of this soil is under cultivation, but it is doubtful if the average crop is profitable under present conditions of farming. Corn is grown to some extent, but the yields are low. Probably the average is not over 15 bushels per acre. During dry years the crops usually fail. Rye, which is grown more extensively than other small grains, usually yields about 8 to 12 bushels per acre. Buckwheat yields 10 to 12 bushels per acre. Clover and the grasses do not thrive and the pasturage is of little value except early in the season. Potatoes are of fairly good quality, but yields are small. This type is low in organic matter, and in order that farming operations may be profitable the most careful methods of soil and farm management are necessary.*

Land of this type sells for $10 to $20 an acre. Farm buildings are usually inferior and fences and other improvements in poor condition.

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*For chemical composition and management of this soil see page 48.

PLAINFIELD SAND.

The surface soil of the Plainfield sand to an average depth of about 12 to 14 inches consists of a fairly loose, brown to dark-brown loamy sand of medium texture. There is a considerable amount of fine sand mixed with the medium sand in places, and in such places the soil might be classed as a fine sand if of sufficient extent. Litmus-paper tests indicate that the soil is acid. The subsoil consists of a lighter brown medium sand which gradually becomes a yellow sand at from 28 to 36 inches. The deep subsoil consists of stratified sand in which varying amounts of gravel may be found. As a rule the soil next to the bluffs is darker and slightly heavier than that close to the river.

The largest area of this type mapped in the present survey occurs as a narrow terrace along the Chippewa River Valley in the northwestern part of the county. This terrace ranges in width from one-eighth to one-half mile, and has a length of over 10 miles and an elevation above the flood plain of the river of 20 to 50 feet or more. The rise from the flood plain is quite abrupt in most places. At the mouth of Big Waumandee Creek there is a terrace of the same soil about 4 miles long and in its widest place about three-fourths of a mile across. None of this type is found outside of the Mississippi and Chippewa Valleys.

The terrace occupied by this soil has the same position as that occupied by the La Crosse fine sandy loam, and the surface is usually level or gently sloping toward the streams. In places there is an undulating or billowy topography, where the wind apparently has altered the original surface features to a slight extent. On account of the loose, open structure of the material the type is excessively drained and subject to drought.

Being of a terrace formation, the type is alluvial in origin, the material having been deposited by the Mississippi River during the glacial period, when the volume of water carried by that stream was much greater than at the present time. A small quantity of gravel is mixed with the sand in the lower sections, and this gravel is doubtless of glacial origin, as is also a part of the sandy material.

The greater proportion of this type was originally in the condition of a prairie, with only a few scattered scrubby oaks. Prairie grass was the most common growth, though this was not heavy.

More than half the area of the Plainfield sand is under cultivation, although as a whole it must be considered of rather low agricultural value. During the most favorable years, when the rainfall is well distributed, fair crops are obtained, but usually, owing to the lack of moisture and of plant food, the ordinary yields are not satisfactory. That part of the type immediately along the bluffs has probably been influenced to some extent by the wash from the heavier upland soils, and for a short distance from the bluffs yields are usually better than along the outer margin of the type. Some areas are uncultivated practically all of the time, because of their extremely sandy nature and consequent low productiveness. On some fields a crop is grown every second year and the ground fallowed in alternate years.

On this type rye is an important crop and yields of 20 to 25 bushels per acre are common during the most favorable years. Corn yields 25 to 40 bushels per acre under the most favorable conditions, but the ordinary yields are far below these figures. Buckwheat is grown to some extent. Clover can be grown successfully only on the lower, darker portions of the type, and even here the yields are not large. Potatoes do fairly well, but only a few are grown for market.

The selling price of land of this type ranges from $10 to $40 an acre, depending upon location, improvements, etc.

CHEMICAL COMPOSITION AND MANAGEMENT OF SANDS AND FINE SANDS.

On chemical composition these sandy soils show much less 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 700 to 800 pounds per acre, while the amount of potassium is about 16,000 pounds in an acre inches. The organic matter in these soils is about half that in the Knox silt loam and less than one third of that in the dark prairie soils of the state.

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 defi-

cient 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. All systems of farming on such land should be planned in such a way as either to conserve its natural fertility, or supply it by the use of commercial 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, or a corrugated roller can be used to do the work of both. 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. The use of a light application of manure will assist in making the nitrogen of the peat become available to plants.

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 phosphorus 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.

Soybeans or yellow lupine or spring vetch may be grown on sandy soils and if plowed under they furnish organic matter and nitrogen to the soil. When the soil has been built up, a nurse crop may be used in seeding clover and other legumes to better advantage than when the soil is run down and poor.

A three, four, or five year rotation may be followed. If but little stock is kept, a three year rotation consisting of a cultivated crop of corn or potatoes followed by rye or oats and clover the third year works well. The second crop of clover should be plowed under. If manure is scarce, acid phosphate and potash must be applied in addition to green manuring crops to keep up the fertility of sandy soils. If considerable stock is kept the rotation can be increased to four years using the clover field one year for pasture before plowing up. The manure applied in the winter or early spring of the year the clover is pastured increases the value of the pasture and benefits the next crop. The silo should be used to supplement pasture on sandy soil.

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.

MISCELLANEOUS MATERIAL.

ROUGH STONY LAND.

Rough stony land includes rock exposures, cliffs, and land which is too steep and rough to plow or cultivate profitably. It may be considered nonagricultural, as it is of value only for the small amount of timber and pasture which it supplies.

This type occupies a large part of the steep walls bordering the valleys and forms a border between the valley bottoms and the high land of the ridges. The type is developed as narrow bands, many miles in extent, winding in and out of the valleys and coves, but 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 found. The bluffs and cliffs are highest along the western portion of the county, and frequently reach an elevation of 450 to 500 feet above the valley bottoms there. The ridge tops are also wider here than elsewhere, and range in width from one-half to 1 mile, while in the interior of the county and along the eastern portion the valleys ramify more extensively, the ridge tops are narrower, and the steep valley walls are not so high. The elevation of the ridge tops ranges from 150 to 250 feet above the valley floor throughout most of the interior of the county.

Rough stony land is quite uniformly distributed throughout the upland portion of the county and is intimately associated with Knox silt loam and the steep phase of that type. Wherever there are a few inches of soil it is usually a silt loam, though there are exceptions to this in the region of sandstone rocks where the soil is sandy. The greater proportion of the rock exposed consists of lower Magnesian limestone, though there is also considerable Potsdam sandstone exposed directly below the limestone.

The forest growth consists of white oak, red oak, hickory, and a few birch and elm trees. The best of the timber has been removed and the remainder serves to protect the slopes from washing.

The inclusion of Rough stony land in farms reduces the value of better land and it renders the fields and farms 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 this class of land.

THE GENESEE SOILS.

This series of soils includes all material deposited in the present flood plains of the Mississippi and Chippewa Rivers which border the county on the west and north, and of the lower part of Buffalo River in the center of the county. Owing to the mixed nature of the material and difficulty in seeing much of it, the separation of types on the floodplains is not done in a strictly detailed manner, the main object being to separate the sandy soils from the heavier ones.

GENESEE FINE SANDY LOAM

This type includes all the sandy material of the floodplains above mentioned. Much of the soil which is a fine sandy loam consists of 6 to 10 inches of compact dark brown fine sandy loam on yellowish brown fine sandy loam or fine sand. Layers of medium or coarse sand often occur in the subsoil at varying depths. Considerable variations in the texture of this type occur. Chocolate brown fine sandy loam or loam soil often borders the banks of the sloughs or sand knolls and ridges occur with intervening swales and low spots of heavier loam or silt loam soil on sand. This type of soil follows the channels of the Chippewa and Mississippi Rivers and the sloughs connected with them all along the north and west sides of the county, occupying a considerable portion of the 32,000 acres of flood plain land in the county. Some of thte islands in the Mississippi River are mere banks or flats of sand built up by the river, others are sandy around the edges with heavier soil in the interior. Considerable amounts of the more sandy phase are included also.

in Sections 12, 13, 24, and 25 east and north of Maxwell Station.

The Genesee soils lie upon a low level to flat irregularly wooded plain cut by sloughs and old stream channels. Some of the sandy knolls are more elevated, the type lying from 1 to 10 feet above normal water stage. Some of the higher sandy knolls are seldom if ever flooded but most of the bottom land is subject to flooding especially in spring. Occasionally as much as 6 or 8 feet of water has covered the bottoms. Floods are less frequent since the discontinuance of logging operations and dams on the sloughs. In general the highest elevations occur along sloughs and along the rivers.

The soil material has been deposited in the valley bottoms by the more recent floods of the rivers and is largely derived from glacial material brought down by the streams from farther north and east.

In the lower portions and bordering the sloughs the soil is timbered, often quite heavily, to elm, oak, birch, and soft maple or birch and willow brush. More elevated or sandy portions subject to considerable drying out at times, have scattered oak and in some cases a semi-prairie condition with red-top grass and scattered oaks, is found.

Some small patches of the soil have been under cultivation and very good yields obtained. Most of the soil cannot be used and serves only as a pasture land and furnishes some hay. The higher sandy portions which are cultivated in one or two places, produce good rye, potatoes, or corn, but in dry seasons are subject to drought due to the open sandy subsoil which prevents capillary rise of water. Less elevated portions of the soil which are also somewhat finer are reported to have produced as much as 60 bushels of corn, 250 bushels of potatoes, and 60 bushels of oats per acre in favorable seasons. These yields cannot be depended upon because these lower portions of the soil type are often subject to overflow.

Low Phase Genesee Fine Sandy Loam.—Within the area of fine sandy loam (largely wooded) are included low open areas of overflow land which are covered with water most of the time. The vegetation consists of reeds, sweet flag, and generally coarser marsh grasses. Where such areas are extensive they have been separated out as low phase of the fine sandy loam.

The soil on such overflow areas is generally heavier than that on the wooded portions and varies greatly in depth and texture.

The soil is generally a grayish drab or mottled brown loam on a sandy loam subsoil. The surface heavy layer is often only 2 to 8 inches deep, but may be as much as 3 feet deep in the larger open areas. Coarse sand layers may be found in the subsoil in shallow places and bluish sticky clay layers are also found where the soil is deeper. In Section 1 southwest of Nelson, the soil of this phase is a mealy chocolate-brown loamy material containing much organic matter, fine silt, and coarse sand grains. This is 6 to 10 inches deep on dark brown sandy loam.

None of this phase of the soil has ever been cultivated and it now has little agricultural use, the amount of hay cut on it being limited because of the generally coarse nature of the grasses which grow on most of these low areas.

GENESEE SILT LOAM.

This is a compact mealy chocolate-brown silt loam becoming lighter brown in color at 8 to 12 inches. Fine and very fine sand particles are found in the subsoil in increasing amounts until at about 16 to 20 inches the soil often becomes a fine sandy loam with yellowish brown sandy loam at 20 to 30 inches. The depth of surface soil varies from 8 to 30 inches. In low wet marshy places the soil is a grayish or bluish mottled color with a sticky clay loam subsoil underlaid at greater depth by sandy loam material.

This type covers about 17 square miles of the bottom lands from Alma north along the Mississippi and Chippewa Rivers.

The surface is level with some small knolls and is cut by old sloughs and drainage courses or slightly lower marshy areas. The elevations are greatest near the larger streams and the best drained areas border the Chippewa and Mississippi Rivers.

Like the other Genesee types the soil was deposited by overflow waters of the rivers and is still subject to overflow in time of high water.

The vegetation consists of heavy timber composed largely of big trees. Elm, soft maple, oak, and cotton wood are interspersed with more open glades covered with a dense growth of tall blue joint grass. Lower more continually flooded marshy areas are covered with coarser grasses, reeds, and sweet flags as well as patches of brush-alder, willow, and birch.

Outside of pasture land and the cutting of blue joint hay, very little agricultural use is made of the soil at present. Farms have been started at a number of places, but the almost annual flooding and uncertainty of crop yields has led to their partial or complete abandonment in most cases. The soil material is highly fertile and in favorable seasons excellent yields of corn, small grain, potatoes, and tame hay have been produced. Drainage would require expensive dikes or levees to keep off floods, but if its drainage could be accomplished this soil would make excellent farm land.

GENESEE SILTY CLAY LOAM

This is a dark brown sticky silty clay loam on medium to fine sandy loam. The depth of heavy surface soil varies from 8 to 30 inches or more. The deepest dark brown surface layer occurs on the higher portions near the streams. Grayish or mottled brown silty clay loam with blue clay subsoil at 18 to 24 inches is found in the lower open marshy areas near the main land. As with the other Genesee types, this soil type is not entirely uniform and includes some soil of lighter texture. A sticky brown or mottled loam or sandy loam on a sandy loam subsoil occurs in places, especially along the immediate banks of the sloughs.

The silty clay loam covers about 8 square miles of the bottoms from Fountain City south to Marshland.

The topography is level with slight knolls or slightly elevated areas interspersed with lower wet areas. In dry years with low water, some of the more elevated portions have sufficient drainage for cultivation. The lower marshy portions and all of the type in times of high water is too wet to cultivate and drainage by diking ditches and probably pumping are necessary to make the land available for continued farming.

The soil is an alluvial deposit laid down in more quiet water than that in which the coarser soils to the north were deposited.

As in the case of the silt loam, the soil is partly timbered with large elm, oak, soft maple, basswood, and birch trees. Tall blue joint grass grows among the more scattered trees. Much of the soil is in a marshy condition and coarse grasses and sweet flags cover these portions with scattered clumps of birch and willow tree brush.

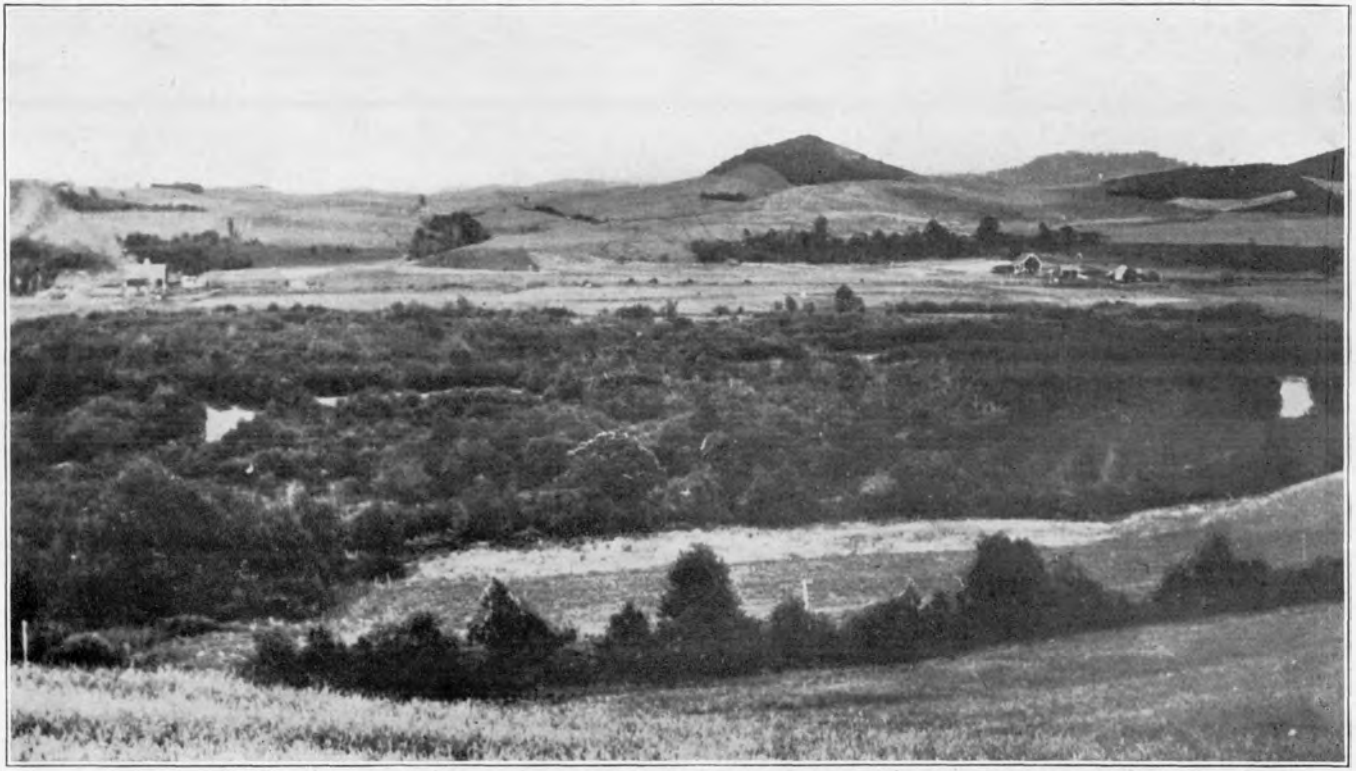
In the southwest corner of the county a part of this type of soil has been protected from overflow and partially drained by straightening the channel of the Trempealeau River by closing some of the sloughs and dredging a main ditch through the area. Crops consist mainly of corn, hay, and some potatoes. Only the higher knolls are cultivated, hay being cut on the lower portions. The soil is fertile material and when well drained produces very good yields.

WABASH LOAM.

The Wabash loam where typically developed consists of a black loam surface soil extending to a depth of 12 to 16 inches, underlain by drab or grayish loam or silt loam which, in the lower subsoil, grades into sandy material. As found in this county, however, the type is quite variable and there is a considerable proportion which does not conform closely with this description. In a number of places the surface soil contains varying quantities of fine and very fine sand, and in such places the color is usually lighter than where the texture is a loam or silt loam. In a number of places the subsoil is darker than the present surface soil, owing to the fact that the original black surface has been covered by wash of lighter colored material from the adjoining slopes. Frequently large amounts of sand and fragments of limestone have been washed out over the soil from the tributary valleys and ravines and the variations which result from such conditions could not be indicated. The material composing the type, however, is better adapted to agricultural development than most of the Genessee Series and was therefore separated from that series.

The Wabash loam is found most extensively along the Buffalo and Trempealeau Rivers and Big and Little Waumandee Creeks and some of their tributaries. It occupies narrow strips along these streams and is the lowest land in the bottoms. The surface usually has a gentle slope toward the streams and most of the type is subject to overflow. By straightening and deepening stream channels much of this type doubtless could be reclaimed. Tile drains could also be used in draining such tracts.

In origin this type is largely alluvial, though there are many narrow valleys and ravines having a small amount of this soil



VIEW ACROSS THE VALLEY OF THE BUFFALO RIVER.

The wooded portion of the valley is the flood plain where Wabash soils occur. On the terrace Lintonia silt loam is found, while on the rolling background Knox silt loam is the most extensive soil.

along the bottoms where the material is colluvial in origin. In such places there is a great rush of water during heavy rains, but this quickly runs off on account of the steep grade.

The growth on this soil consists of willow, hazel brush, poplar, cherry, elm, and soft maple. There is a rank growth of grass over much of the type, affording excellent pasturage, and frequently hay is cut where there is no brush to interfere.

The cutting of hay and pasturing are the only agricultural uses to which the Wabash loam is put at present. If properly drained, as some of it could be, it would be adapted to corn, small grains, timothy hay, alsike clover, and a number of other crops.

PEAT.

Description.—The material mapped as Peat consists of vegetable matter in various stages of decomposition and with which there has frequently been incorporated a very small quantity of mineral matter. The surface is black or dark brown and is usually fairly well decomposed, while the underlying material is of a brownish color and fibrous in most cases. The Peat extends to a depth greater than 3 feet in all cases, and it is probable that it exceeds 10 feet over most of the areas, though the exact depth was not determined.

Extent and Distribution.—The Peat in this survey is of rather small extent. The largest area extends from about 3 miles west of Mondovi west and northwest to the county line and southward through several stream valleys. The area comprises the divide between Farrington Creek, flowing east into Buffalo River, and Big Bear Creek, flowing west into the Chippewa River. This divide, however, is not marked, and no differences in elevation in the marsh can be detected by the eye. Other areas of Peat are encountered in various stream valleys throughout the county, the largest occurring along the Trempealeau River in the southeastern part of the county. These consist of low, wet tracts bordering the river, and it would be difficult to reclaim them.

Native Vegetation.—Some of the areas of Peat are timbered with a dense growth of tamarack, while other portions are treeless and support a thick growth of coarse, wild grass. In Farrington Creek Valley both conditions are found. Over the open marshes

the wild grass is frequently cut for hay, and this is the extent of the present agricultural use of this soil.

In a number of the Peat areas reclamation is practicable. When properly handled the Peat should yield good crops of corn, timothy, and alsike clover, and even small grains can be grown successfully.

None of the Peat soil has been artificially drained, its agricultural use being confined to pasture and production of hay.

Chemical Composition and improvement of Genesee soils and Peat.

CHAPTER VII.

GENERAL AGRICULTURE OF BUFFALO COUNTY.

Agriculture in Buffalo County dates back to the first settlements of this region, which were made between 1845 and 1850. As was the case in other parts of Wisconsin, the production of grain early became the chief branch of farming, and for a considerable time wheat was grown more extensively than all other grains combined. As late as 1885 wheat still constituted about 50 per cent of the grain produced, while oats made up about 27 per cent and corn about 16 per cent. The history of grain growing in this region is similar to that of other parts of the State. Fields were cropped to grain continuously for such a long period that the productiveness of the soil was gradually reduced, and when the prices began to decline and insect pests became troublesome the crop was not very profitable. During the last 25 or 30 years there has been a gradual falling off in the production of wheat, and in 1910 the total acreage for the county was only 4,575 acres. With the decline in wheat growing there has been an increase in the production of oats, hay, and corn, and the system of farming which is followed at present is a much better one than that practiced a half century ago.

The present agriculture consists of general farming, with dairying as the most important and highly specialized branch, and the tendency throughout the county is toward a still greater development of the dairy farming. With this industry are coming better methods of farming, improved grades of live stock, and a greater interest in all lines of agricultural development.

The general farm crops most extensively grown, in the order of their acreage, are oats, hay, corn, barley, rye, and wheat.

Oats are grown more extensively than any other crop in the county, and in 1909, according to the census reports, 1,377,555

bushels were produced from 46,304 acres, or about 30 bushels to the acre. Part of the crop is marketed through elevators at Fountain City, Alma, Mondovi, and Winona, Minn., but the greater part is fed to stock on the farms. Oats form the bulk of the grain fed to horses and are ground as part of the ration for feeding cattle and hogs. The crop is grown mainly on the Knox silt loam. It is grown quite extensively also on the Lintonia silt loam, Boone fine sandy loam, Bates silt loam, and Waukesha silt loam, on all of which good yields are obtained. On the more sandy types yields are considerably lower. The quality of all small grains is best where grown on light-colored soils, and the Knox silt loam is considered to be the best small-grain soil in the county. On dark soils the growth of straw is apt to be too rank and the plants frequently lodge. Also, the grain is slightly inferior in quality, and is lighter in weight than that grown on the lighter-colored silt loam types.

Hay is the second crop in importance. In 1909 hay was cut from 40,709 acres, producing 75,059 tons, or an average of about 1¾ tons per acre. Clover and timothy constitute the greater part of the hay grown. There is a considerably greater acreage devoted to timothy alone than to clover alone. Much wild hay is cut from areas of Peat and Genessee Soils and some from wet areas of Wabash loam. There are a few fields of alfalfa in the county, but this crop is grown only to a very small extent at present.

Corn ranks third in acreage. From 25,043 acres in 1909 a yield of 838,441 bushels was obtained, or an average of over 33 bushels per acre. The Waukesha and Bates silt loams are the best corn soils in the county and on these types yields of 50 to 60 or even 70 bushels per acre are obtained under favorable conditions, and the average yield is always considerably above the average for the county. A large quantity of corn is cut and put into the silo each year, and the quantity is gradually increasing as the dairy industry develops. Practically all of the corn allowed to mature is fed to hogs or other stock on the farms where it is produced, and comparatively little is sold. Dent varieties are grown most extensively, and improvement is being made through the use of more carefully selected seed.

Barley ranks fourth in acreage, 24,911 acres in 1909 giving 632,422 bushels, or an average yield of slightly over 25 bushels per acre. Barley is grown on most of the soils of the county, except the extremely sandy types. It appears to do better than oats on sandy and fine sandy loam soils. The acreage on the Knox silt loam has been decreasing more rapidly than on some of the other types, probably because of the growth of the dairy industry on this type. As in the case of oats, grain of the best quality is produced on light-colored soils.

Rye is one of the most important crops on the light-textured soils of the county, though it is grown to some extent on practically all of the cultivated types. The acreage in 1909 was 4,663 acres and the production 67,511 bushels, or slightly over 14 bushels per acre. This crop is better adapted to sandy soils than the other grains grown in the county.

In 1909 wheat was grown on 4,575 acres, with a production of 88,302 bushels, or about 19 bushels per acre. The crop is grown mainly on the Knox, Lintonia, and Bates silt loams. Some of the fine sandy loams also are used for the production of wheat. The Knox silt loam produces a very good quality of wheat, as well as of other small grains.

Potatoes are not grown on a commercial scale, except in a few instances. The potato patch seldom covers more than an acre or two. According to the census, 1,423 acres were devoted to the crop in 1909, producing 177,849 bushels, or about 125 bushels per acre. During favorable seasons yields of 250 bushels an acre are obtained from fields which have received special attention.

In the vicinity of Alma and Fountain City small fruits and grapes are grown successfully, and the trucking industry has been developed to a small extent. In the southern part of the county about Marshall and also in the northeastern part about Mondovi there is a little trucking carried on, and it would seem that this industry might be profitably extended. Peas and beans are not extensively grown, but cucumbers, chiefly for pickling, are grown in various parts of the county, Alma and Fountain City having pickling stations. Raspberries, currants, strawberries, etc., do very well. Many farmers have small apple orchards from which fruit of good quality is usually obtained, but apples

are not grown on a commercial scale. There are a large number of excellent orchard sites throughout the county, the climatic conditions are favorable, and it would seem that apple growing might well be developed on a commercial scale.

In 1913 there were 17 cheese factories and 10 creameries in Buffalo County, and the output of dairy products is gradually increasing. Dairying is carried on in all parts of the county, but is most highly developed on the silt loam and fine sandy loam soils. Considering the county as a whole, dairying is probably better adapted to the Knox silt loam than to any other type. This type is excellent grain, grass, and clover soil, fair corn soil, and has associated with it a large amount of steep land and Rough stony land which provides an abundance of excellent pasturage.

Most of the dairy herds in the county are made up of grade animals, with occasional herds of pure-bred Holstein, Guernsey, and Jersey. The use of purebred sires is gradually bringing the dairy stock of the county to a higher standard. Beef cattle are raised to some extent. Among the pure beef breeds the Shorthorn and Aberdeen Angus are represented most largely. There is some Hereford blood in the county also, and the number of all purebred animals is gradually increasing, though most of the beef cattle are grade stock. A considerable number of calves and young stock are shipped out of the county each year.

On the dark, level soils of the valleys corn is grown more extensively than in the upland regions, and therefore in these sections hog raising is carried on to a greater extent than elsewhere, though some hogs are raised in all parts of the county in connection with dairying. More hogs and other stock are raised in the Waumandee Valley and in the vicinity of Mondovi than in other portions of the county.

There are more horses raised in Buffalo County than in any other section of the State, and purebred Percheron, Morgan, Clydesdale, and Belgian horses are to be seen throughout the county. Most farmers raise their own work stock, and many plan to have a heavy draft team to sell every few years. There are a few farmers who make a business of raising horses.

Sheep raising is carried on to some extent, and there are a number of farmers raising purebred sheep in various parts of the county.

The adaptation of soils to crops is recognized to some extent.

The dark Waukesha and Bates soils are known to be better corn soils than the lighter colored types, and the Knox silt loam is held better adapted to small grains than are the dark soils. Rye and buckwheat are confined principally to the sandy types of soil, because experience has shown that these soils can be used profitably for this crop.

While crop rotations vary on the different soils throughout the county, probably the most common rotation consists of corn followed by a small grain, such as oats, barley, rye, or wheat one year, or possibly two years, and then seeded to timothy and clover. Hay is usually cut for two years. Very often the hay field is not pastured, since there is a large area of rough land on most farms which is devoted largely to grazing. On the sandy soils the ordinary rotation is somewhat different, and may consist of one year corn, followed by one year rye seeded to clover, followed by corn. On some farms but little thought is given to the selection of crop rotations best suited to the conditions, but more attention is each year being given to such matters, with the result that farm methods are gradually improving and yields increasing.

Stable manure is about the only fertilizer generally used at present within the county. Some green manuring is practiced, but it is not at all common, and commercial fertilizers are seldom used, except in a small way for special purposes. The methods of cultivation followed by the majority of the farmers are thorough, and agriculture is highly developed in nearly all parts of the county. The Waumandee Valley is considered to be one of the richest sections of the county, chiefly because of the rather extensive areas of level, black silt loam which are to be found there. On the Bates silt loam and fine sandy loam, as well as on the Knox and Lintonia silt loams, very fine farms are to be found. Special methods of cultivation are frequently required in this county, because of the danger of erosion on the steep hillsides. These special methods of hillside cultivation are covered under the discussion of the various soil types to which they refer.

Of the weed pests which are found in Buffalo County the Canada thistle and quack grass are probably the most troublesome.

Farm improvements vary with the character of the soil, but

as by far the greater proportion of the soil in the county is productive most of the farms are well improved, and the buildings are substantial and kept in good repair. The best farms and buildings are found on the Knox, Waukesha, and Lintonia silt loams, and on the Bates silt loam and fine sandy loam. On the extremely sandy soils the poor quality of the soil is reflected in the buildings, fences, crops, and farm machinery.

Obtaining farm labor is sometimes difficult, and on account of this condition the systems of agriculture followed are often more extensive than would otherwise be the case. In many instances all of the work is done by the farmer and his family. When a man is hired for the entire year the monthly wage is about $25 to $30.00 with board and washing free. When employed only for the summer or the growing season or for haying and harvesting the wage is higher. When married men are employed, a house, fuel, and garden patch are often supplied in addition to the regular wage.

According to the census of 1910, 92.8 per cent of the land in Buffalo County is in farms, and of this 49 per cent is classed as improved. The average size of farms is given as 189 acres and the average amount of improved land on each farm is 92 acres. Eighty-one per cent of the farms are operated by their owners, and considerably over half of these are free from mortgage debt. In most cases where land is rented, cash rather than share payments, are made.

During the period from 1900 to 1910 the value of lands in Buffalo County increased 67.7 per cent. Values vary greatly, depending upon the soil, location, improvement, etc. The best farms in the county have a selling value of $100 to $150 an acre. The poorest farms, on the extremely sandy soils, could probably be bought for $10 to $15 an acre. Farms on the Waukesha silt loam, Bates silt loam, Bates fine sandy loam, Knox silt loam, and Lintonia silt loam have a higher value than those on other types. These are recognized as the best soils of the county. The Knox silt loam is the most extensive type but some of the others mentioned, while of small area, are highly improved. In Waumandee Valley, for example, farms on the Waukesha silt loam are as highly developed as, or possibly more highly developed than,

those in any other section, and Waumandee Valley is considered one of the richest agricultural sections of the county.

In general, it may be said that the methods of farming and agricultural practices followed in the county are fairly well adapted to the existing conditions.

CHAPTER VIII.

THE PROBLEM OF EROSION IN BUFFALO COUNTY.

The most important single problem in soil management in Buffalo County is due to the large amounts of steep or rolling land. The county is in the so-called residual portion of the state where the streams which drain the area have cut down their beds through the formerly level elevated plain lying on limestone and into the sandstone beneath. These valleys have never been altered or filled by action of glaciers which once covered most of the state. The valleys were at first mere erosion ditches or small stream beds which have been enlarged and deepened during geological ages till their beds lie from 200 to over 400 feet below the limestone topped ridges which extend between. The valleys and their tributaries radiate like the veins of a leaf and the steep slopes which lead down from the ridge top to valley bottom make up a considerable part of the area of the county.

Most of the soil on the sloping land is heavy and is included in the steep phase of the Knox silt loam. These slopes which originally were timbered or brush-covered have been largely cleared and cultivated. Because of their unprotected condition and exposure to the work of surface run-off water from higher land, fields on this type of soil are often extensively washed and gullied by the descending storm water and the water from melting snow in spring.

Other soils subject to erosion are the soils of the Boone series derived from sandstone and which often occupy lower slopes in the valleys. The soils of the Lintonia series which lie in narrow benches along the sides of the valley bottoms are also subject to severe gullying. The swift flowing water from the ridges and slopes must cross these benches before reaching the valley stream and deep ravines, gullies, and ditches are developed. Soil erosion is a farm problem not only because fields are cut by ditches and gullies which make cultivation difficult, but because erosion removes the finest and most fertile soil particles first and reduces

VIEW SHOWING HOW RAVINES MAY BE STARTED ON A GENTLE SLOPE WHERE THE SURFACE IS NOT PROTECTED BY A GROWING CROP.

Much of the land in Buffalo County is subject to erosion and care should be exercised in cultivation and in rotations followed on the steep land so as to reduce the amount of damage by washing to the minimum.

the fertility and yield of fields by removing fine soil and organic matter from the surface. The causes of removal of soil from the surface without formation of gullies generally lie in improper methods of cultivation or poor arrangement of fields. Fields where this kind of erosion occurs are often only gently rolling or undulating and the rain water does not collect in larger swift-flowing rills or streams which have power to cut ditches, but follows the cultivated rows such as corn or potatoes or the drill rows of grain fields and the soil is removed only from the knolls and deposited in the hollows.

Contour cultivation and arrangement of the crop rows across the slope instead of with or down the slopes retards the movement of soil in such fields. Keeping the most exposed places in sod as much as possible and the cultivation of the field in alternate strips of crop and sod across the slopes are inconvenient but often necessary methods.

Rotation of crops in such a way that two cultivated crops do not follow in succession gives the field opportunity to recover from its losses under cultivation and avoiding a hard bare condition of the eroded ground after harvest as much as possible prevents surface wash in the fall. A cover or catch crop of rye or peas in the corn rows helps protect the soil after harvest and furnishes pasture until winter.

Deep plowing and plowing under of straw, manure, or a second crop of clover to increase the organic matter in the soil also give the surface of the field greater absorbing capacity and resistance to erosion.

Gullying occurs where greater volumes of water collect forming cutting-streams where steeper slopes cause the water to flow faster or in places where the soil has an unstaple foundation of sandy material which easily undermines when the water once cuts through the surface soil and establishes a fall which cuts back in the sandy subsoil. In favorable situations large gullies ½ mile or more in length are sometimes cut during a single season.

In their beginnings most small gullies are easily handled. Small drainage-ways or shallow ditches can be filled with straw or manure and plowed shut. Such shallow drainage-ways should be left in permanent sod. The plow can be easily thrown out in passing across them. On the level terraces or where heavy soil lies on light sand or sandy gravelly subsoil, small ditches must

be immediately tended to because all ditches on such soil are dangerous.

Where the subsoil is clay and where clay or silt soil material is being brought down by the flood water, large gullies may be made to fill by putting in a dam of stumps, brush, and logs. Where the subsoil is sandy much greater care is required. If dams are built in the latter case, they need to be carefully constructed to prevent the water from cutting around them.

Dams of concrete, stone, wire mesh, and brush have been successfully used. Flume devices also have been used to carry the water over the head of the ditch and down into it preventing its continued growth.

Planting willows and bushes on the sides and bottom of ditches too deep to fill often arrests the growth of the ditch. Sorghum, sweet clover, or rye make good emergency crops on eroded spots and fields which later need to be seeded to grasses and left in permanent sod.*

*See Bulletin 272 of the Wisconsin Experiment Station.

CHAPTER IX.

CLIMATE*

"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 unusually fortunate, since about half of the total rainfall comes in May, June, July, and August, and nearly 70% from April to

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***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.**

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 the 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, which is as much rain as is 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 from one to four weeks, and occasionally longer. Observations taken at Madison over a period of 30 years, from 1882–1911, 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.

Buffalo County lies partly within the Mississippi Valley and partly within the Southern Highlands, which are recognized as forming two of the eight climatic provinces in Wisconsin. The Mississippi Valley is a rather deep depression, the warm influence of the lower altitude being apparent from Dubuque, Iowa, as far north as Grantsburg, Wis. This narrow valley is much cooler and has drier winters than the Lake Michigan shore. The mean summer temperature averages about 78° F., and is similar to that of New Jersey, southeastern Pennsylvania, Ohio, or southern California. The mean winter temperature in the northern part of this valley resembles that of northern Vermont, northern Michigan, or eastern Montana. On an average of seven days during the winter the thermometer drops to –10° F. or lower, while during summer afternoons a temperature of 95° may be expected. The growing season in this valley ranges from 150 to 175 days, about the same duration as that of the Hudson

River Valley, nearly all of Ohio, the northern half of Illinois, western Kansas, or the Columbia River Valley.

The Southern Highlands includes the rough and rolling region, generally over 1,000 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 29° F.) being similar to that along the Michigan shore, while the mean winter temperature is only 2° higher than along the Superior shore. The growing season, averaging 145 days, is apparently 20 to 30 days shorter than on 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.

The first of the following tables gives the mean monthly and annual temperature and precipitation at Wabasha, Minn., and at Whitehall, Wis. Wabasha is situated just across the Mississippi River from Buffalo County, and Whitehall is located in Trempealeau County, which borders Buffalo County on the east.

The station at Wabasha has an elevation of 681 feet above sea level and the station at Whitehall is 675 feet above sea level, so that these records indicate the weather conditions of the Mississippi Valley and the Trempealeau River Valley rather than of the whole region surveyed. The greater part of the county is from 200 to 400 feet higher than the river valleys, and varies somewhat in the length of growing season, as indicated above.

The second table gives the normal monthly, seasonal, and annual temperature and precipitation and the average dates of first and last killing frosts at Eau Claire, about 14 miles north of the north county line. This station has an elevation of 800 feet. A comparison with the tables from the other points mentioned may be of interest.

NORMAL MONTHLY AND ANNUAL TEMPERATURE AND PRECIPITATION AT WABASHA, MINN., AND WHITEHALL, WIS.

Month	Wabasha, Minn., 14 years		Whitehall, Wis., 17 years	
	Temperature	Precipitation	Temperature	Precipitation
	°F.	Inches	°F.	Inches
December	20.2	1.19	18.8	1.34
January	14.4	.99	14.1	.84
February	16.7	.95	14.2	.96
March	30.5	1.77	30.5	1.58
April	47.5	2.52	46.2	2.41
May	59.3	4.23	57.0	4.06
June	67.8	4.12	66.2	4.30
July	72.3	3.54	70.2	3.45
August	70.0	3.43	68.3	3.63
September	62.4	3.56	61.6	3.80
October	49.7	2.84	49.2	2.46
November	33.1	1.56	33.9	1.39
Annual	45.3	30.68	44.2	30.22

NORMAL MONTHLY, SEASONAL, AND ANNUAL TEMPERATURE PRECIPITATION AT EAU CLAIRE, EAU CLAIRE COUNTY

Month	Temperature			Precipitation		
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year	Total amount for the wettest year
	°F.	°F.	°F.	Inches	Inches	Inches
December	18.7	54	—28	1.48	0.27	0.84
January	13.1	54	—34	1.00	0.32	0.32
February	14.3	59	—40	1.28	2.26	0.87
Winter	15.4			3.76	2.85	2.03
March	8.7	75	—18	2.04	2.85	2.10
April	45.6	88	11	2.58	2.22	3.72
May	57.0	94	20	4.37	1.96	7.03
Spring	43.8			8.99	7.03	12.85
June	66.8	97	25	4.66	1.50	2.44
July	70.7	103	41	3.47	1.27	8.78
August	69.2	98	36	3.26	0.23	5.09
Summer	68.9			11.39	3.00	16.31
September	61.1	99	.0	3.93	0.77	9.12
October	48.6	86	10	3.22	5.13	1.99
November	32.1	72	—15	1.67	1.79	0.65
Fall	47.3			8.82	7.69	11.76
Year	43.9	103	—40	32.06	20.57	42.95

Average date of first killing frost in autumn, October 1; of last in spring, May 10.

The extremes in temperature show a wide range. The highest ever recorded was at Wabasha, where 105° F. was reached, while the lowest was at Whitehall, where a temperature of –46° F. was once recorded. Such extremes are very rare, however, and of short duration.

Reference to the following figures gives the length of growing season in Buffalo County as compared with other portions of the state.

The average date of the last killing frost in the spring at Wabasha is May 1 and at Whitehall May 6. The average date of the first killing frost in fall at Wabasha is October 5 and at Whitehall October 4. This gives an average growing season at these two stations of approximately 150 to 155 days. On the higher elevations and in small valleys and ravines the season is somewhat shorter than at the stations where the records were taken. It is very seldom, however, that corn is damaged by early frosts, even where the growing season is the shortest. At Eau Claire the growing season appears to be a few days shorter than at the other two stations. The records from these three stations may be considered as representing fairly well the respective portions of Buffalo County having about the same elevations as the stations.

Good water is available in nearly all parts of the county, though on the higher ridges it is often necessary to drill to considerable depths. While there is overflow land along the larger streams, swamps are rare and healthful atmospheric conditions prevail throughout the region.

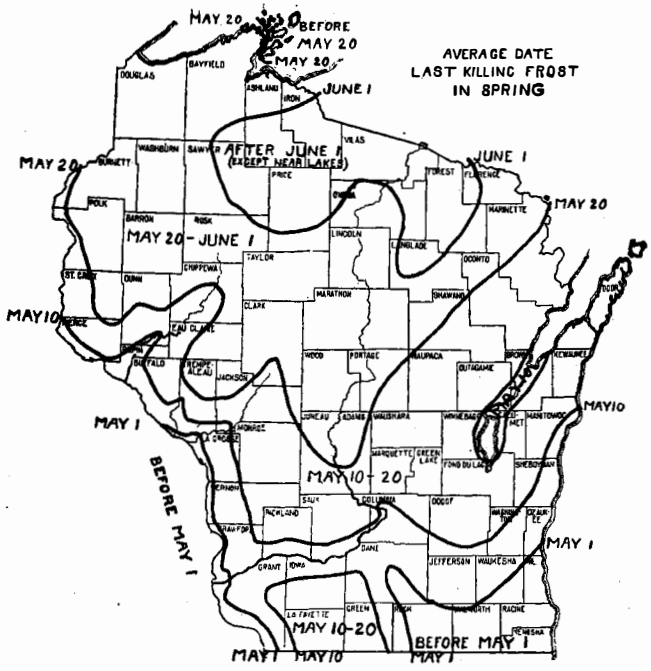

FIGURE 2. LAST KILLING FROST IN SPRING.

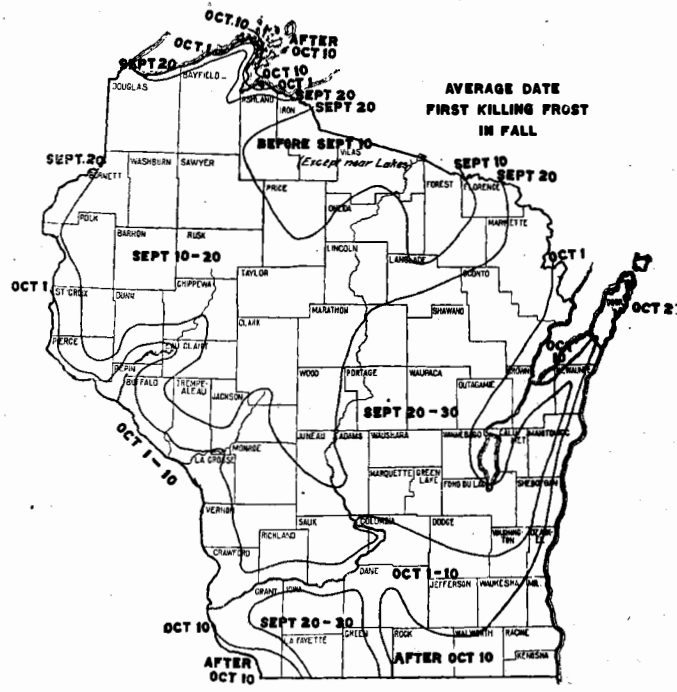

FIGURE 3. FIRST KILLING FROST IN FALL.

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.

SUMMARY

Buffalo County is situated midway along the west State line of Wisconsin and comprises 687 square miles, or 439,680 acres. It may be divided broadly into two divisions, the valleys and the uplands. The topography of the valley is level to undulating, becoming gently rolling in a few places, and in the upland the surface is gently rolling to hilly. 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 county.

The first settlements in the territory embraced within the county were made between 1845 and 1850. All parts of the county are now well settled.

Three railroad systems enter the county, and these with the Mississippi River provide adequate transportation facilities, except for interior points. Alma, the county seat, is 353 miles from Chicago, over the Chicago, Burlington & Quincy Railroad, and 89 miles from Minneapolis.

The mean annual temperature of the county is about 45° F. and the mean annual precipitation about 30.5 inches. The length of the growing season is about 150 to 155 days.

Over practically all the county agriculture is well developed and prospering. The leading type of agriculture is general farming, with dairying as the main feature. The crops most extensively grown are oats, hay, corn, barley, rye, and wheat. The steep slopes afford excellent pasture and are usually kept in grass to prevent erosion.

Buffalo County lies within the unglaciated portion of the State and the soils have been derived largely from the disintegration products of the underlying limestones, shales, and sandstone, although probably there has been influence in places by wind-blown material or loess, and from the material washed down from the slopes, transported by the streams, and deposited as terrace formations.

Including Rough stony land, Peat, and the Genessee Soils, 19 types and 3 phases of soil are recognized in the county.

The Knox silt loam, with its steep phase, is an extensive type and is found throughout the upland portion of the county. It

is a good general farming soil and upon it dairying is carried on quite extensively. It produces a better quality of grain than any of the other types.

The Waukesha series consists of dark-colored terrace soils, found as terraces along many of the streams throughout the county. This series includes some of the finest agricultural land in the county. The types mapped are the Waukesha silt loam, and gravelly sandy loam.

The Boone series of soils is derived from the disintegration of the Potsdam sandstone.

The Lintonia series forms the light-colored terraces throughout the county, but is not very extensively developed. The types mapped are the silt loam, fine sandy loam, and fine sand. The Lintonia silt loam is very similar to the Knox, except in topography and origin.

The Plainfield series of terrace soils includes the sand and fine sandy loam found along the Buffalo, Chippewa, and Mississippi Rivers. The fine sandy loam is used for general farming. farming.

The Bates series is similar to the Boone, but the soils are black instead of light colored. The types mapped include some of the best soil in the county. The Bates silt loam and fine sandy loam are recognized and mapped as belonging to this series.

Peat comprises areas of partially decomposed vegetable matter which occupy low, poorly drained positions, chiefly along streams. This soil is rather inextensive in Buffalo County.

Rough stony land includes rock exposures, cliffs, and land which is too steep and rough to cultivate profitably. It is only of value for the small amount of timber and pasture it supplies.

The Genessee soils include a fine sandy loam, silt loam and silty clay loam. Soils on flood plains of streams and subject to occasional or frequent over flow make up this series.

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.