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WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

ERNEST F. BEAN, Director and State Geologist
A. R. WHITSON, In Charge Division of Soils

SOIL SURVEY IN COOPERATION WITH THE COLLEGE OF AGRICULTURE

H. L. RUSSELL, Dean

BULLETIN NO. 60A SOIL SERIES NO. 34

SOIL SURVEY

OF

PIERCE COUNTY

BY

A. R. WHITSON, F. L. MUSBACH, W. J. GEIB, H. R. LATHROP AND W. H. PIERRE, OF THE WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY, AND M. J. EDWARDS, E. H. TEMPLIN, AND E. H. BAILEY OF THE U. S. DEPARTMENT OF AGRICULTURE, BUREAU OF CHEMISTRY AND SOILS

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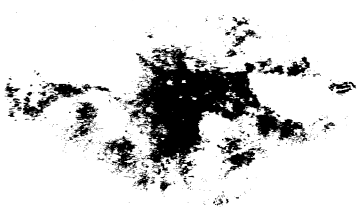

INTRODUCTION*

The State of Wisconsin, working in cooperation 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 more 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 take 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 depend chiefly upon texture, which refers to the size of the individual soil grains, or particles. A coarse sandy

* Recognition of assistance in the work of this survey is due to several residents of the county, and especially to H. G. Seyfurth, county agricultural agent.

soil, for example, will not retain moisture as long as a loam soil, or clay loam, because the finer the soil grains, the greater will be the total 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 method of separating soil grains into seven different groups. These are known as clay, silt, very fine sand, fine sand, medium sand, coarse sand, and fine gravel.

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

Soil Classification

Soils are grouped according to texture into soil *classes*, a soil *class* being made up of soils having the same texture, though differing in other respects. A certain fine sand, for example, may be light colored and of alluvial origin, 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 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 belongs 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

1. Sand.—Over 25% fine gravel, coarse and medium sand, and less than 50% fine sand.
2. Fine sand.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.

Soils Containing Between 20–50% of Silt and Clay

3. Sandy loam.—Over 25% fine gravel, coarse, and medium sand
4. Fine sandy loam.—Over 50% fine sand, or less than 25% fine gravel, coarse, and medium sand.

Soils Containing More Than 50% of Silt and Clay

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

Soils may be grouped in another way. Where soils are closely related through similar sources of the material from which derived, mode of origin, topographic position, etc., so that the different soils constitute merely a graduation in texture of otherwise uniform material, such a group is called a "soil series." It corresponds to the family which is made up of different individuals having the same parentage. The Miami series, for example, includes light colored, glacial soils 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 with heavy types predominating. The Plainfield series includes light colored soils in regions where no limestone is present, and where the material occurs as outwash plains or stream terraces. The soils in this series also have a wide range in texture, but sandy types predominate. 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 which has a distinct agricultural unity,—that is, it is adapted to the same crops and requires 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 con-

ducted, every farmer should be familiar with the soil types on his farm, and their leading characteristics. It is sometimes necessary to show minor variations in types where a portion of the type is more stony than the rest, or less well drained, or has a steeper slope. Such minor portions are mapped *as phases.*

SOIL SURVEY OF PIERCE COUNTY

CHAPTER I

GENERAL DESCRIPTION OF AREA, CLIMATE, AND SOILS

Pierce County, named after President Pierce, is located in the west-central part of Wisconsin and is separated from Minnesota by the Mississippi and the St. Croix Rivers. The county has an extreme length east and west of about thirty-three miles, and a width north and south of about twenty-two miles. The area of the county is approximately 375,000 acres, divided into seventeen geographical townships.

TOPOGRAPHY

The surface of the county is generally an undulating upland with slopes extending toward the south or southwest. The entire county lies within the drainage basin of the Mississippi River, and most of the drainage water finds its way directly into this stream. The drainage channels have carved out deep valleys extending, in a few cases, nearly across the entire width of the county. These valleys or "coulees" are prominent features of the topography, ranging in depth from less than fifty feet to more than three hundred feet in a few cases. The stream beds are not base levelled and are yet modified to a considerable extent by the processes of erosion. Along the Mississippi River the surface is intersected by numerous deep ravines and valleys bordered by high precipitous cliffs. The general elevation of the upland part of the county is approximately eleven hundred feet above sea level, but the elevation of a number of isolated points is somewhat greater. The elevation above sea level for some of the towns is as follows:

Maiden Rock, 682 feet; Elmwood, 780 feet; Spring Valley, 941 feet; and Ellsworth, 1069 feet. These figures are given on the authority of the Mississippi River Commission and the C. and N. W. Ry.

GEOLOGICAL FEATURES

Within the area included by Pierce County there are a number of rock formations deposited during early geological ages. These were either limestone or sandstone. The lowest rock and hence the first deposited is known as the Cambrian (Potsdam) sandstone. It is found as a surface rock along the valley of Plum Creek and Rush River. It is also found along Isabelle Creek and Trimbelle River, but probably the largest area occurs along the Mississippi River in the vicinity of Hager and Bay City. This bed of sandstone varies in thickness, averaging from 600 to 800 feet in most places.

A layer of limestone known as Lower Magnesian, varying in thickness from 50 to 250 feet, overlies the Cambrian sandstone. This deposit appears as surface rock throughout the eastern and southern parts of the county, and to a lesser extent in the western and northwestern portion of the county. It is more extensive than any of the other formations found.

A deposit of sandstone known as the St. Peter, of about one hundred feet in thickness, lies directly over the Lower Magnesian limestone. Near Ellsworth and Beldenville are characteristic exposures of this rock. Overlying the St. Peter sandstone there is another layer of limestone known as the Black River (Trenton) and Galena limestone. This deposit varies from 90 to 100 feet in thickness. These formations appear as surface rock in the northwestern portion of the county, chiefly in the towns of River Falls, Martell, and Trimbelle. West Ellsworth is situated on this limestone deposit.

It is quite evident that the resulting soils formed as the product of weathering are dependent in a large measure on the bed rock from which they were formed. That is, on sandstone areas sandy soils would be formed, and on a limestone area clayey soil would result. Were no other

agencies involved, the process of soil formation would become quite simplified.

There were, however, many other factors at work exerting a decided influence in determining the character of the soil formed. One of the most important of these is the glacier, working over residual soils and mixing with them soil and stony material from farther north. The topographic features were likewise altered. Another important factor, especially prominent in Pierce County, is the action of wind. In this county large areas of wind-blown soil known as loess were deposited in the southern two-thirds of the county. This deposit of loessial material appears as a surface formation over much of the county and has given rise to the predominating soil in a large part of the area under discussion.

CLIMATE

The influence of climate upon agriculture is of great importance. The county is favored by an ample supply of rain, the greater part of which comes during the growing season, April to September inclusive. Occasionally, some crops suffer from moisture during the latter part of the summer. Such droughts are seldom severe nor of long duration, and total crop failures from drought are practically unknown.

Temperature conditions are modified to some extent by the Mississippi valley. The annual temperature is somewhat higher than that found in localities of the same latitude in the interior of the state. The highest temperature recorded at Red Wing on the opposite side of the river in Minnesota, is 106 degrees above zero, while the lowest recorded at the same station is 41 degrees below zero. These are extreme conditions, and ordinarily the range is much less than these figures would indicate.

There are, of course, occasional years of extremes in rainfall. The long-time record at Red Wing shows an extreme minimum of 13.28 and an extreme maximum of 41.4 inches. But extremes are much less frequent in Wisconsin than in most other sections of the country.

The following table indicates the temperature and rain-

fall conditions for River Falls which represents conditions in the north and northwestern parts of the county.

NORMAL MONTHLY, SEASONAL, AND ANNUAL TEMPERATURE AND PRECIPITATION AT RIVER FALLS

(Elevation, 906 feet)

Month	Temperature	Precipitation	Month	Temperature	Precipitation
	Mean	Mean		Mean	Mean
	°F.	Inches		°F.	Inches
December	17.0	0.86	June	66.3	6.20
January	12.0	.88	July	69.7	3.73
February	15.2	1.03	August	68.3	3.13
Winter	14.7	2.77	Summer	68.1	13.06
March	27.6	1.80	September	60.3	3.74
April	43.2	2.03	October	47.4	1.68
May	51.0	4.03	November	31.2	1.71
Spring	40.6	7.86	Fall	46.3	7.13
Year				42.4	30.82

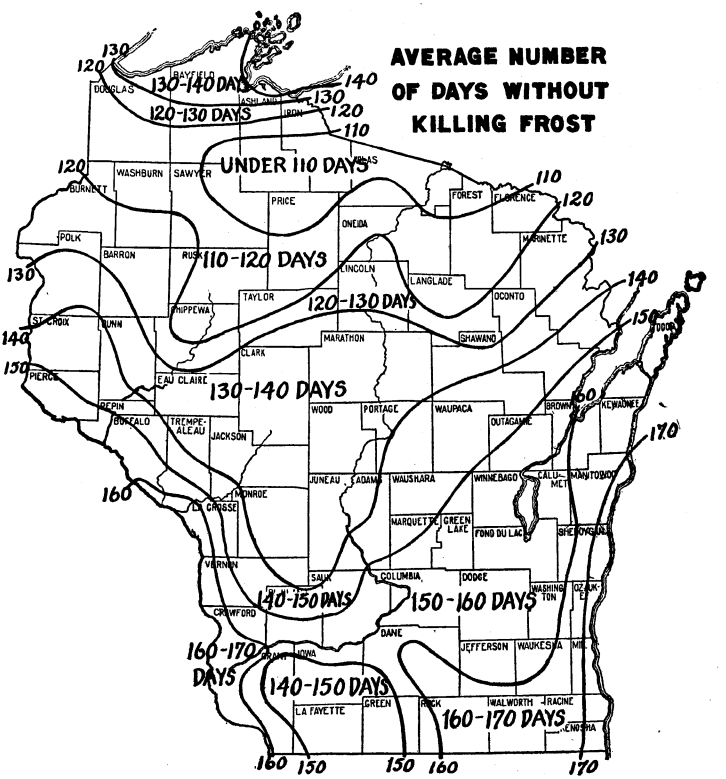

Fig. 1. Average number of days without killing frost in Wisconsin.

It will be noted that nearly two-thirds of the rainfall comes during the spring and summer months. In June, as a rule, heaviest rainfalls occur.

The first snowfall occurs usually in December, and as a rule the ground remains snow-covered until the following spring. Seldom do open winters occur as is the case in some of the southern counties of the state. Winter killing of clover and alfalfa, due to these favorable weather conditions in winter, seldom, if ever, occurs.

The records at Red Wing, Minnesota, in the valley indicate a frost-free season, averaging 155 days, and at River Falls a similar season of 121 days. This season is sufficiently long to mature most crops grown in the county. The latest recorded killing frosts at Red Wing and River Falls, respectively, were on May 22 and May 25, and the earliest in the fall were on September 26 and September 13.*

Soil Formations

About 75 per cent of the soils in the county are classified as silt loam. To a depth ranging from 10 to 15 inches the surface soil consists of fine earth particles containing 50 to 60 per cent of silt. The subsoils are somewhat heavier than the surface layers but are neither very heavy nor compact. In plowed fields the color varies from a grayish brown to a buff color, except in the case of the prairie soils where a distinctly dark colored soil containing a considerable percentage of organic matter is found.

The two most important soil types comprising approximately two-thirds of the soil in the county are the Knox and the Lindley silt loam. The Knox silt loam, deep phase, is found principally in the southern half of the county. A steep phase of the Knox is also mapped, differing from the typical Knox chiefly in its topographic position. It is found in connection with the rough stony land on steep slopes which form valley walls and heads of small streams of the county.

The Knox silt loam deep phase represents chiefly wind-

* For further information on climate see Experiment Station bulletin on climate of Wisconsin.

blown material to which the name, loess, is given. The soil is quite uniform in character to a considerable depth and contains no glacial material, except that in some localities old glacial drift is found underlying the wind-blown deposit.

The Lindley silt loam is similar in color and texture to the Knox silt loam, deep phase. This soil is derived from old glacial material over which a thin blanket of loess soil was deposited. In some places this loess soil is very thin or entirely lacking. This type is found chiefly in the northern half of the county. A greater part of both the Lindley and the Knox are under cultivation and represent soils of high agricultural value. Probably three-quarters of these types are now under cultivation.

In the northwestern part of the county, and in a few isolated areas elsewhere, there are extensive well-drained uplands in which the soils are very dark colored, containing a large percentage of organic matter to a depth of twelve inches. These dark colored lands were originally prairies with very little or no tree growth. The higher content of organic matter or humus came from the roots of the prairie grasses. These prairie soils are mapped as Carrington silt loam and loam, and the soil and subsoil are of glacial origin. The Waukesha series represents soils of similar character but differing in origin in being water-laid material.

A number of sand and sandy loam soils are also mapped, totalling less than 10 per cent of the soil areas in the county.

Rough stony land includes steep, rough, and rocky land which cannot be cultivated. It forms steep walls and valleys and is very extensive in this county, covering practically 12 per cent of the land area.

On pages 39 to 65 of this report, the soils of this county are described in detail, and their agricultural characteristics are discussed. In the following table the acreage and proportionate extent of each of the various soil types are indicated.

ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS MAPPED IN PIERCE COUNTY

Type of Soil	Acres	Per Cent	Type of Soil	Acres	Per Cent
Deep Knox silt loam	136,448	41.4	Lintonia silt loam	7,296	1.9
Steep phase	19,072		Lintonia loam	1,600	.4
Lindley silt loam	76,224	22.6	Waukesha silt loam	640	.2
Steep phase	8,640		Waukesha loam	1,408	.4
Lindley fine sandy loam	12,992	3.5	Waukesha fine sandy loam	4,096	1.1
Carrington silt loam	8,320	2.2	Plainfield sand	4,864	1.3
Carrington fine sandy loam	512	.1	Genesee silt loam	19,136	5.1
Lindley gravelly loam	1,792	.5	Genesee sandy loam	4,352	1.2
Baxter silt loam	4,800	1.3	Alluvial soils undifferentiated	4,288	1.1
Knox silt loam (shallow phase)	2,304	.6	River wash	320	.1
Boone fine sandy loam	4,032	1.1	Rough stony land	45,312	12.1
Boone fine sand	2,944	.8			
Conover silt loam	1,408	.4			
Clyde silt loam	2,240	.6			
			Total	375,040	

CHAPTER II

SOIL MANAGEMENT AND LAND UTILIZATION

Chemical Composition and Fertility of Silt Loam Soils

Farmers recognize the fact that there is a considerable variation in the crop-yielding power of soils. Even on the particular farms on which they happen to operate, certain fields may be much more productive than others. The soil, it should be understood, is a complex mass made up of mineral matter and organic matter, or humus. All of it is populated with bacteria, fungi, and other organisms which form an important part in what is known as productive soil. Plants as well as animals require food. Moreover they require a balanced ration. By means of chemical analyses it is possible to determine the amounts of essential plant food constituents which may be found in the soil to a depth of eight inches or more. During past years several hundred farmers in Pierce County have had samples of soil from their farms analyzed by the State Soils Laboratory. Phosphorus, nitrogen, potassium, and calcium are four of the important elements which are required by all crops. From a study of soil analyses made, it has been found that the total phosphorus content ranges from 900–1400 lbs.; the potassium content of the predominant type such as the silt loam shows an average of 35,000–40,000 lbs. per acre to a depth of eight inches; and the nitrogen content ranges from 2500 to 3500 lbs. per acre. There are, of course, a considerable number of variations; but in general it appears that the older cropped lands bordering the Mississippi River are lower in both nitrogen and phosphorus than are the interior townships which have been subjected less to grain farming.

While the total supply of plant food furnishes considerable information concerning the reserves of plant food in the soil, it does not necessarily mean that other factors are not of equal or even greater importance in the production

of high yields. Especially the rate at which plant food comes into solution and becomes available is a matter of particular interest. A number of factors affecting the availability of plant food may be mentioned.

Organic Matter

A good supply of organic matter is necessary. Organic matter produces good tilth, gives ease for working, and increases the capacity for soil moisture. It is also of particular significance in connection with making plant food available for crop use. In the decay of organic matter, or humus, weak acids are formed which in turn react with soil minerals, thus furnishing available phosphate, potash, nitrogen, etc.

Freshly decomposing organic matter is much more valuable than old resistant organic matter which is slow in breaking down. A ton of clover or soy beans, for example, has more effect on liberating plant food than many times this amount of old resistant humus, or organic matter.

Stable manure is also a source of organic matter, serving also, as a source of plant food.

Legume Crops

Legume crops are important not only because of their value in furnishing high protein feed for the dairy herd; they are also of great value as soil builders. Legumes are deep rooted plants and are thus able to tap stores of plant food in the subsoil and build them up into the tissues of the plants used for roughage. It must be remembered, however, that legume crops depend upon the surface eight to ten inches of soil for their principal supply of food. Legumes have also the power of securing plant food in forms less available to other crops, and finally through the decay of the root masses these crops assist in setting plant food free. Of course, it must not be overlooked that legumes properly inoculated have also the ability of extracting large amounts of nitrogen secured from the air in the soil.

USE OF LIMESTONE

The use of limestone serves, at least, two purposes in the soil. It furnishes calcium plant food required by all crops, more particularly the legumes such as alfalfa, clovers, soy beans, etc. Lime material also promotes the activity of bacterial action in the soil, a matter of great importance. Many of the bacteria fail to thrive, or their activity is materially reduced in soils, indicating an acid reaction. It is possible to get good stands of clover and, in some cases, alfalfa without recourse to liming. Better yields can usually be secured when lime materials are utilized. The trend is now toward the use of more lime. The county is fortunate in having fine deposits of limestone that are now being used for this purpose. Many portable crushers are in use.

Legume crops are heavy feeders on calcium. Besides, best yields are not obtained where the soil shows a high degree of acidity. Not only are the legume crops benefited; recent Experiment Station results indicate that practically every crop grown in the rotation has benefited either directly or indirectly from the use of lime material. In general, the soils of the county do not show a high degree of acidity at the present time. In fact, many fine fields of alfalfa were noted on which limestone had not been used in the preparation of the land. Two to two and one-half tons per acre is a fair application, and wherever possible it should be applied a year in advance of the new seeding.

The amounts to apply will, of course, vary with the needs of lime, and the farmer should have either the County Agent, or the Soils Department of the College of Agriculture test samples from his farm before investing in lime materials.

Ground limestone is the most economical form in which lime can be utilized in the county. Large amounts of limestone are annually shipped into the county in addition to that which comes from portable mills located in different sections of the county. Analyses made of local rock indicate that the quality is entirely satisfactory for agricultural purposes. Finely ground rock should be given preference.

TILLAGE

Plant foods may also be liberated by proper tillage methods. Land that is plowed at the proper time and prepared as a good seed bed in spring, other things being equal, produces better yields than land not so well prepared. Then, too, the cultivation of intertilled crops serves to conserve moisture and destroy weeds, thus furnishing conditions better suited to these crops.

MAINTAINING FERTILITY

It should be pointed out, however, that these practices,—liming, increasing the organic matter supply, the growing of legume crops, and good tillage practices, important as they are, all serve to make it possible for crops to secure larger amounts of phosphorus, potassium, and other minerals from the soil. Consideration should, therefore, be given to a matter of special importance, that of maintaining and, if possible, increasing the level of mineral plant food in Pierce County soils.

As already emphasized, the total amount of phosphorus found now in the soil is relatively low. The total stores of potassium, on the other hand, are ample for good crops for an almost indefinite period, but are slowly available. The problem to consider is that of liberating plant food, especially potash in sufficient quantities, at the time that crops require this particular element. Nitrogen, on the other hand, may be secured in ample quantities, providing legume crops are grown and the roughage fed to the animals on the farm. A ton of alfalfa hay contains about 50 lbs. of nitrogen, a good part of which may have come through nodular organism from the unlimited supply in the air. Two-thirds to three-quarters of the nitrogen contained in the feed stuff may be returned to the field, and the soil enriched to that extent. It may be pointed out, however, at this time that the amount of nitrogen returned will depend upon the manner or method in which stable manure is handled. In many instances half or more of the nitrogen contained in the manure is lost before it is returned to the soil.

MANURE

In systems of diversified farming similar to that followed in Pierce County, a large share of the plant food removed by the various crops grown is returned to the soil in one form or another. The manure produced by the feeding of the crops grown, together with the straw used for bedding, is the principal source in which plant food is thus returned. Where considerable mill stuffs are fed to the dairy herd, much plant food, likewise, is brought to the farm. The amount so returned depends on the tonnage of feed stuff consumed. In some instances, though rare, more is returned through mill stuffs fed them than is lost through the sale of products and otherwise.

Manure should be depended upon in a large measure to return plant food removed by crops. Its value justifies taking precaution in preventing unnecessary losses. As a rule, least losses are incurred where manure is hauled directly from the stable to the field. On steep land this practice may result in some losses.

Where manure is distributed in spring for corn or other cultivated crops, considerable loss results where the manure is left exposed to the weather. Not only is moisture evaporated, but through chemical changes nitrogen also escapes. The losses may be easily avoided by disking the manured ground directly after manure is applied. In the same way, sod land should be plowed as soon as possible after manure is spread.

In this diversified system of farming a sort of revolving fund of plant food is established, for crops may use repeatedly some of the plant food removed by preceding crops which were fed and the manure returned. In this process, however, it is seldom possible to return more than sixty to seventy-five per cent of the plant food extracted by the crops grown and fed. For example, in the sale of milk produced by a cow producing 300 lbs. of butter fat, there are removed in phosphorus amounts equivalent to that found in about 65–70 lbs. of 16 per cent superphosphate. A 1000 lb. animal sold off the farm likewise carries off the equivalent of phosphorus found in 100 lbs. of 16 per cent super. Where grains are sold, the losses are even greater,

since most of the phosphorus is found in the grain and relatively small amounts in the straw.

PHOSPHORUS

The fact that much the greater share of milk produced is separated, and only cream sold, alters but little the statement made with reference to phosphorus losses. The skim milk is usually fed to poultry, hogs, and young calves, but little of the manure from the hog lots or the poultry yards is ever returned to the field in the same measure that manure from the dairy barn is returned. Then, too, the growing animals extract large amounts of phosphorus for building bone and muscle so that the losses of plant food, especially phosphorus, are almost as great where cream only is sold as where a farmer patronizes a cheese factory.

The most practical means of maintaining and, if possible, increasing the phosphorus stores in the soils of Pierce County comes through the use of a phosphate-bearing fertilizer. For this purpose either finely ground rock phosphate may be used, or the 20 per cent or the 45 per cent superphosphate. Because of the great necessity of growing large crops of legumes, alfalfa, and clovers, a part of the fertilizer treatment should be applied broadcast or in drills for the small grain crops with which clover or alfalfa is seeded. Three hundred pounds of 20 per cent, or about 125 lbs. of 45 per cent phosphate make a fair application. The material may be applied by means of a lime sower, but by far the best tool is a combination fertilizer and grain drill.

POTASH

On farms where an insufficient supply of manure is available, or where land has been subjected to cropping for some years, potash also may be used to good advantage in increasing yield of hay, alfalfa, or clover, as well as that of small grains. Under such circumstances 75–100 pounds of muriate of potash may be added with either of the phosphate fertilizers indicated above. Where ready mixed fertilizers are given preference, 250–300 pounds of a mixture similar to an 0-14-14 may be used. Fertilizers should be

disked-in on plowed land before drilling the grain unless a combination fertilizer grain drill is used.

NITROGEN

Legume crops are indispensable for the dairyman. There should be little or no difficulty in maintaining the nitrogen supply under conditions where 25–30 per cent of the plow land is in one or more of these legume crops. It might be stated that where there is good legume hay, corn, silage, and home grown grain made up of barley and oat mixtures, economical production records may be made without the use of much or any purchased mill stuffs. Only in the case of high producers will it be necessary to resort to the use of protein mill stuffs.

CORN FERTILIZATION

Corn is an important crop. It is utilized not only for silage purposes, but the crop is matured to a large extent and used for grain. Maturity is, therefore, important. Where the crop is grown on legume sod with a moderate application of manure, a moderate application either of straight superphosphate or a mixture containing some potash will be found useful, not only in hastening the maturity of the crop but also in increasing yields and improving the quality. Checked in the hill, 125–150 pounds per acre makes a fair application. This is in addition to the fertilizer applied broadcast on land for small grains which is being seeded to clover or alfalfa. On old sod land the use of a little nitrogen may be found helpful in getting the corn started earlier in the spring.*

GRAIN AND CLOVER FERTILIZATION

Fertilizer tests indicate that small grain crops respond to phosphorus, and the need of supplying this element is of first importance in securing profitable yields. Best results, however, are obtained with commercial fertilizers containing potash in addition to phosphate. Not only will the

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* For information on pasture management see page 32.

small grain show benefit from the use of fertilizers, but usually the improvement in the clover or alfalfa crop the year following is of considerably more value than the increase in grain yields. From the standpoint, therefore, of maintaining the general fertility of the farm, applying fertilizers on the small grain and new seeding is of much greater importance than that of fertilizing the corn in the row, or in the hill. If only one system of fertilization is possible, that of broadcasting or drilling for the small grain crop should be given preference.

Three hundred pounds of 20% super, or 125–150 pounds of the 45% treble phosphate makes a fair treatment for small grain and new seeding. Potash may be added by using 80–100 pounds of muriate of potash salt, and home-mixing it with either of the phosphates referred to above. A good ready mixed fertilizer is one similar to an 0-14-14, or an 0-16-12. Three hundred to 400 pounds per acre is the usual treatment. A higher grade fertilizer such as an 0-20-20 at the rate of 200–250 pounds per acre may be found more economical. Two hundred pounds of an 0-20-20 carries approximately the same amount of phosphorus and of potash as is contained in 300 pounds of the lower grade, 0-14-14.

Grain fertilizer may be applied by means of a lime sower. The best tool, however, to use for distributing fertilizer is the combination grain drill. With this drill the grain, fertilizer, and alfalfa, or clover seed are drilled in the one operation thus saving time. Another advantage of drilling fertilizers as compared to broadcast treatments is that fertilizer is placed more evenly, and in close proximity to the seed, since the grain and fertilizers pass down the same drill spout, whereas in broadcasting a less even distribution is secured. With the usual small grains no injury occurs where fertilizers and grain are drilled in this manner. Peas, on the other hand, are more sensitive to fertilizer injury, and the practice of drilling this crop with fertilizers in the way mentioned above is not recommended. It is better to spread the fertilizer and work it into the soil before sowing.

CHEMICAL COMPOSITION AND MANAGEMENT OF THE FINE SANDY LOAM SOILS

These lighter textured soils contain a somewhat smaller amount of mineral plant food elements than the heavier silt loam soils. They have, however, some advantages over the heavier soil in that they warm up earlier in the spring, can be worked under a wider range of moisture conditions, and are especially well adapted to potatoes, and general truck crops.

The fine sandy loams are well adapted to a considerable range of agricultural crops and types of farming. The soils are sufficiently heavy in most cases to support a fair to good growth of grass, either as pasture or meadow, and small grains may be depended upon also to make good yields. Because the soil is of a nature which warms up readily in the spring, it is well adapted to corn, and such special crops as potatoes, tobacco, cabbage, and general truck crops. Small fruits and berries also do well in suitable locations.

In the further management of this group of soils, increasing the humus or organic matter content deserves careful attention. Plowing under green manuring crops, especially legumes, is a commendable practice. The legumes, however, are sensitive to acidity, and one of the requirements for good stands is an application of two to three tons of finely ground limestone per acre. Wherever it is possible, it should be applied a year in advance of the new seeding. This ordinarily means liming the corn ground. The frequent stirring of the soil through cultivation serves to mix the lime material thoroughly with the soil thus overcoming the acidity, and getting the ground in better condition for the legume seeding the year following.

These valuable crops are also heavy feeders of the minerals, phosphate and potash. Frequently clover or alfalfa either fails or makes a poor yield on limed land because of the deficiency in the soil of either available phosphate or potash, but generally both. Limestone, it should be stated, does not take the place of phosphate or potash, and likewise these plant food elements cannot be substituted for limestone.

For the usual farm crops grown in this section, a fertilizer mixture supplementing stable manure should consist of a phosphate-potash mixture. On old cropped land maximum crop yields cannot be secured without the use of commercial plant food unless large amounts of stable manure are available. The fertilizer formulae and the methods of application for different crops already discussed in Chapter II under the heading of silt loam soils apply in a general way also to similar crops grown on the sandy loams.

Where potatoes are grown as a cash crop, the use of fertilizers supplementing stable manure is advised. A good application for the tuber crop is 600–800 lbs. per acre applied in the row. For this purpose, fertilizers similar in composition to that of a 3-12-12 or a 3-9-18 may be recommended.

The cabbage crop responds to liberal fertilizer treatments. Where a liberal dressing of manure is available, fertilizers of the 0-12-12 or 0-14-14 composition may be applied at the rate of 300–400 lbs. per acre by means of an attachment to the transplanter at the time of setting. Where only moderate amounts of manure are used, a complete fertilizer such as a 3-12-12, or a 3-14-14 at the rate of 400–600 lbs. per acre makes a good application.

Where bush fruits, blackberries, and currants are important crops, the question of plant food supply should be considered. Successful growers have found stable manure the best material for bush fruits and strawberries. Manure adds not only plant food but also organic matter. In the absence of manure, green manuring crops may be substituted, supplemented by commercial plant food.

Complete fertilizers are required for these crops, and mixtures similar to a 3-10-10 or a 3-8-6 may be used at the rate of 4–6 lbs. per hundred-foot rows. Even when manure is used, commercial plant food will be found profitable in producing better yields, and also more vigorous canes.

Strawberry growers, at times, find it necessary to side-dress the crop with a nitrogen fertilizer early in the season. For this purpose nitrate of soda is used, applied before the plants begin to bloom at the rate of one-half to three-quarters of a pound of nitrate of soda per hundred-foot row.

CHEMICAL COMPOSITION AND MANAGEMENT OF THE SANDY SOILS

Sandy soils are represented in the county by two types, the Plainfield sand and the Boone fine sand. Both of these types embrace an area of about 8,000 acres.

Sandy soils are characterized by a low content of organic matter, and they have an open porous texture, resulting in a soil formation of low water-holding capacity. They are also low in plant food, are quite generally acid, and in many cases are subject to flooding which injures crops just starting to grow and is detrimental in other respects as well. Because of these conditions, the management of sandy soils presents many difficulties. On the other hand, sandy soils have certain advantages. They are easily worked, there is no loss of time after rain before they can be worked, and they warm up quickly in the spring. Moreover, they can be purchased at a much lower price per acre than heavier soils, so that a farm represents a much smaller investment of money and labor.

In the further management of the sand, consideration should first be given to increasing the organic matter content. This, in turn, means a higher capacity for moisture, although it should be understood that the soil capacity for moisture can be improved only to a limited extent. The soils by nature are open and porous, and organic matter tends to decompose rapidly so that it is not possible or practicable to increase the organic matter content to any such extent as is possible on the heavier textured soils.

The practice of plowing under green manuring crops is sound, not only because of the value of the organic matter thus contributed, but also because of the effect in assisting in liberating plant food. Legume crops should be given preference, but other crops of non-legumes such as rye and buckwheat may also be used with profit. A good practice is that of growing rye in the corn stubble, planting the crop as early as it is possible to be used, either as a green manuring crop the next year or to serve as a cash crop. Whenever it is possible, a growing crop should be maintained on the ground during the fall and winter so as to utilize avail-

able plant food which would otherwise be lost through leaching processes.

Legumes, on the other hand, have the advantage of contributing nitrogen, providing the crop is well inoculated. These crops, however, are sensitive to acidity and require an application of lime material to furnish calcium for the crop as well as to overcome the acidity. In general, 2½–3 tons of limestone per acre are necessary.

The supply of phosphorus ranges from 500–800 lbs. to the acre, potassium about 25,000 lbs., and nitrogen from 1000–1400 lbs. per acre. These amounts are much less than the amounts found in the heavier soils of the state, such as the Knox silt loam. Where manure is available, it should be applied in moderate amounts of 6–8 tons per acre. Manure may be profitably supplemented with commercial plant food. Since the legumes are so important from the standpoint of soil improvement, as well as from the standpoint of furnishing high protein roughage for the livestock, commercial fertilizers may be used profitably in connection with the seeding down of alfalfa or clover. Potash, especially, should be used on sandy soils. These soils are always low in this element.

On soils that have been cropped heavily, legumes may be seeded without a nurse crop in order to conserve moisture for the new seeding. A fertilizer treatment of 400 lbs. of a phosphate-potash mixture similar to a 0-8-24, or a 0-9-27, or a 0-15-30 may be used. This should be disked-in on plowed land, or better, applied by means of a combination fertilizer grain drill.

Soy beans also make fairly good yields on the sandy land, although good yields are obtained only where lime and commercial plant food have been used. Soy beans, however, are less sensitive to acidity than are alfalfa and the clovers, and the crop should be utilized for green manuring purposes as well as for furnishing high protein hay crops.

Rye is one of the safe grain crops. Corn may be grown and fits well into the rotation following alfalfa or clovers. Besides a moderate application of manure, a small amount of fertilizer applied in the hill may serve to start the corn off quickly and also increase the yield. For this purpose

100–125 lbs. per acre of a fertilizer similar to a 2-12-6, or a 3-8-6 may be used.

MANAGEMENT AND FERTILIZATION OF POORLY DRAINED SOILS

This group of soils includes soils of three somewhat different kinds; first, Clyde silt loam, described on page 63, which is characterized by its high content of organic matter as well as poor drainage; second, Conover silt loam, a soil occurring in small pieces in depressions of otherwise well drained upland which it resembles except that it is somewhat heavier and more poorly drained; and third, land along stream bottoms including Genesee silt loam, sandy loam, and the alluvial soils undifferentiated, described on pages 61 to 63.

The Clyde silt loam, when drained, is a soil of good fertility. It is especially well supplied with nitrogen and in this county it is usually well supplied with lime brought in from higher areas by underground water. It is, however, likely to be more deficient in available potash than the general upland soils of the county. This element, therefore, should be supplied in the form of a potash fertilizer to balance the nitrogen and lime already there. When such land has been under the plow for some years, phosphate may be needed in addition.

The Conover silt loam calls for the same management with reference to fertilization as other upland soils, but, in general, it requires drainage to best fit it for major crops.

The Genesee and river bottom soils are for the most part subject to flooding during periods of high water and so are in general not available for cultivated crops but are usually used as pasture. Under these conditions, the suggestions offered for the fertilization and management of pasture land given on page 32 may be helpful.

PASTURE AND WOODLAND

In the classification of soils, some types, on account of their mode of origin, are essentially level or gently undulating. This includes such alluvial soils as Plainfield, Waukesha, and Genesee formations. Others such as Knox,

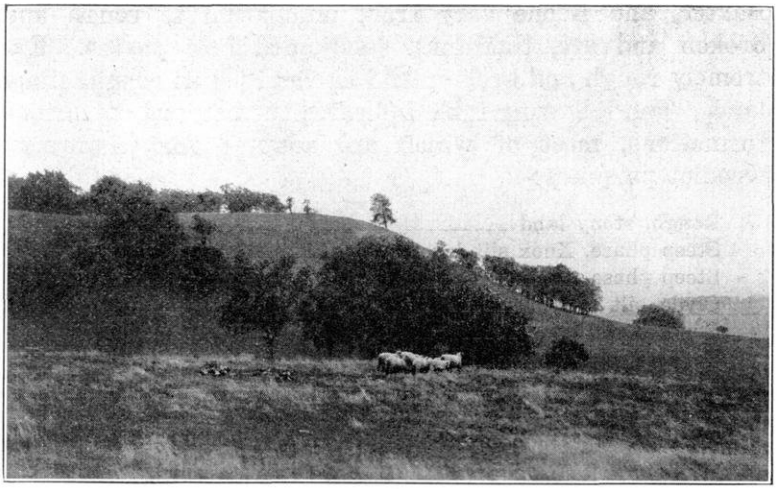

Fig. 2. When properly protected from erosion, moderately steep land can be used for pasture for sheep or cattle. Fertilizers should be used to replace plant foot removed by stock.

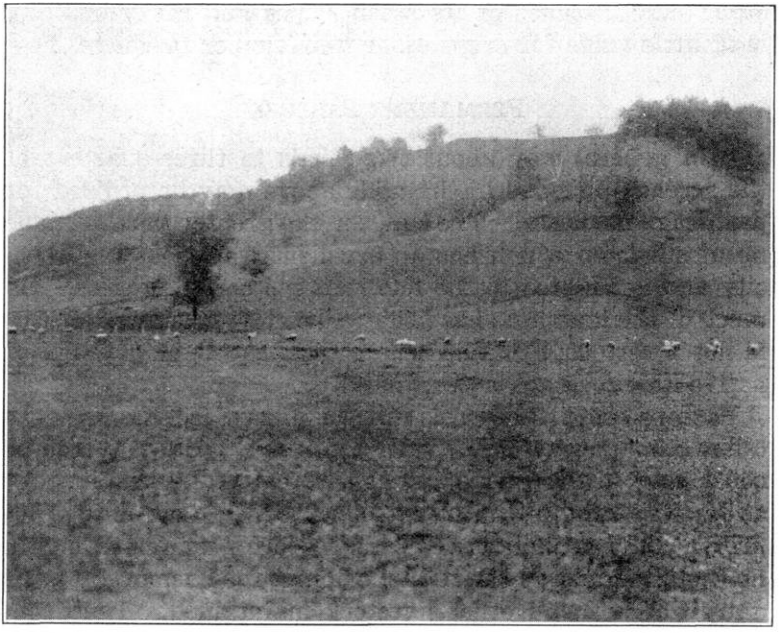

Fig. 3. The wood on the upper part of this hill should not have been cut all at once. The larger trees could be cut, leaving the younger ones to grow, thus keeping a piece of woods to protect the lower slopes from erosion. The woodland should not be pastured or the tree seedlings will be destroyed.

Baxter, and Boone vary from undulating to rough and broken and are, therefore, subdivided into phases. Extremely rough and broken land is classified as rough, stony land. The following table indicates the acreage of various formations, most of which are adapted for pasture or woodlot purposes:

Rough, stony land	45,312 acres
Steep phase, Knox silt loam	19,072 "
Steep phase, Lindley silt loam	8,640 "
Clyde silt loam	2,249 "
Genesee silt loam	19,136 "
Genesee sandy loam	4,325 "
Undifferentiated alluvial soil	4,280 "
Lindley gravelly loam	1,792 "
	104,806 acres

Some of the bottom land represented by the Clyde and Genesee types is under cultivation and represents soils of high agricultural value. The greater part of the rough stony land, because of its steep slopes and rocky outcrop, is of little value for crops other than timber products.

PERMANENT PASTURE

In a general way about two-thirds to three-quarters of the acreage included in the table above may be utilized for pasturage purposes. The soil, for the greater part, is made up of silt loam which has an excellent water-holding capacity and is adapted to the fine root system of grasses. On much of the land lime has been reduced by leaching, yet this is not a serious situation where such excellent deposits of native lime rock are close at hand.

Pasture crops, however, require plant food the same as other crops grown on the farm. In fact, pasture should be considered in the same class as a cereal or hay crop as far as fertility requirements are concerned. Many of the permanent pasture plots have been grazed for many years with no thought given to the return of plant food removed by the dairy animals and other livestock maintained. The droppings of the animal in only a small way return plant food removed by the grazing animal.

Where clovers make up a considerable part of the pasture

crop, little thought needs to be given to the question of nitrogen fertilizers since the legumes can secure their nitrogen by fixation. Some of the recent work of the Experiment Station indicates clovers may be established by seeding early in the spring before the frost is out of the ground, providing the supply of plant food is sufficient to meet the requirements of the crop. Alsike and white clover can be seeded where there is a very poor stand of grass and where it will catch. Quite frequently land so seeded may be utilized for pasture purposes the same fall, but it has been found not desirable to pasture in the spring the first year after seeding, in order that a good system may be established.

On soils which show a medium acid reaction, limestone is needed which should be top dressed at the rate of two tons to the acre. The fertilizer treatment should consist of a liberal application of phosphate, together with a moderate potash application. A fair treatment consists of 300 lbs. of 20 per cent superphosphate together with about 100 lbs. of muriate of potash. In case ready mixed goods are used, about 500 lbs. of an 0-14-14 fertilizer per acre may be used. This fertilizer may be applied broadcast in late March or early April, at the time of the seeding, if any is done.

On good pastures in this region from one and one-half to two acres will supply the feed for an average cow for five or six months, but it is usually necessary to supplement pasture crops a part of the time without overgrazing in order to maintain the herd in a thrifty condition and at maximum milk production. Where it is possible to secure five months' feed from the pasture land, it is quite apparent that this type of land may be profitably utilized for producing dairy feed. The same is undoubtedly true if used for grazing beef cattle and sheep. Thus pasture economy is at once apparent when one considers that cost of pasture land is only for interest, taxes, and fencing, amounting to approximately $10.00 for the pasturing period, or $2.00 per month. On the other hand, the cost of feed during the winter period may range from $8.00 to $10.00 per month. Moderate steepness of slope is, therefore, not such a serious handicap, providing this land does not constitute a larger portion of the farm than can well be utilized for pasture purposes.

The majority of farms in the county, as at present laid out, include a fair amount of tillable land associated with rougher land adapted for pastures. In order that this steep land may be used to best advantage, livestock must be kept, and this is one of the principal reasons why the livestock industry is developed on such a large scale in the county. Livestock farming, it may be stated, is about the only type of agriculture that can fully utilize the steep land as well as the low, poorly drained areas. Dairying is therefore, being developed on a large scale, as it is able to utilize land which in a grain system of farming would have little or no value.

Forest Products

A considerable proportion of the area included in the rough stony land as well as parts of the steep phases of Knox and Lindley silt loam are still in timber, chiefly hardwood such as oak, basswood, elm, maple, and scattering pine. While the timber is even now of considerable value as firewood, for posts, and to a limited extent as saw timber, there is undoubtedly a considerable opportunity to increase the value of timber products. On land where the slope gets as steep as 40–45 per cent, pasture grasses fail to make a good development. Where steep tracts have had timber removed, serious losses from gullying frequently result.

Space does not permit details in the discussion of the management of woodland, and it may be pointed out that one of the important things contributing to the improvement of young tree growth is the exclusion of livestock. Tramping of cattle kills off the seedlings and small trees and disturbs the surface covering of vegetable matter which is so desirable for the growth of trees. In some cases replanting may be essential for best results, while in other cases natural reproduction will often fill out gaps and in time will produce a good stand of forest growth. In the future management of forest growth, attention should be given to the cutting of timber, limiting it to such trimming as will be beneficial, trimming branches at the proper time, and destroying the underbrush.

The increase in the cost of lumber at the present time makes the conservation and the possibilities of woodland

in this region more and more important. The single item of firewood alone means an average of $75–$100 annually to each farmer. Many farmers find it possible to make a saving in the construction of fences by growing posts on land of little value for other purposes. It might also be stated in passing that the yellow locust tree, highly desirable for fence posts, makes exceptionally good growth on soils of the character found in the rough and steep tracts of the county. Saw logs of white oak have a high value on the farm for such uses as whiffle trees, tongues, stone boats, etc. They command a good price when sold for such purposes or for building material. It is also quite probable that pine may be grown successfully in this section of the state. The very scattering distribution of it, however, on the rough stony land, together with the fire hazards, make forestry a somewhat expensive proposition.

Soil Erosion

One of the important problems in soil management in Pierce County is that of checking erosion. There are a number of factors which influence the possibility of serious losses from this source. One of the most important is the surface features, or the lay of the land. In much of the county considerable steep land occurs, especially in areas immediately bordering the Mississippi River where the valley floor lies 200–500 feet below the ridges which extend between them. Again, the fine loessial soil represented by the deep Knox silt loam is peculiarly subject to washing and gullying. The slopes of the deep Knox silt loam originally timbered or brush-covered have, in a considerable measure, been cleared and cultivated. Because of their unprotected condition and exposure to the surface runoff from higher land, any fields on this type of soil are extensively washed and gullied by heavy storm water, and finally the amount of rainfall and the system of cropping are factors that must be considered in this connection.

Hillside or sheet erosion.—By hillside erosion is meant the removal by water of the more fertile part of the surface soil from fields which may have only a gentle slope. Not only are the soil particles removed; the loss of the organic matter is of equal or greater importance.

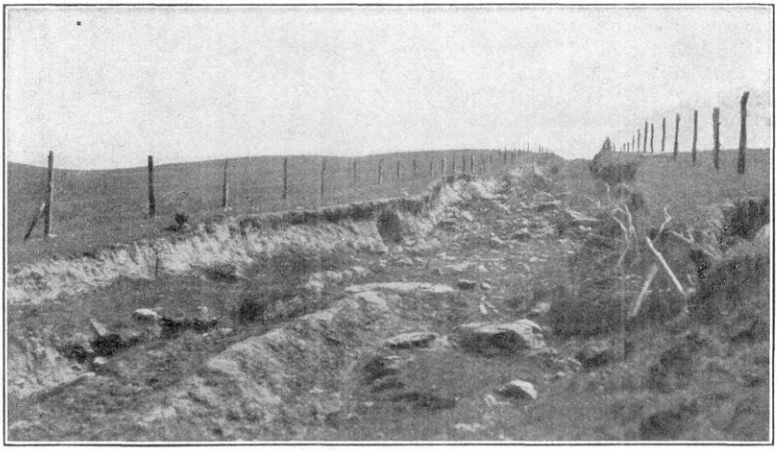

Fig. 4. Paths in lanes cause gullies. A grassed shallow ditch along the fence outside the lane will often prevent this.

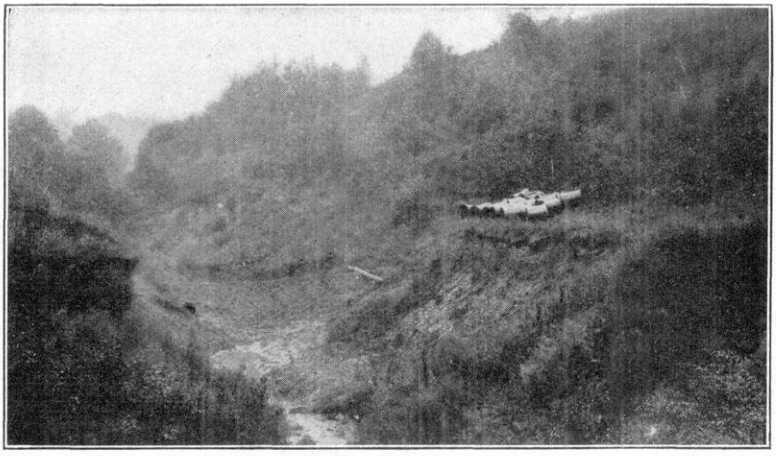

Fig. 5. Upper side of dam in gulley just made to cause filling of gulley. The tile through the dam will be extended upward as the gulley fills.

Injurious washing due to hillside or sheet erosion, may be controlled in a considerable measure by adopting proper cropping systems. Land subject to losses from this source should be kept as much as possible in hay, or pasture, and the ground devoted to cultivated crops as little as possible. Such crops as alfalfa may be grown, the crop being left on the land continuously for a period of three to five years, followed by a cultivated crop, and then again reseeded.

It is also very desirable, wherever it is possible, to plow up only a section of the slope land following the contour so that while the lower half, for example, is in cultivated crops, the upper half may remain in hay or pasture crops. Likewise, when the lower half is laid down to hay or grass, the upper section may be devoted to grain or cultivated crops. This practice has been followed by many farmers with good results.

Where there is any tendency for small gullies forming, these should be maintained in sod strips to protect the field from the flow of water during rains and prevent deep gullies which are sure to follow unless methods of protection are taken. These sod strips should be of sufficient width so that gullying does not begin at the side, resulting in two new gullies in place of the original one.

Increasing the supply of organic matter is one means of increasing the water-holding capacity of the soil, and thus of helping to prevent erosion. Plowing under of a green manuring crop, stable manure, and crop residues, such as straw and cornstalks, are processes that may be mentioned in this connection.

On much of the hillside land of this county which must be used for cultivated crops, the construction of terraces by the use of a plow and road grader will greatly lessen erosion. These terraces carry the water across the slope at a very low gradient so that it carries little silt or earthy matter with it and prevents the formation of gullies. Such terraces can be made on most of this land at an average expense of $1.50 to $2.00 per acre, which is very small compared to the benefit that it produces. They are broad and low so that farm machinery can be operated over the entire field as before.*

* For further information on the construction of terraces, see Experiment Station bulletin on erosion.

Gullies.—Erosion commonly leads to the formation of gullies unless prompt preventive measures are taken. Where these gullies are allowed to go unchecked, the entire field may soon be made practically useless for farming purposes.

It is, therefore, of the greatest importance that farmers in this region do everything possible to reduce and control losses from this source. Control measures include the prevention of the development of gullies in the early stages by filling in with brush, straw, or other material. This must be done carefully so the water will not wash under the filling. The sides, especially, must be protected so other gullies will not start.

In many cases, gullies already formed can be kept from further development through the construction of dams which will cause the accumulation of soil above them while it permits the water itself to continue down the slope. Different forms of dams have been used for this purpose. Under some conditions, an earth dam may be satisfactorily used. In other cases a concrete dam is built but, in case of either the earth or the concrete dam, tile should be laid beneath the dam, extending down the gully so as to draw off the water above the dam before it reaches the top and carry it down a slope without permitting erosion losses.

Planting willows and brush on the sides and bottom of ditches too deep to fill often arrests the growth of the gully. Full information on the construction of dams will be found in the Experiment Station Bulletin on erosion.

Bottom land.—Many of the bottom lands along the streams in the county are badly cut up because of the meandering tendency of streams. The straightening out of the stream bed in these bottom lands will be of some help. During periods of spring freshets, or after any heavy rainfall, an enormous quantity of water collects in these valley bottoms, rendering control measures difficult. Were more of the steep slopes maintained in timber, or forest growth, the runoff would be materially reduced, and the losses to the bottom land would be less destructive.

CHAPTER III

GROUP OF HEAVY AND MEDIUM TEXTURED SOILS

Deep Knox Silt Loam

Soil.—Deep Knox silt loam to a depth of eight to ten inches consists of a grayish brown smooth silt loam. The subsoil is a light brown or yellowish brown compact silt loam which at a depth of eighteen to twenty inches grades into a compact silt loam or silty clay loam. At lower depths the material is unweathered loess, light yellow in color and composed almost entirely of silt and very fine sand. This silty material continues to a depth ranging from three feet to more than twenty feet, and it rests on the underlying rock or on a thin layer of old glacial drift.

The soil is uniform in color, texture, and structure, but it has a few minor variations. In uncleared areas the surface layer of two or three inches is darker in color than the typical soil, owing to the accumulation of vegetable matter. Where the fields have been long under cultivation, the surface soil, when dry, has a light ashy or gray appearance.

Extent and distribution.—Deep Knox silt loam is the most extensive soil in the county and the most important from the view point of agricultural production. It is the predominant soil in the southern half of the county, and it is mapped to some extent in nearly every township. Many farms are made up entirely of this type.

Origin.—While the exact geological origin of deep Knox silt loam is not thoroughly understood, it is considered quite probable that the deposition of this soil was made by the wind when climatic conditions were very different from those occurring at the present time. In its original unweathered condition it consisted of a yellowish fine-grained silty material, known as loess, which has been modified by the accumulation of plant residues, and to a certain extent by residual material derived from the consolidated

rock of the region. In some places where the loess covering is thin, and where the underlying rock is limestone, it is very evident that the residual material from this formation has influenced the type to a certain extent. In other places, however, the evidence is not so clear, and the pure loessial material appears, ranging in depth from three feet to more than twenty feet.

Surface features.—Areas of this soil vary from nearly level to gently rolling and hilly. Most of the land is undulating or gently rolling. The level or gently undulating areas are less extensive and the steep areas are least extensive. On the soil map the very steep land is separately indicated. Owing to the uneven surface features the natural drainage is good, but the soil is subject to erosion. The problem of erosion has been discussed in an earlier chapter. As a rule, the land is practically free from stone, except in areas which grade into the Lindley silt loam where some stone and bowlders are found.

Native vegetation.—The original timber growth on this soil consisted of hard maple, oak, basswood, elm, hickory, butternut, and some walnut. Maple trees predominate in many places along the Mississippi River bluffs, and for several miles back of the river, but beyond that the oaks are more plentiful, and on the northern areas oaks predominate. A considerable number of farm woodlots are on this soil. In Rock Elm township about 4,000 acres of deep Knox silt loam are in farm woodlots. Many of them are on land which when cleared will make good farming land.

Agricultural development.—It is estimated that from 75 per cent to 80 per cent of the Knox silt loam is cleared and under cultivation, and the greater part is highly improved. The leading type of agriculture followed consists of dairying in conjunction with general farming. As the growing of wheat, an important industry forty years ago, declined, the raising of live stock and the dairy industry gradually developed.

The principal crops grown are hay, oats, corn, barley, and wheat. The quality of the small grains grown is excellent, and this soil is generally held to be one of the best grain soils in Pierce County. Most of the grain and corn grown is fed to stock raised on the farm.

The crop rotation most commonly followed consists of a small grain crop such as oats, barley, or wheat with which clover or alfalfa is seeded, the hay being cut for two or more years, after which the land is again plowed for corn. Since much the greater part of the grains is fed, a practice now becoming common is that of growing a succotash mixture consisting principally of barley and oats, or this mixture with a little spring wheat. On land kept up in a reasonable state of fertility, corn yields 40–50 bushels per acre; oats, 40–60 bushels; barley, 35–45 bushels; wheat, 20–25 bushels; and hay, 2–2½ tons per acre.

The acreage of legume crops has increased remarkably during the past ten years. Especially is this true of alfalfa grown to the extent of about 10,000 acres in 1927 where only a few hundred acres were grown ten years prior. Clover, or clover and timothy mixtures, are grown on practically every farm. Both clover and alfalfa are grown quite successfully without the use of lime materials, although the indications are that for best yields of alfalfa, especially, a moderate application of limestone is one of the requirements for securing good yields.

The pastures are, in general, excellent, but on bare ridges where the soil is likely to be thin they may fail in dry weather. Then, too, farmers have failed to realize that the fertilizer requirements for pastures should be considered as well as the fertilizer requirements for any other crop. The result is that the carrying capacity per acre has been considerably reduced.

Deep Knox Silt Loam, Steep Phase

The steep phase of deep Knox silt loam differs essentially from the typical soil in its surface features. It occurs with rough stony land on steep slopes which form the valley walls and heads of small streams of the county. As a whole, the colors and texture of the soil may be somewhat lighter than the typical soil, and the average depth to rock is less. Because of its steep broken character this phase has a much lower agricultural value.

The steep phase of the deep Knox silt loam is intimately associated with the main type and frequently grades into

it in such a way as to make the drawing of a definite boundary line difficult. On the 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 gullying while these slopes are under cultivation. When the slopes are neither wooded nor covered by growing crops to protect them, the soil washes away and, when ditches are once started in this way, it is difficult to check such losses without considerable expenditure of labor.

The original timber growth consists of the same trees as on the typical soil, oaks predominating. Most of the standing timber outside of the bottom land is now found on this phase and on the rough stony land with which it is associated although a considerable proportion of the steep land is cleared and either in cultivation or pasture land. The steeper portions of this phase should remain in timber, or be devoted to grazing purposes.

In the following table is indicated the mechanical composition of samples of the surface soil, subsurface, and subsoil of deep Knox silt loam.

MECHANICAL ANALYSES OF DEEP KNOX SILT LOAM

No.	Description	Fine gravel Per Cent	Coarse sand Per cent	Medium Sand Per cent	Fine Sand Per cent	Very fine sand Per cent	Silt Per cent	Clay Per cent
3138116	Surface soil, 0 to 4 inches	0.1	0.2	0.1	1.4	31.3	59.0	7.4
3138117	Subsurface soil, 4 to 14 or 16 inches	.0	.2	.0	.8	29.8	59.2	9.5
3138118	Subsoil, 14 to 36 inches	.0	.0	.0	.8	30.0	56.1	13.2
3138119	Subsoil, 36 to 72 inches	.0	.0	.0	.4	38.4	52.7	8.8
3138120	Subsoil, 72 inches+	.0	.0	.0	.4	44.6	50.1	4.7

KNOX SILT LOAM, SHALLOW PHASE

The surface soil of the shallow phase of Knox silt loam to a depth of eight inches consists of a grayish brown silt loam which closely resembles in color the deep Knox silt loam. Between depths of eight and twenty-four inches,

the material is gray silt loam, or fine sandy loam. Below a depth ranging from twenty-four to thirty-six inches is the underlying rock which consists of sandstone or shaly sandstone. In some places the soil is more than three feet thick. In others, bed rock is present within two feet of the surface.

The soil occurs almost exclusively in Rock Elm township where its total area is several square miles. The surface ranges from rolling to hilly, and the natural drainage is good.

The timber growth consists largely of oak of several varieties, with some maple and hickory and a little basswood, and some elm in the lower places. About half of the soil is cleared, but it is somewhat inferior to the true Knox soil. General farming is practiced, and all crops common to the region are grown. Because of the uneven surface, the soil is more difficult to cultivate than any other important types found in the county.

LINDLEY SILT LOAM

Soil.—The Lindley silt loam to a depth of eight inches is a grayish brown silt loam. The subsoil is a light yellowish brown silt loam which grades at a depth of 14–22 inches into a yellowish brown heavy silt loam or silty clayey loam containing a few glacial pebbles. Below two feet, the material is yellow or yellowish brown in color and consists of gravelly or sandy clay material.

The thickness of the silty upper layer shows some variation. Where the soil borders deep Knox silt loam, the silt covering is, in many places, nearly three feet thick, and the line between the two soil types is an arbitrary one. In other places, especially in Gilman township, the glacial material comes almost to the surface and often crops out in the form of gravel knolls.

Stones and bowlders are common on this soil type, but in only a few places are they sufficiently numerous to interfere with cultivation.

Extent and distribution—Lindley silt loam is found chiefly in the northern tier of townships. It is the most extensive type in the townships of Martell, River Falls, Clifton, and Gilman. It is also present in El Paso, Ellsworth, Trim-

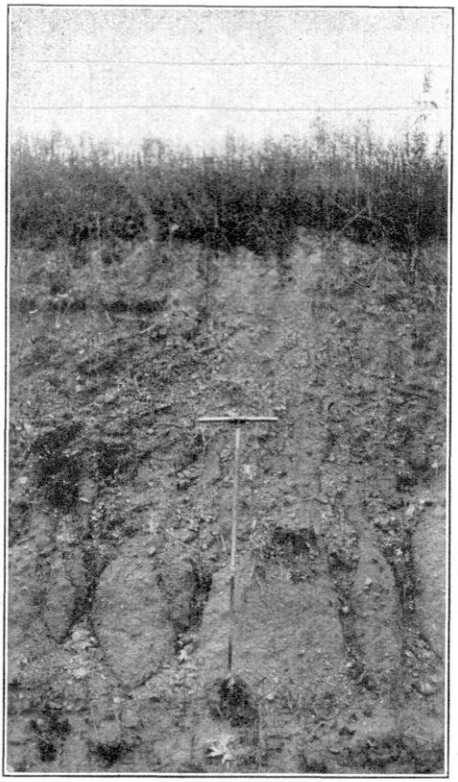

Fig. 6. Cut in Lindley silt loam showing gravelly tilt in the subsoil of glacial origin.

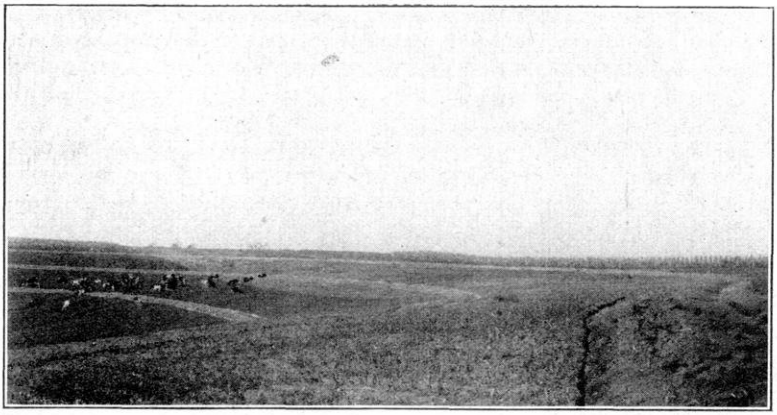

Fig. 7. Terraces constructed on moderately sloping land to prevent erosion.

belle, and Oak Grove townships, but not in such large areas as in the other townships. It is the second most extensive soil type in the county and, agriculturally, one of the important ones. Of the total land area of the county, 22.6 per cent is included in the Lindley silt loam and the steep phase of the same type.

Origin.—This soil is derived, for the most part, from ice-worked material of an early drift sheet which covered this part of the county. The soil represents a mixture of glacial material to which some loess, or wind-blown material, has been added. In many places this loessial blanket is very thin, or entirely lacking.

Surface features.—The surface of Lindley silt loam varies from level to steeply rolling, but the greater part is gently rolling. Because of the surface features and the nature of the subsoil, the natural drainage, for the most part, is good. In local areas, however, beds of heavy clay are found in the subsoil which prevent the downward movement of water rapidly enough, thus interfering with farm operations. Where such areas occur in sufficient size, they have been separated and mapped as Conover silt loam.

Native vegetation.—The original timber growth was largely of several varieties of oak, hickory, elm, and some ash and maple. A large part of the merchantable timber has been cut, but a number of wood lots remain, and some steep rocky slopes afford good stands of timber at the present time.

Present agricultural development.—The greater part of the Lindley silt loam is cleared and under cultivation. It may be classed as a good agricultural soil equal to the Knox silt loam. It is, for the most part, highly improved, and well suited to the production of all farm crops grown in the county. Dairying and livestock raising are the chief kinds of farming followed. Corn, alfalfa, clover, and the usual small grains are successfully grown. The acreage of alfalfa and corn is increasing with the development of the livestock industry.

LINDLEY SILT LOAM, STEEP PHASE

The steep phase of the Lindley silt loam comprises those areas which lie on the steep slope of valley walls and valley

beds. Because of its rough surface features, the soil is used principally for pasture and timber land.

LINDLEY GRAVELLY LOAM

The surface soil of this type to an average depth of seven inches consists of brownish gravelly loam. The subsoil is composed of similar material, reddish brown in color. From a depth of 20 inches to more than 36 inches is fine gravel containing some sand and a little clay. The soil varies somewhat, chiefly in the depth to the gravel bed, but the covering of fine soil is in most places sufficient to cause the soil to be classed as agricultural.

The Lindley gravelly loam is of small extent comprising less than three square miles. It is located principally in the northern part of the county where evidences of glacial action are most pronounced. In Gilman township more than twenty separate areas were mapped, varying in size from a few acres to about eighty acres. Some patches are too small to be shown on the map. This soil is closely associated with Lindley silt loam and is found in most of the townships where the silt loam is mapped.

The soil mass making up this type is largely of glacial origin and thoroughly leached of any lime carbonates which it may have contained. Both the surface and the subsoil are acid.

The native timber growth consists chiefly of oak and hickory. The best timber, however, has been cut, with only here and there a good wood lot remaining. In many of the hills gravel pits have been opened and road material removed. This is of good quality and gives much of the land a value greater than its agricultural value. More than half of the area is cleared and used in some way, mostly for pasturage purposes. Some of the land is devoted to cultivated crops, but these are apt to suffer during dry spells.

LINTONIA SILT LOAM

Soil.—The surface soil of the Lintonia silt loam consists of dark brown, or dark grayish brown silt loam about three inches thick. This is underlaid by grayish brown or yel-

lowish brown silt loam which extends, as a rule, to a depth of about fifteen inches where it grades into yellowish brown silty clayey loam. This heavy subsoil extends to a depth of three or more feet. Pockets of sand are frequently present at a depth of four or five feet.

The surface soil is subject to some variation in color. In some places it is dark and resembles the Waukesha silt loam. In other places the subsoil is mottled and resembles that of the Conover silt loam.

Extent and distribution.—The largest area of the Lintonia silt loam is in the valley of the Mississippi River northwest of Bay City. Numerous areas are also found along Plum Creek, Cady Creek, Eau Galle River, and some of the other streams in the county. The total area of this soil type in the county is approximately ten square miles.

Origin.—The Lintonia silt loam occurs chiefly on stream terraces. The soil mass is derived principally from waterlaid material brought down from the surrounding uplands.

Surface features.—The type occurs mostly on stream terraces. The surface is, for the most part, level or gently sloping toward the stream channel along which it occurs. In only a few places is the land undulating. In general, drainage is good, but where the soil occurs along intermittent streams, or where it borders the Genesee silt loam, more areas may be subject to flooding.

Native vegetation.—The soil supported a natural growth of maple, oak, elm, basswood, and hickory, but much the greater part of the timber has already been cut.

Present agricultural development.—For the most part, the soil is under cultivation and forms part of well improved farms. Very few farms are made up entirely of this soil as the stream valleys are long and narrow, and usually only portions of the many farms are in the valleys. It is a productive soil and classed as good agricultural land. It retains moisture well, is easy to cultivate, and works easily into a good seed bed.

The principal crops grown are corn, hay, and small grains. The methods of farming used are similar to those followed on the Knox silt loam. Some alfalfa is grown, and the acreage is increasing. Where the farm buildings are located in the valleys, the manure is most often used on the

bottom land, and the fertility of these acres seems to be greater than that on the hills. Where farms occupy both hill land and bottom lands, the problem of maintaining the fertility on the uplands must be given careful consideration. Since little or no manure is returned to these areas, the organic matter content may be maintained by occasionally plowing under a clover crop. The commercial fertilizers may also be required to offset the losses that come in the removal of crops from year to year without the return of stable manure.

LINTONIA LOAM

Soil.—The surface soil of Lintonia loam consists of grayish brown or brown loam to a depth of about 14 inches. This is underlain by brown loam or by silt loam which continues to a depth of 28 inches, approximately, where it grades to a more yellowish soil mixture containing pockets of fine sand. This soil is quite variable throughout its entire profile. Fine sand may be found within eighteen inches of the surface, and in some places gravel is present. Especially is this true in the north-central part of the county where glacial soils are extensive. The surface soil ranges from light-textured silt loam to fine sandy loam, while the deep part of the subsoil may vary from sandy loam to gravelly material in extreme cases.

Extent and distribution.—The type is found chiefly in townships of Spring Lake and River Falls, totalling an area of a little more than two square miles. Most of the areas comprise less than a quarter section and few, if any, farms are composed entirely of this soil type.

Origin.—The soil formation is of alluvial origin and occurs on benches or terraces along stream channels. The material composing the soil was deposited when the waters were flowing at a higher level than at present.

Native vegetation.—The original timber consisted chiefly of hardwood, practically all of which has been removed and the land cleared and placed under cultivation.

Present agricultural development.—The soil works easily and responds to the use of fertilizers and careful treatment. The soil, as a whole, is well drained, but during spring floods some parts are subject to overflow. Flood

water never stands on the land for any length of time and seldom interferes with or destroys crops. The crops grown, yields obtained, and the methods followed, are about the same as on the Lintonia silt loam.

CARRINGTON SILT LOAM

Soil.—The surface soil of Carrington silt loam is a black to dark brown, smooth-textured silt loam, 10–12 inches deep, containing a comparatively large quantity of organic matter. The subsoil consists of a dark brown silt loam becoming lighter in color with depth and grading into a yellowish brown, or sometimes yellow, silt loam below eighteen inches. The clay content gradually increases until at 20–30 inches it becomes a heavy silty clayey loam. At a depth of three feet or more, small amounts of fine sand are sometimes found with the heavy material. The soil is very uniform in most respects, but in places, especially on slopes, the color is lighter brown than the typical soil.

Extent and distribution.—Carrington silt loam occurs exclusively in the western part of the county, chiefly in the townships of Clifton and Oak Grove. The total area includes somewhat more than 8,000 acres, or about 2.2 per cent of the total land area. Its high productivity makes it agriculturally quite important.

Origin.—The soil mass of the Carrington silt loam is chiefly of glacial origin. The surface soil to a depth of three feet or more is made up of a loesslike material deposited over a typical glacial till made up of clay, silt, sand, and gravel. The till has a considerable amount of stone and bowlders, while the surface profile to a depth of three feet or more is almost free from gravel, stone, and bowlders, and is remarkably uniform in its loesslike structure and texture. The surface contains but little carbonate of lime, and an acid condition prevails over much of the type.

Surface features.—The surface of this type ranges from nearly level to gently rolling. Drainage of the type is excellent. It is practically all under cultivation, and the land is so situated that modern farm machinery can be used.

Native vegetation.—Carrington silt loam is locally known as a prairie soil, and part of the land was no doubt treeless.

In places, however, there was a scattered growth of trees. Much of the native vegetation was rank grass, the decay of which from year to year was responsible for the dark color and high humus content of the soil.

Present agricultural development.—Carrington silt loam has been considered one of the best soils in the county, and it is highly prized for its fertility. It is well adapted to all crops common to the region, and good average crops are secured.

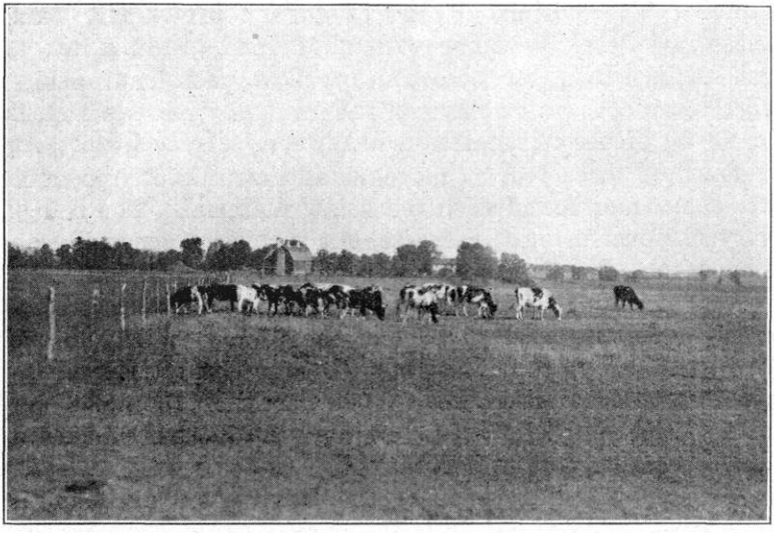

Fig. 8. View on level Carrington silt loam in Pierce County.

Diversified farming is followed to a large extent with a greater part of the income derived from dairy products and livestock.

Baxter Silt Loam

Soil.—The surface soil of Baxter silt loam to a depth of seven inches is a light brown silt loam. From seven to fourteen inches the material is yellowish brown heavy silt loam, in places mottled with gray. Below fourteen inches, and to a depth of about two feet, the soil profile shows a brown clayey loam with a greenish tint. At a depth of about two feet, a layer of brownish green clay is found which resists to a considerable degree the downward move-

ment of moisture. The surface soil is commonly darker than that of the Lindley silt loam. In some areas the subsoil is brick red in color, the greenish cast which is typical in this county not always being found. The depth of the silty covering over the clay is also variable.

Extent and distribution.—The Baxter silt loam is small in extent, embracing an area of about seven to eight square miles. It is associated chiefly with Lindley silt loam in rather small areas, many of these being less than forty acres in extent. The principal areas are found in the townships of Martell and River Falls.

Origin.—For the most part, this soil is residual from limestone rock. With it is associated some shale which may have contributed to the formation of the heavy clay subsoil. The presence of glacial bowlders seems to indicate that part of the soil may have been derived from glacial drift.

Surface features.—Areas of Baxter silt loam range from level to gently rolling, and in some places the soil occurs on flat topped hills or elevated benchlike situations. Where the surface is gently rolling in character, the drainage is nearly always as good as on the Lindley silt loam; but on the more level areas the soil is backward in the spring on account of the slow downward movement of water due to the heavy clay subsoil found at varying depths. The surface is generally free from stone, but in numerous areas stony patches are found, resembling in this respect the Lindley silt loam with which it is associated.

Native vegetation.—The timber growth on this soil was chiefly oak, hickory, elm, and some maple. Although some wood lots remain, most of the soil which is productive has been cleared and placed under cultivation.

Present agricultural development.—Baxter silt loam may be considered a good general farming soil although it is somewhat more difficult to manage than either the Lindley or the Knox silt loam. The soil is inclined to be cold and backward in the spring; it is, therefore, not as well adapted for corn crops as are the better drained silt loams already discussed. The usual small grains and grasses do very well. The type of farming engaged in is similar to that followed by farmers on the Lindley silt loam.

WAUKESHA SILT LOAM

Soil.—The surface soil of the Waukesha silt loam, to a depth of twelve to eighteen inches, consists of a dark brown, or black silt loam containing a high percentage of organic matter. The subsoil consists of brown or buff-colored silt loam which becomes heavier in texture and lighter in color, and at a depth of 24–30 inches assumes a yellowish brown color, and a silty clayey loam texture. At a depth of 3–3½ feet the soil becomes more sandy in character. In a few places gravelly material is mixed with the sand in these lower layers. Some variation in color occurs, also, but the soil is everywhere darker than the Lintonia silt loam already described.

Extent and distribution.—The type is of very small extent and occurs principally in the township of River Falls as terrace soil along the Kinnickinnic River. A few other areas occur along stream courses in other townships.

Origin.—The soil is mostly derived from alluvial material deposited as stream terraces or as outwash plains during the period of the ice invasion.

Surface features.—The surface is level, or nearly level, and natural drainage is good. The depth to the sandy soil in the deep subsoil is in most cases sufficient to make the soil fairly drought resistant.

Native vegetation.—The soil was prairie land, and the chief native vegetation was prairie grasses, the decay of which caused dark color and high organic matter content. The little timber growth developed was mainly oak, elm, and soft maple.

Present agricultural development.—Although this soil is of small extent, it is one of the most desirable soils in the county. It is well adapted to all crops common to the region. Cabbage is a special crop which does well providing the soil has been maintained at a high productive capacity.

WAUKESHA LOAM

Soil.—The surface soil of Waukesha loam consists of a dark brown or black loam high in organic matter underlain at a depth of 6–12 inches by a brown to dark brown

loam. Between depths of eighteen inches and three feet, the soil grades to gravel or sandy material.

As mapped, this type shows some variations. The surface soil ranges from almost a sandy loam to a silt loam. The subsoil may be a sandy loam which grades into sand or gravel at a depth of 12 or 15 inches.

Extent and distribution.—This type is of small extent, and the most of it is found in the townships of River Falls, Oak Grove, and Salem. The total area includes a tract of about 1400 acres. Parts of the cities of River Falls and Prescott are on this soil type.

Origin.—This soil is of alluvial origin, having been deposited by running water as outwash plains or stream terraces in the same manner as the Waukesha silt loam already described.

Surface features and native vegetation.—The surface of this soil is level to gently undulating, and natural drainage is excessive in many places because of the coarseness and openness of the subsoil. This was originally prairie land with some acres of oak openings. The chief vegetation was prairie grasses, the accumulation of which accounts for the dark color and high organic matter content.

Present agricultural development.—Waukesha loam is a productive soil but may in periods of reduced rainfall suffer from drought. It is well adapted to all crops grown in this region. It also makes a good truck soil for such crops as tobacco and cabbage. Potatoes may be grown successfully in seasons of normal rainfall.

Rough Stony Land

Rough stony land comprises deep rocky slopes bordering the terraces and bottom lands along the Mississippi River and most of the tributary streams. Over 45,000 acres of land in the county, representing 12 per cent of the total land area in the county, have been mapped as rough, stony land.

In places, these rough areas include almost perpendicular rock cliffs rising to a height of several hundred feet, and in other places the steep rocky slopes are covered by a thin veneer of soil. Where there is a covering of soil, the land

supplies some grazing and supports a growth of trees. Areas in forest should remain forested, and the timber cut as it matures.

Many of the rocky areas have no agricultural value aside from growing timber. None of it should be used for cultivated crops, and in fact very little of it could be so utilized. Many of the farms in the county include some of this type of land.

The rock outcrop is for the most part limestone although there are also some outcrops of sandstone. The limestone has considerable economic value; it is now being utilized as a source of road material and as a source of lime material for agricultural purposes. The past years local limestone crushers have been installed in various localities of the county, and thousands of tons have been pulverized and utilized by the farmers in overcoming the acidity of the soil in order to fit their ground for legume crops, alfalfa, and clover. Near Elmwood a large stationary plant has been installed, furnishing both road material and limestone for agricultural purposes. Many tests have been made, and invariably the limestone deposits found in this County show a high neutralizing value. The importance of these local deposits cannot be overestimated as a source of ground limestone by the farmers, especially those who otherwise would have long wagon hauls from railroad stations if the material were shipped in from other localities. In a considerable measure this is one reason why, through the efforts of the county agent, Pierce County has such a large acreage of alfalfa at the present time.

CHAPTER IV

GROUP OF FINE SANDY LOAM SOILS

The soils of this group are intermediate in texture between the silt loams and loams and very sandy soils. They are sufficiently heavy to have fairly good water-holding capacity and so are fairly well adapted to most general crops including corn, small grain, and hay crops. But they warm up quickly in the spring and are more friable so that they are better adapted than heavier soils to some of the special crops, particularly potatoes.

Their fertility is somewhat less than that of the heavier soils and especially is their content of available potash and nitrogen lower. It is even more important, therefore, that legume crops such as clover be grown on them to secure the nitrogen and, when special crops are grown, potash should be used in a fertilizer, either alone or with phosphorus and nitrogen. For general management with reference to fertility, reference should be made to the discussion of fertility in Chapter II.

LINDLEY FINE SANDY LOAM

Soil.—The surface soil to a depth of about eight inches consists of medium brown fine sandy loam. The subsoil to a depth of about sixteen inches is made up of lighter brown fine sandy loam which at a depth of about 16 inches grades to yellowish brown coarser material. Below 24 inches is a layer of sandy clay loam which at a depth of about three feet changes to a sandy loam. The subsoil in many places contains some fine gravel and stone. In some places the sandy clay loam is very thin, while in others it continues to a depth of more than three feet.

Extent and distribution.—The type embraces a total of about 20 square miles but is widely scattered. It occurs chiefly in the townships of Gilman, Salem, Trimbelle, River

Falls, Clifton, and Oak Grove. The largest areas occur in the valley of the Kinnickinnic River.

Origin.—The material making up this soil type is derived chiefly from glacial deposit, but nowhere does it occur very far from sandstone formation from which the sand material has been, in part, derived through ice action. It is chiefly associated with the Lindley silt loam, already discussed.

Surface features.—The surface varies from level to extremely rolling, but the greater part is gently rolling in character. Because of the nature of the subsoil and the lay of the land, the natural drainage is in most places good.

Native vegetation.—Native vegetation consisted principally of mixed hardwood together with a little pine. A few wood lots and scattered clumps of trees remain, but practically all of the merchantable timber has been cut.

Present agricultural development.—This soil is mostly cleared and cultivated. It may be classed as fair to good farming land, well suited to the crops commonly grown in this region. From the areas included in the steep slopes the greater part of the land is now under cultivation. It is considered one of the general purpose soils which may also, to a limited extent, be devoted to special truck crops.

Carrington Fine Sandy Loam

Soil.—The Carrington fine sandy loam to a depth of about ten inches is a dark brown, to almost black, fine sandy loam high in organic matter. Between eight and twenty-two inches the material in most places is light brown fine sand grading into a sandy clay loam which may extend to a depth of three feet or more. The soil on the whole is somewhat variable in character both in the surface and subsoil.

Extent and distribution.—The Carrington fine sandy loam is not extensive, covering less than a square mile. It is found chiefly in River Falls and Clifton townships. It is associated with Carrington silt loam and in places with the Boone soil.

Origin.—The type is derived mostly from glacial material although some of it which lies over, or is adjacent to

sandstone formation, may have been derived in part as residual material from the underlying rock.

Surface features.—The surface of this type ranges from level to gently rolling, and the natural drainage is good. On the lighter portions of the type the drainage may even be somewhat excessive. This condition also prevails where the underlying rock is found near the surface.

Native vegetation.—This is also a prairie soil, and the natural vegetation included only a few scattering trees. The chief growth was prairie grass, the decay of which accounts in part for the high organic matter content and the dark color of the surface soil.

Present agricultural development.—Carrington fine sandy loam is a good farming soil well suited for all crops grown in this region. It can be worked under a wide range of moisture conditions but is less productive than the Carrington silt loam with which it is associated. It is well suited to truck crops and, where market conditions are favorable, it could well be used for this type of farming. At the present time, most of it is used for general farming.

WAUKESHA FINE SANDY LOAM, DARK COLORED PHASE

This type to a depth of six inches consists of dark brown fine sandy loam underlaid to a depth of about eighteen inches by a yellowish brown heavy fine sandy loam or loam. Below a depth of eighteen inches it is dark yellowish brown gravelly loam which grades into nearly pure gravel at a depth of about two feet. The soil is variable in texture and also as to the depth to gravel.

The type occurs principally along the bottom lands in the townships of Trenton, Diamond Bluff, and Salem. The areas are level, or nearly so, and natural drainage is good. On account of the gravelly subsoil, crops suffer sometimes, due to droughty conditions.

The material forming this soil is alluvial in character, having been deposited by streams during glacial times. In early days the areas embraced by this soil type were said to be practically treeless. Chief growth was prairie grasses, the decay of which accounts for the dark color of the soil. Most of it has been brought under cultivation.

Because of its small area, few farms consist entirely of it. This soil is well adapted to the growing of truck crops and, where market facilities are favorable, it should be devoted, in a measure, to this type of farming. It is also suited for diversified farming, providing the soil has been prepared for such crops as the legumes by proper soil treatments. Oats, corn, and rye make fairly good yields and, where proper rotation is followed, good yields may be expected.

BOONE FINE SANDY LOAM

The surface soil of Boone fine sandy loam to a depth of about eight to ten inches consists of brown fine sandy loam. The subsoil is made up of similar material, but it is a little lighter in color than the surface soil. At a depth of about 22–24 inches the material grades into a fine sand, or fine sandy loam, yellowish brown in color.

This soil is somewhat variable in texture, ranging from a fine sand to a heavy loam. Sandstone fragments are mixed with the soil in places. The supply of organic matter in the surface soil is not large and for best crop yields should be increased.

This soil is of rather small extent in Pierce County. It occurs chiefly in the townships of Clifton, River Falls, Oak Grove, Martell, Maiden Rock, Salem, and Trimbelle. In these areas it comprises a trifle over six square miles.

The soil mass has been derived largely from the weathering of St. Peter sandstone. It is, therefore, made up chiefly of residual material, although some of it, no doubt, has been moved by the action of ice or water.

The surface is sloping, and natural drainage is good. The native timber was largely mixed hardwood among which oak predominated, but some scattering pines were also present.

Most of the soil is cleared and under cultivation. It is devoted to general farming and is also well adapted to special crops because it warms up early in the spring, is easily worked, and responds quickly to proper fertilization.

CHAPTER V

SANDY SOILS

Boone Fine Sand

Boone fine sand consists of a layer of light brown to yellowish brown, fine to medium sand to a depth of six to eight inches. This is underlain by a fine sand of a lighter yellow color than the surface, extending to a depth of three feet or more. The soil varies to some extent in color and texture but, on the whole, is quite uniform.

Most of the areas are in the northwestern part of the county. None of these are large, but they are distributed widely over the townships of River Falls and Clifton, with some in other townships, totalling nearly five square miles.

This soil occurs only where sandstone forms the surface rock. It is, therefore, largely residual material derived from the underlying sand rock. The surface of this type varies from gently undulating to gently rolling. In some areas the slopes become rather steep, resulting in excessive drainage, and crops suffer from drought.

The original timber growth on this type consisted chiefly of scattered scrub oak. Coarse grasses and sand burs are also found growing on the type. On account of its loose open character, and the resulting droughty condition, its low content of organic matter, and the fact that in places it is subject to drifting, this soil has a rather low agricultural value. While most of the land is under plow, a considerable proportion of it is not farmed very intensively. Crop yields are considerably lower than those of other soil types, and only by careful management and good soil practices may profitable yields be secured.

Plainfield Sand

Soil.—The surface soil consists of dark gray brown sand containing, also, some coarse sand and gravelly material.

The subsoil between depths of 10 and 26 inches is made up of similar material, although lighter in color, and below two feet or so the soil mass is composed chiefly of yellowish brown sand. This type occurs most extensively on the high terraces along the Mississippi River in the townships of Isabelle and Trenton. More areas are also found along other streams in the county. The total acreage mapped is between seven and eight square miles.

Origin.—This type is derived from alluvial material deposited in the form of stream terraces or outwash plains. The material is largely quartz sand, but small quantities of material from crystalline rock are also present.

Surface features.—Areas of this soil type are usually level, and, because of the sandy texture of the soil profile to a depth of three feet or more, the natural drainage is excessive, and the soil becomes droughty. Practically all of the terraces on which this soil occurs are more than fifty feet above the river so that the water table is far below the surface.

Native vegetation.—The land embraced in the Plainfield sand was originally partly prairie and partly forested with scattering oak, and possibly some pine.

Present agricultural development.—The type has a somewhat low agricultural value. It was easily brought under cultivation from the virgin condition, and was, likewise, easily worked. Because of these advantages the areas were subjected to constant cropping, and little attention was paid to the maintenance of fertility and the growing of legume crops, so necessary on this type as well as on others. The sandy soils require careful management, especially with reference to maintaining the supply of organic matter. The legume crops invariably fail at the present time so that the land is devoted to such crops as rye and corn grown in alternate years. Then, when these crops fail to pay, the land is abandoned for a few years, the weeds turned under, and again a crop of either rye or corn removed. In any event the yields are low and the returns small.

CHAPTER VI

POORLY DRAINED SOILS

These are soils in which drainage is frequently the limiting factor. The plant food supply is usually satisfactory. They are excellent soils for pasture and hay crops.

GENESEE SILT LOAM

Soil.—This is a compact chocolate brown silt loam becoming lighter brown in color at eight to twelve inches. Fine and very fine sand particles are found in the subsoil in increasing amounts until at about 16–20 inches the soil often becomes a fine sandy loam with yellowish brown sandy loam at 20–30 inches. Considerable variations, however, are found, and in many places the silt loam extends to a depth of three or more feet. Again, in numerous areas the subsoil at a depth varying from 18–24 inches is black, or nearly black.

Extent and distribution.—One of the largest areas of Genesee silt loam is found near the mouth of Rush River. Many other long narrow areas are scattered over the county along the small streams and intermittent drainage channels. This formation makes up what may be called a first bottom soil as distinguished from the Lintonia silt loam which occurs as terraces on the second bottom.

Origin.—Like the other Genesee types, this soil was deposited by overflow water of the rivers and, of course, it is still subject to overflow in time of high water.

Surface features.—The surface is level with some small knolls and is cut up by old sloughs and drainage courses or slightly lower marshy areas.

Native vegetation.—The native vegetation consisted principally of ash, elm, soft maple, willow, and some oak. Most of this timber has been removed, and considerable of the soil is now devoted to pasturage purposes.

Present agricultural development.—The better drained areas are good agricultural land and are farmed in many places. Although they may be subject to overflow, the water does not stand on the ground long at a time, and crops may be grown on most of it every year. In some places, however, where the soil is found along the border of the upland, the surface is flooded only at very rare intervals. The better drained areas are mostly in the broad bottoms where the valleys are from four miles to half a mile in width. Numerous areas are found along Rush River as well as along many of the other streams of the county. A few farms are made up entirely of this soil as most of it occurs in narrow strips along the stream courses.

This is one of the productive soils in the county. Where drainage is adequate, good crops of corn, small grains, and hay may be grown although the small grain is subject to lodging.

Genesee Sandy Loam

This type includes the light textured bottom land of the Genesee series. The areas range in texture from sand to sandy loam. Because of the danger of flooding, the soil is used mostly for pasture and affords fair to good grass. The areas mapped include some small tracts of river wash which are of little value for agricultural purposes.

The Genesee sandy loam occurs in Spring Lake township along the Eau Galle River and Cady Creek, in Union township along Plum Creek, and in a few areas along Rush River and Kinnickinnic River. Some of these areas were too small to map and were included with mapped areas of Genesee silt loam. The soil as a whole has only a nominal agricultural value at the present time.

Alluvial Soil Undifferentiated

In the survey of the county, the soils of the first bottom along the Mississippi River are grouped together as undifferentiated alluvial soil. Because of the extreme variation in color and texture, and because the material changes from year to year due to flooding, it was impractical to undertake the separation usually made in soil mapping. However, two general separations were made.

Heavy textured group.—The first is a heavy textured group which, when typically developed, has a surface soil of brown smooth silt loam, eight inches thick and quite uniform in texture. Below eight inches to more than three feet, the soil mass is made up of light brown silt loam with thin layers of very fine sand through it. In most places the material in the lower depth is somewhat mottled. The largest area is found along the Mississippi River bottom between the head of Lake Pepin at Bay City and Diamond Bluff. In places this bottom land on the Wisconsin side is more than a mile in width.

This land is mostly forested with oak, elm, ash, soft maple, and other trees and shrubs which thrive under moist conditions. The open places are covered by a dense growth of grasses. In the spring and after heavy rains most of the land is covered with water. In dry seasons this grass land would supply good grazing, but as a rule little use is made of it because of the water-filled sloughs, and abandoned water channels make it impossible to get live stock on the land. None of this soil is utilized for cultivated crops.

Light textured group.—The second group is much lighter in texture and is made up, for the most part, of fine sand and sandy loam. It is also alluvial land and is being added to or moved about by each flood. Where timber is found, it is about the same as on the heavy textured soil.

The largest areas of this light textured soil are between Bay City and Diamond Bluff and along Lake St. Croix at the deltas of small inflowing streams. Such places are chiefly barren sand areas. They have little or no agricultural value at the present time.

Clyde Silt Loam

Soil.—The surface soil of Clyde silt loam to a depth of seven inches consists of black silt loam having a high organic matter content. The subsoil to a depth of twenty inches is made up of dark silty clay loam which grades at the lower depth, extending to forty inches, to a dark gray and yellow mottled silty clay loam. The type lacks uniformity as to color and depth to the mottled subsoil, and

also as to content of organic matter. Occasionally, peaty material is encountered in the subsoil, and in other places the surface soil may be made up in a large measure of well decomposed peat.

Extent and distribution.—Clyde silt loam is of small extent, embracing an area of about 3½ square miles in the county. It occurs in a number of patches ranging in size from a few acres to a half section. It is most extensive in the northern and central part of the county.

The type occupies low, poorly drained areas, usually along the border of marshes of peat or muck. It forms the gradation from the true upland soil to the muck or peat. The organic matter which imparts the dark color to the soil varies from five to fifteen per cent in amount.

Areas of Clyde silt loam are level and generally depressed, and the natural drainage is deficient. Much of the type occupies small depressions in the upland or occurs along stream channels as low bottom land, part of which is subject to overflow.

Native vegetation.—The native timber growth consisted chiefly of ash, elm, soft maple, and willow. Most of the merchantable timber has been removed, and the areas are now used for permanent pastures.

Present agricultural development.—In a few places where drainage conditions are better than the average, the soil may be cultivated. In southern Wisconsin, well drained Clyde silt loam is found to be one of the best soils for corn. At the present time, areas of Clyde silt loam are utilized chiefly for pasturage and for hay. Soils of this type are generally low in available potash but with potash alone will produce as good crops as with manure.

Conover Silt Loam

Soil.—The surface soil of Conover silt loam to a depth of eight inches consists of grayish brown, or light grayish brown silt loam. The subsoil to a depth of eight to twenty-eight inches is mottled gray and brown heavy silt loam which becomes more mottled with depth. Below twenty-eight inches the material is very mottled, reddish yellow and brown in color, grading into a sandy loam or sandy

clay at a depth of about three feet. The soil resembles Lindley silt loam in some respects but differs by being strongly mottled. It is very uniform in surface texture and color, the grayish-brown being predominant.

Extent and distribution.—This type is most extensive in the township of Ellsworth where there are more than a dozen areas ranging in size from 20 to 175 acres. Small areas are also found in other townships in the county. It is usually associated with both the Lindley and the deep Knox silt loam.

Surface features.—The surface is level or gently sloping, and the soil occurs in small depressions, or on gently sloping land around stream heads where there may be some seepage. Because of its position and the character of the subsoil, natural drainage is deficient.

Native vegetation.—The timber growth native to this soil is oak, elm, ash, and some maple.

Present agricultural development.—By far, the greater part of the soil is cleared and under cultivation. Where well drained, it gives fair returns; but drainage over most areas is deficient, and the soil is cold and backward and best suited to grass crops and hay.

Drainage is important in the improvement of this soil. Tile drains could be installed with profit in numerous places, but little tiling has been attempted thus far.

River Wash

River wash is a term applied to the most recent stream deposits. Most of the material is sandy and gravelly and is being modified continually by flood water. It occurs only in small areas and has no agricultural value. Some of it is found in the townships of Trenton and Diamond Bluff. Here it occurs as small barren stretches of sand, or sand and gravel, and has very little vegetation on it. It is all subject to overflow, the only use being made of it is as a source of road material.

CHAPTER VII

GENERAL AGRICULTURE

History of Agriculture in Pierce County

The history of agriculture in Pierce County dates back to the early fifties when the western part of the county was settled in what is known as the township of Clifton today. Prescott in 1853 already had a population of 200, and this thriving village became the principal shipping point for northwestern Wisconsin. The surrounding area was soon opened up, much of which for miles around consisted of oak openings and prairie. The early settlers found wheat to be a staple crop and one that could be relied upon for good yields. Wheat raising became profitable and the county long remained as the leading wheat county in Wisconsin. Up to 1880, nearly three-quarters of the total cropped land was devoted to wheat. In 1880, the U. S. census shows the following acreage in the county:

Wheat	61,169 acres
Barley	2,034 acres
Oats	10,323 acres
Corn	8,968 acres

In later years because of the ravages of the chinch bug, the wheat acreage was reduced, and other grain crops became more important. With this change from wheat farming, a trend toward livestock raising and dairying began which has continued through the years, so that at the present time the farmer's income from the sale of grain crops is practically negligible.

Ninety-five per cent of the total area of the county (approximately 365,000 acres) is divided up among 3,073 farmers, eighty per cent of which are owned, and about 20 per cent are operated by tenants. While practically all of the land area is in farms, only about 55 per cent of it is in crops and plowable pasture. In a considerable measure

this is due to the fact that nearly one-third of the land area is included in land too steep and otherwise rough, stony, and rocky for crops other than timber or permanent pasture; or it is included in land that has little or no agricultural value.

Crops Grown in the County

Oats are by far the most important grain crop in point of acreage, followed by barley, wheat, and rye, in the order named. By referring to the table below, it will be noted that during the decade from 1918 to 1927 the acreage of oats and barley has remained nearly stationary, while a considerable reduction has taken place in the acreage devoted to rye and the wheat crop.

With the increase in the dairy business, the acreage of the corn crop has likewise increased during the same period.

The dairy cow has also, in a large measure, been responsible for the increase in the acreage of alfalfa hay. During the ten year period the acreage, as will be noted, has increased from a little more than 100 acres to 8,950 acres reported in 1927.

Truck crops such as sugar beets, tobacco, and cabbage are only of minor importance. Interest in apple growing has resulted in an increase of nearly forty per cent of trees during the ten year period. The following table indicates the acreage and production of the principal crops, together with average yields per acre for the years 1918 and 1927, as reported by the Wisconsin Department of Agriculture:

ACREAGE AND PRODUCTION OF PRINCIPAL CROPS IN 1918 AND IN 1927

Principal Crops	1918		1927	
	Acres	Bushels per acre	Acres	Bushels per acre
Oats	47,192	50	48,590	36
Barley	27,884	36	25,610	34
Spring wheat	15,918	26	5,000	20
Winter wheat	250	23	1,020	25
Rye	11,679	21	4,950	24
Corn (Silage)	7,378	8 tons	12,980	7 tons
Corn (Grain)	18,791	44	16,060	40
Corn (Hogged off)			5,160	
Buckwheat	155	19	160	17
Flax seed	684	8.5	1,250	13
Potatoes	2,277	141	1,240	111
Hay Crops				
Alfalfa	117	3 tons	8,950	3.2
Clover—timothy mixed	37,877	1.8	40,140	2.1
Wild hay	660	1.7	650	1.2
Sugar beets	114		10	8 tons
Tobacco	65		70	
Apples	23,521 trees		32,523 trees	
Cabbage	340	9 tons	190	9 tons

LIVE STOCK INDUSTRY

Within a period of less than fifty years, the farming practice in the county has been radically changed. In the eighties practically the entire income came from grains. At the present time returns from cash grains are unimportant, and practically 90 per cent of the gross income for the farmer is derived from livestock and livestock products. In part, this change has been brought about through economic conditions, the competition of the western grain growers, and the expansion in other important areas, together with low yields of grain due to insect pests. The market for quality dairy products, too, made the production of both butter and cheese a lucrative business.

The county also attracted a class of farmers of North European stock who were naturally good dairymen. Finally, the character of the soil made it possible to grow good crops of corn and small grains necessary in compounding a dairy ration. Legume crops such as alfalfa and clovers are well adapted to the heavy silt loam, the predominant soil type of the county. The favorable climatic conditions should also be mentioned as another contribut-

ing factor which made it possible for this county to develop into a highly diversified farming section.

The proportion of income from various sources by farmers in the county in 1928, and also for the entire state, are shown in the following table:

GROSS INCOME—1928

	Pierce County	State
	%	%
Milk	45	52
Hogs	21	13.6
Cattle, calves	11	11.0
Eggs and poultry	9	8.4
Grains	6	2.6
Sheep, wool	3	1.0
Wisconsin cash crops, potatoes, fruits, etc.	5	11.4

It will be noted that 45 per cent of the total gross income is derived from milk and milk products. In 1928, the report of the Department of Agriculture shows a cattle population of nearly 50,000 head on January 1, 1928. Of this number 28,300 are classed as milk cows. The production per cow is indicated as 5300 lbs. of milk per animal per year.

The creamery business established early has flourished, and today much of the larger proportion of the milk disposed from the farm is used in the manufacture of creamery butter. The record for 1927 is as follows:

Creamery butter	121,000,000 lbs.
Cheese, all kinds	10,000,000 lbs.
Cream shipped out of state	4,000,000 lbs.
Ice cream	264,000 lbs.

Pierce County farmers produced dairy products in that year to the extent of more than $3,000,000. This, however, does not include milk used on the farm, nor that manufactured into dairy butter on the farm, nor the amount fed to young stock.

The hog business, as a rule, may be developed profitably as a side line in the dairy section. On January 1, 1928, there were 43,500 hogs reported for the county, and as noted from the table above, hogs were responsible for 21 per cent of the gross income of farmers.

Beef cattle has never become an important business in the county, yet there are some farmers who find it profitable, and this class of stock, together with cows and calves, brought a return of 11 per cent in 1928.

Sheep raising is an important branch of the live stock industry, and on account of the large acreage of steep land the raising of sheep, to make full use of this class of land, may well be continued and even increased. On the first of January 1928, 17,900 sheep were reported on the farms of Pierce County.

The poultry business is no longer considered unimportant when nine per cent of the farmer's gross income must be credited to eggs and poultry. Perhaps there is no other single line of business on the farm where more improvement has been made in feeding, care, and breeding than in the case of the poultry work.

The record of business as indicated in the above statement is a splendid illustration of successful diversified farming. While milk furnishes the most important source of income, yet the livestock sold, together with poultry and grain to a small extent, furnish sources of income, some of which will always be found profitable. This is in striking contrast to the system of single cropping whether it is grain or other crops. To a certain extent it may also be stated that danger of single crop farming may also be applied to systems of farming where dependence is placed upon the income from the dairy herd only. Recent surveys have shown that where the income from the dairy exceeds sixty per cent, the gross income from the farm has been lowered.

Taking it all and all, the systems of farming followed by Pierce County farmers, are on a pretty sound basis.

FARM VALUES

Farm land in this county as elsewhere varies greatly in price, depending upon the character of the soil, improvements, locations with respect to public roads and schools, as well as other factors. The best farms on the good silt loam range in value from $100 to $150 an acre. On some

of the lighter soils and where there is considerable rough land, the prices vary from $25 to $50 an acre.

Farm lands in the county passed through a period of inflation during the World War but to a much lesser extent than in some of the other sections of the state. In 1920 the average value per acre of land and buildings, as reported by the U. S. census, amounted to $101.91. Five years later in 1925 these values were reported as $78.10. Since 1925 prices of farm land have held their own with a tendency toward some advances for good farm property.

SOIL MAP OF PIERCE COUNTY WISCONSIN

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LEGEND

- Lintonia loam (Lm)
- Baxter silt loam (Bsl)
- Lintonia silt loam (Lr)
- Genesee sandy loam (Gs)
- Boone fine sand (Bs)
- Genesee silt loam (Gl)
- Boone fine sandy loam (Bf)
- Waukesha fine sandy loam (W)
- Knox silt loam (Kl)
- Lindley fine sandy loam (Lf)
- Carrington fine sandy loam (Cf)
- Lindley silt loam (Ls)
- Carrington silt loam (Cl)
- Steep phase (Ls)
- Deep Knox silt loam (Dk)
- Plainfield sand (Ps)
- Steep phase (Dk)
- Lindley gravelly loam (Tg)
- Clyde silt loam (Cy)
- Waukesha loam (Wl)
- Conover silt loam (Cm)
- Waukesha silt loam (Ws)
- Riverwash (Rv)
- Rough stony land (R)
- Alluvial soils (Undifferentiated) (Al)

CONVENTIONAL SIGNS

CULTURE (Printed in black)

- City or Village, Roads, Buildings, Wharves, Jetties, Breakwater, Levee, Lighthouse, Fort
- Secondary roads and Trails
- Railroads: Steam and Electric
- Bridges, Ferry
- R.R. crossings, Tunnel
- Ford, Dam
- School or Church, Cemeteries
- Mine or Quarry, Mine dumps, Made land
- Bluff, Escarpment, Rock outcrop, and Triangulation station
- Stony and Gravelly areas
- Soil boundaries
- Boundary lines
- Boundary lines
- Boundary lines
- U.S. township and section lines

RELIEF (Printed in brown or black)

- Contours: Depression contours
- Prominent Hills, Mountain Peaks
- Sand, Wash, and Sand dunes
- Shore and Low-water line, Sandbar

DRAINAGE (Printed in blue)

- Streams
- Lakes, Ponds, Intermittent lakes
- Intermittent streams
- Springs, Canals and Ditches, Flumes
- Swamp, Salt marshes
- Submerged marsh, Tidal flats

The above signs are in general use on soil maps. Variations from this usage appear in some maps of earlier date.

Soils surveyed by A. R. Whitson, W. J. Geib, and H. R. Lathrop of the Wisconsin Geological and Natural History Survey, and M. J. Edwards, E. H. Templin, and E. H. Bailey, of the U. S. Department of Agriculture.

Scale 1 inch = 1 mile

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