Soil Survey
of
Wheeler County, Nebraska

By
BASIL ABASKIN, Nebraska Soil Survey, in Charge
and
F. A. HAYES
United States Department of Agriculture

Bureau of Chemistry and Soils
In cooperation with the University of Nebraska State Soil Survey
Department of the Conservation and Survey Division

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SOIL SURVEY OF WHEELER COUNTY, NEBRASKA

By BASIL ABASKIN, Nebraska Soil Survey, in Charge, and F. A. HAYES, United States Department of Agriculture

INTRODUCTION

Wheeler County is a little northeast of the geographical center of Nebraska (fig. 1). It is part of a former nearly level or rolling plain which was once mantled with light-colored floury silt, known as loess. The mantle probably was not very thick, and most of it has been removed by erosion or covered by wind-blown sand. The only loess-covered areas still existent include about 18 square miles in the southeastern corner and small isolated bodies in the eastern and southern parts of the county. The loess-covered area in the southeastern corner has been subjected to rather severe water erosion and is strongly rolling and hilly, except on narrow divides where the land surface is nearly level. The smaller loess-covered bodies have smooth surfaces.

The rest of the county, comprising about 96 percent of its total area, is part of the vast sand-hill section of north-central Nebraska. It is covered to various depths by sand and in most places has the typical dune-sand relief, characterized by a monotonous succession of sparsely grassed sand hills and ridges ranging from 10 to 100 feet in height. The ridges and hills are separated by valleys, pockets, and swales of various sizes. Marshy conditions prevail in a few of the lower places. The sand hills are traversed by several perennial streams with broad valley floors which lie at or near the water table and support a luxuriant grass vegetation.

The principal grasses on the loess-covered uplands are grama, buffalo, and wheat grasses, and on the sandy uplands *Stipa*, or needlegrass, predominates. Moisture-loving grasses of different varieties, intermixed here and there with patches of rushes and reeds, occur in all the lower localities.

An abundance of good well water is readily obtained in all parts of the county at depths ranging from 20 to 250 feet. Flowing, or artesian, wells are in most of the valleys throughout the sand hills.

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1 Report written by F. A. Hayes.
The climate is characterized by high summer and moderate or low winter temperatures. The mean annual precipitation is nearly 22 inches and the mean annual temperature is 47.2°F. Most of the precipitation falls during the principal part of the growing season—April to September, inclusive.

According to the Federal census, about 25 percent of the land was used for crops in 1930. This includes land used for wild hay, which alone occupies as large an acreage as all the cultivated crops combined.

Approximately 70 percent of the county is in pasture land, and livestock raising is the most important industry. Cattle are the chief source of income. The value of domestic animals, poultry, and bees on farms April 1, 1930, was more than twice as great as that of all crops produced in 1929.

Of the cultivated crops, corn has occupied the leading acreage since farming began. It is grown chiefly on the loess-covered areas and in the more protected localities throughout the sand hills, wherever soil and moisture conditions are favorable. Oats, wheat, rye, and barley are grown chiefly on the finer textured well-drained soils, and alfalfa is an important crop on parts of the bottom lands. No cultivated crop, however, occupies as large an acreage in Wheeler County as it does in most of the counties of Nebraska.

The soils vary widely in character and in agricultural adaptations. They all have accumulated organic matter through the growth and decay of the grass vegetation and contain some dark-colored material in their surface layers. Organic accumulations in the less stable soils of the sand hills, on the steeper slopes of the loess-covered areas, and on some of the most recently deposited sediments in the bottom lands are very slight. In these localities, which collectively occupy the greater part of the county, the soils are prevailingly light in color. Dark soils occur on the smoother parts of the loess-covered areas, on the loessial terraces, and in rather poorly drained pockets and valleys throughout the sand hills. They are comparatively inextensive.

In this report, the individual soils of the county are separated on the basis of drainage conditions and moisture content, which largely determine their utilization, into three broad groups as follows: Well-drained soils of the uplands and terraces, excessively drained soils of the uplands and terraces, and soils of the bottom lands and poorly drained uplands.

The soils of the well-drained uplands and terraces include the best general-farming soils in the county. The Holdrege, Marshall, Hall, and Anselmo soils belong to this group. The first three have developed from loess and have thick dark topsoils well supplied with organic matter. The Anselmo soils consist mainly of sand, but they contain considerable silt in their subsoils. They are low in organic matter and have light-colored topsoils. All these soils have good surface drainage and underdrainage. None of them is droughty. Practically all the area occupied by them is under cultivation and is well suited to any crop adapted to the climate. The Holdrege and Hall soils contain an abundance of lime. With the exception of the Hall soil, which is on terraces, all soils of this group are on the uplands.
The soils of the second group include dune sand, rough broken land, and the Valentine, Colby, Thurman, and O’Neill soils. Of these, the Colby soils and rough broken land are developed on loess and have high moisture-retaining powers. They have been subjected to such excessive surface drainage and severe erosion, however, that they have been unable to retain much of the organic matter in their topsoils and are rather light colored from the surface downward. The Colby soils are suited to crops if carefully managed, but rough broken land is used entirely for grazing. The other soils of this group are composed largely of sand. Dune sand and the Valentine and Sparta soils are unstable, have light-colored topsoils, and are of little value except for pasture land. The O’Neill and Thurman soils have accumulated considerable organic matter and have dark topsoils. They have low moisture-holding powers, however, and much of the area occupied by them is too dry to be used for cultivated crops. The Sparta and O’Neill soils are on terraces, and the others are on the uplands.

The soils of the bottom lands and poorly drained uplands include all the Cass, Sarpy, Lamoure, Wabash, and Gannett soils. The first four are on flood plains along streams, and the Gannett occupies wet depressions in the sand hills. All these soils, except the Sarpy which consists of recent water-laid sand and is light colored throughout, are well supplied with organic matter and have very dark topsoils. The Wabash and Lamoure soils are composed largely of silt, and the latter are very limy, especially in the subsoil. The other soils of the group are sandy. Owing to poor drainage and a high water table, most of the area occupied by these soils is poorly suited to cultivated crops. All the sandy soils, however, will produce high yields of native hay and are used mainly for this crop. In many places along Clearwater Creek and locally along Beaver Creek they are sufficiently well drained for the production of alfalfa and corn, and higher yields of these crops are obtained than on any soil of the well-drained uplands and terraces.

COUNTY SURVEYED

Wheeler County is a little northeast of the geographical center of the State. Bartlett, in the central part, is about 65 miles almost due north of Grand Island. The county is nearly square, each boundary being about 24 miles long. It comprises an area of 568 square miles, or 363,520 acres.

The area now included in the county comprises part of a former nearly level or rolling plain which was mantled to various depths by loessial deposits composed mainly of limy and floury silt. In the southern part the loessial mantle consisted of two layers, the upper being light grayish yellow or almost white and the lower pale red. Their combined thickness exceeded 60 feet in places. The loessial mantle thinned rapidly to the north and probably did not greatly exceed 15 feet in thickness along the northern boundary of the county. Throughout most of the county the loessial material has been removed or is deeply covered by wind-blown sand. Loess still caps several square miles of the uplands to an average depth of about 50 feet in the southeast corner. Northward it occupies a few of the sandhill valleys and thinly caps some of the uplands to
a point beyond the northern State line, indicating that the loessial mantle was at one time continuous over this and adjoining counties.

The total area on which loess still mantles the surface probably does not exceed 18 square miles, or about 3 percent of the county. The largest loess-capped body, which occupies about 14 square miles, is the one in the southeastern part. Although this body has been subjected to rather severe water erosion, it is still continuous. Except along its northern edge, where it gives way rather abruptly to the sand hills, it has been little modified by wind-blown sand. The relief ranges from nearly level to rough and broken. The headwaters of several tributaries to Cedar River have carved narrow steep-sided north-south valleys across it. The intervening divides have smooth flat tops which lie at or near the level of the old loess plain and from 40 to 70 feet above the present valley floors. They have been greatly narrowed through headward erosion of small drainageways and have irregular tortuous outlines. Few of them exceed one-half mile in width. In places they have been cut through by drainage, leaving only tabular remnants of the former plain.

The smaller developments of loessial material, all of which are completely surrounded by higher lying sandy deposits, are remnants of the old loess plain, which have escaped destructive erosion or burial by sand. They occupy a few widely scattered bodies in the eastern half and southwestern quarter of the county. In most of them the red loess which underlies the white in the southeastern part is absent, and the lighter colored loessial material is only a few feet thick over sand or sand and gravel. Few of these bodies exceed 640 acres in size, and most of them are less than 80 acres. The largest, comprising about 700 acres, is along the northern boundary of the county in the vicinity of Deloit, Holt County. They all have nearly level relief unmodified by drainage channels, as all surplus moisture is carried away in the underdrainage. Many of these bodies occur as small pockets, or swales, throughout the sand hills.

Except in the loess-covered areas, the surface features throughout the uplands are largely the result of wind action. About 80 percent of the county, including practically all the uplands not covered by loess, is mantled by loose incoherent sand and has the typical sand-hill relief. In most places the sandy material has been whipped by the wind into a monotonous succession of irregularly distributed hills and ridges ranging from 5 to about 100 feet in height. In places the hills are capped by gray drifting sand and pitted by blow-outs, the latter occurring mainly on the north or northwest sides. Most of the sand, however, supports a sufficiently dense cover of grass to prevent excessive drifting. The billowy surface is relieved here and there by nearly level valleys, basins, and pockets of different sizes. Surface drainage is not established, because the valleys and basins are obstructed by sand dunes. Locally water accumulates in the lower lying pockets, creating small patches of marshy land, but in most places all surplus surface moisture rapidly drains away through the loose porous sands, and only a negligible part of the sandy uplands is poorly drained.

Alluvial lands, including the flood plains and terraces, occupy about 16 percent of the county. They occur in continuous strips of various widths along Cedar River and Dry Cedar, Clear, Beaver,
and Clearwater Creeks, all of which flow east or southeast in crooked meandering channels through the sand hills. The flood plains, or bottom lands, occupy the broadest and longest strips. Those along Clearwater Creek average more than 3 miles wide and those along Beaver Creek commonly exceed 2 miles. The bottom lands along the other streams are much narrower.

The relief of the bottom lands is nearly level, although it is modified here and there by old and present stream channels, slight elevations, and shallow depressions. The bottom lands lie only 3 or 4 feet above the normal level of the streams but are seldom subject to overflow from the main channels. All seepage from the sand hills to the streams, however, passes through the bottom lands which, in most places, are kept constantly saturated with moisture to a level within 2 or 3 feet of the surface of the ground. In many depressions, the water rises to the surface, creating small areas of marshy land. The water table as a whole lies a little lower under the bottom lands along Clearwater Creek than it does under those along most of the other streams.

Terraces occupy only a few hundred acres in this county and occur as small scattered bodies, chiefly in the valleys of Cedar River and Dry Cedar Creek. The largest terrace, or bench, comprising about 100 acres, is along Clearwater Creek near Deloit. The terraces are remnants of former flood plains established before the streams had cut to their present levels. They all are well drained. Their surfaces lie from 8 to 10 feet above the valley floors, and the relief is nearly level.

The average elevation above sea level is about 2,031 feet.² The highest point in the county is on the sandy uplands in the west-central part, and the lowest is probably at the point where Beaver Creek crosses the eastern county line. The land slopes gradually to the east and south.

Drainage is carried eastward and southeastward into Elkhorn and Loup Rivers, respectively. Most of the streams are without surface tributaries, as practically all the water is received as seepage through the sand hills. Cedar River, in the southwestern part, and Clearwater Creek, in the northern part, flow swiftly and are actively deepening their channels. Most of the other streams, except those which head in the large body of loess in the southeastern part, where erosion is severe, are rather sluggish in places and are filling their channels.

Well water of excellent quality is readily obtained in all sections. The upland wells throughout the sand hills and loess-covered areas range from 75 to 250 feet in depth. In the alluvial lands an abundance of water suitable for livestock lies within a depth of 20 feet, but most of the wells are extended to a depth of 50 or 60 feet, to insure against contamination of the water through seepage. Flowing, or artesian, wells are in most of the stream valleys throughout the sand hills, especially in the northeastern and southwestern parts of the county. They are most numerous in the valley of Beaver Creek, where they range in depth from 80 to 120 feet. The flowing wells have sufficient pressure to lift the water 3 or 4 feet above the surface of the ground.

The native vegetation consists predominantly of grasses. Trees grow only in small scattered groves or narrow strips throughout the bottom lands and in planted groves on the uplands. They are of little value except for shade and fuel. The leading grasses on the sandy upland soils are *Stipa*, or needlegrass, sandgrass, and long-leafed reedgrass. On the finer textured soils of the uplands, grama, big bluestem, and little bluestem predominate, and in the bottom lands, sloughgrass, panic grass, and other water-loving species grow luxuriantly.

The first permanent settlement in the area now included in Wheeler County was made in 1874, in what was then unorganized territory. The county was established by an act of the State legislature in 1877 and was organized in 1879. The western half was taken to form Garfield County in 1884, leaving Wheeler County with its present boundaries.

According to the Federal census reports, there were 1,683 inhabitants in the county in 1890, 1,362 in 1900, 2,292 in 1910, 2,531 in 1920, and 2,335 in 1930. The density of the population was four persons to the square mile in 1930. Settlement is densest on the loess-covered part of the uplands in the southeastern corner, in the valleys along the river and larger creeks, and in the towns and their vicinities. The sand-hill sections are sparsely settled.

Ericson, situated in the southwestern part of the county, with 272 inhabitants, and Bartlett, the county seat, in the central part, with a population of 133, are the only towns. They are distributing points for a part of the farm implements, supplies, and produce. A bottling plant and a grain elevator are located in Ericson, and both towns have cream stations.

The public-road system is fairly well developed. United States Highway No. 281 extends northwest-southeast across the county, and a State highway crosses in a northeast-southwest direction. The Federal highway is surfaced with gravel or asphalt, and a part of the State highway is graveled. Both pass through Bartlett. The county roads are of earth construction. Most of those in the loess-covered uplands follow section lines and are kept in good repair, but in the sand hills only a few are graded, and most of them are simply trails, with gates on property lines. The only railroad, which terminates at Ericson, is a branch of the Chicago, Burlington & Quincy.

Rural mail-delivery routes or star routes reach nearly all localities, telephones are on many of the farms and ranches, and the public-school system is well developed.

**CLIMATE**

The climate is continental and similar to that of other counties in north-central Nebraska. It is characterized by rather high summer and moderate or low winter temperatures. The spring and fall seasons are cool. The former is characterized by considerable precipitation and the latter by only occasional periods of rainy weather. There is not enough variation in relief within the county to cause appreciable differences in climate.

Complete weather bureau records are not maintained in this county. Table 1, compiled from records of the Weather Bureau
station at Dumas in the northeastern part of Garfield County, gives
the normal monthly, seasonal, and annual temperatures and pre-
cipitation, which are similar to those in Wheeler County.

<table>
<thead>
<tr>
<th>Month</th>
<th>Temperature</th>
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</tr>
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<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Absolute maximum</td>
</tr>
<tr>
<td></td>
<td>°F.</td>
<td>°F.</td>
</tr>
<tr>
<td>December</td>
<td>23.4</td>
<td>73</td>
</tr>
<tr>
<td>January</td>
<td>26.6</td>
<td>69</td>
</tr>
<tr>
<td>February</td>
<td>25.4</td>
<td>69</td>
</tr>
<tr>
<td>Winter</td>
<td>23.1</td>
<td>73</td>
</tr>
<tr>
<td>March</td>
<td>33.6</td>
<td>80</td>
</tr>
<tr>
<td>April</td>
<td>46.9</td>
<td>87</td>
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<td>May</td>
<td>57.1</td>
<td>87</td>
</tr>
<tr>
<td>Spring</td>
<td>45.9</td>
<td>87</td>
</tr>
<tr>
<td>June</td>
<td>66.7</td>
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<td>July</td>
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<td>August</td>
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<td>September</td>
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<tr>
<td>October</td>
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<td>91</td>
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<tr>
<td>November</td>
<td>36.4</td>
<td>82</td>
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<tr>
<td>Fall</td>
<td>49.5</td>
<td>98</td>
</tr>
<tr>
<td>Year</td>
<td>47.2</td>
<td>106</td>
</tr>
</tbody>
</table>

1 Trace.

About 78 percent of the mean annual precipitation falls during
the principal part of the growing season, April to September, inclu-
sive. The summer rains usually come as heavy thundershowers, but
torrential rains are rare. Severe droughts seldom occur in spring,
but during middle and late summer dry spells are common, some
lasting several weeks.

The average date of the last killing frost is May 9 and of the
first is October 4. This gives an average frost-free season of 148
days, which is ample for the maturing of all farm crops commonly
grown. During the 20-year period from 1895 to 1914 there were 4
g years in which killing frosts occurred 10 or more days later in
the spring than the average date and 5 years in which they occurred 10
or more days earlier in the fall.6

From October 1 to about April 1 the prevailing wind is from the
northeast, and from April 1 to October 1 it is from a southerly direction.
Strong winds are common, but tornadoes are rare. The aver-
age relative humidity is about 70 percent.

5 Reed, W. G. (FRONT AND THE GROWING SEASON. U. S. Dept. Agr., Of. Farm Manage-
ment, Atlas of American Agriculture * 8 * pt. 2, Climate, sec. 1, p. 9 (advance
sheets no. 2), Illus. 1918.
AGRICULTURE

Since the earliest settlement in this county, agriculture has consisted mainly of cattle grazing and the production of wild hay. The first settlers were mostly cattlemen who grazed their cattle on the free open range. By 1885 most of the small area of loess-covered uplands in the southeast corner of the county was being used for cultivated crops. Small areas in the better drained parts of the bottom lands and the more stable parts of the sandy uplands have gradually been added to the cultivated acreage. By far the greater part of the land, however, is too sandy and unstable or too poorly drained for cultivated crops and remains with its virgin cover of grasses. It is used almost exclusively for cattle grazing on fenced ranches and for wild-hay land.

Of the cultivated crops, corn has occupied the largest acreage since farming began. The acreage devoted to this crop has always been exceeded by that used for pasture land and since 1850 by that used for the production of wild hay. During the first few years, when wheat was needed for food and for cash, this crop ranked next to corn in acreage, but when farming conditions became more stable, more livestock feed was needed, and the acreage in oats has generally exceeded that in wheat since 1890. In order to supply the increasing demand for feed, more and more of the sandy-land soils, which were not entirely too unstable or too droughty for grain crops, were brought under cultivation. Since rye does better than most other crops on such soils, its acreage has gradually increased. By 1905 rye was grown much more extensively than wheat, and since 1920 it has occupied about as large an acreage as oats. No cultivated crop occupies as large a proportionate acreage in Wheeler County as it does in most of the other counties of Nebraska.

According to the Federal census, 120,045 acres, or about 32 percent of the land area, was available for crops in 1934. This acreage includes that used for wild hay which alone occupied as large an acreage as that of all cultivated crops combined.

Most of the farms and ranches range in size from 260 to 1,000 acres, although 54 exceeded 1,000, 3 of which included more than 5,000 acres in 1930. The average size of the individual holdings in 1935 was 777.7 acres.

The farm buildings, in general, are fairly good. Most of the houses are one-story wooden structures which, as a rule, are kept in good repair. The barns and other outbuildings are generally large enough to house the crops, except hay which is stacked in the field. The Nebraska agricultural statistics show that 23 farmhouses had modern heating plants, 79 had running water, 33 were equipped with electricity, and 130 had radios in 1930. The farms and ranches are fenced and cross-fenced, most of them with barbed wire. The work animals are heavy draft horses and mules. A few farmers use tractors and trucks for the heavier farm work. There were 41 tractors, 71 gas engines, 80 trucks, 296 automobiles, 18 grain threshers, and 2 combines in the county in 1930. The farm machinery, especially that used in haymaking, is of the most modern and labor-saving types. Hay stackers, gang mowers, sweeps, and rakes are common on most of the ranches, and there are also many
hay balers. Part of the haymaking machinery is equipped for tractor power.

During the last few years, farm labor has been plentiful and unusually cheap. Monthly farm wages range from $15 to $30 with board and lodging. Day labor is plentiful at 75 cents or $1. Most farmers do their own work, except during the haymaking season when extra help is hired.

The Federal census reports owners on 44 percent, tenants on 53.9 percent, and managers on 2.1 percent of the farms in 1935. According to the Nebraska agricultural statistics 42 percent of the farm acreage was rented for cash and the rest for a share of the crops in 1930. Under the cash system the renter pays $3 or $4 an acre for the better farming land and from $100 to $150 a section (640 acres) for pasture land. Under the share system the owner receives one-third or two-fifths of the grain and usually one-half of the hay, when all labor, seed, and machinery are furnished by the tenant. Most tenants pay a lump sum for the use of the pasture land and a share of the crop for the use of the hay and grain land.

The average value of the land and buildings on farms operated by full owners was $21.74 an acre in 1930. Of these farms, 57.8 percent were mortgaged with an average mortgage debt of $11.91 an acre during that year. The average tax paid in 1929 was 25 cents an acre.

The selling price of individual farms and ranches ranges widely, depending on the character of the soil, the relief, drainage, improvements, and location with respect to markets.

The raising of livestock is the most important industry. The value of all domestic animals, poultry, and bees on the farms on April 1, 1930, was $1,170,767, and that of all crops, including forest, nursery, and greenhouse products, produced in the county in 1929, was $536,538. Cattle represent about 74 percent of the value of livestock; horses, mules, and colts about 10.7 percent; and hogs about 11.3 percent. The remainder, approximately 4 percent, represents the value of chickens, sheep, goats, and bees.

Table 2, compiled from the Federal census reports, gives the number and value of all domestic animals and poultry on the farms and ranges in this county in 1900, 1910, 1920, and 1930.

**Table 2.—Number and value of domestic animals and poultry in Wheeler County, Nebr., in stated years**

<table>
<thead>
<tr>
<th>Livestock</th>
<th>1900 Number</th>
<th>1900 Value</th>
<th>1910 Number</th>
<th>1910 Value</th>
<th>1920 Number</th>
<th>1920 Value</th>
<th>1930 Number</th>
<th>1930 Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>23,660</td>
<td>$343,840</td>
<td>13,172</td>
<td>$343,840</td>
<td>21,411</td>
<td>$1,147,043</td>
<td>15,315</td>
<td>$894,303</td>
</tr>
<tr>
<td>Swine</td>
<td>7,840</td>
<td></td>
<td>10,276</td>
<td></td>
<td>11,301</td>
<td></td>
<td>9,563</td>
<td></td>
</tr>
<tr>
<td>Horses</td>
<td>1,516</td>
<td></td>
<td>2,551</td>
<td></td>
<td>3,608</td>
<td></td>
<td>3,053</td>
<td></td>
</tr>
<tr>
<td>Mules</td>
<td>97</td>
<td></td>
<td>299</td>
<td></td>
<td>352</td>
<td></td>
<td>322</td>
<td></td>
</tr>
<tr>
<td>Sheep</td>
<td>1,533</td>
<td></td>
<td>372</td>
<td></td>
<td>2,113</td>
<td></td>
<td>3,630</td>
<td></td>
</tr>
<tr>
<td>Chickens</td>
<td>11,203</td>
<td>$3,218</td>
<td>22,679</td>
<td>11,018</td>
<td>31,454</td>
<td>27,117</td>
<td>27,125</td>
<td>20,618</td>
</tr>
</tbody>
</table>

1 Total value of all livestock, $743,080.

1 All poultry, mainly chickens.
All livestock is of good quality. Most of the cattle are grades, but the herds are usually headed by a purebred Hereford or Short-horn bull. Practically all the beef cattle are raised locally. Throughout the sand-hill parts of the county most of the cattle are sold as feeders when 2 or 3 years old, after coming off summer range. In the southeastern part, however, where the loess-derived soils favor the production of abundant feed, some farmers fatten their cattle on corn and alfalfa before shipping them to market. Most of the cattle are sold in the Omaha stockyards.

Dairying is of minor importance, and no farm is devoted exclusively to the dairy industry. Nearly every farmer keeps from 3 to 10 milk cows, chiefly of mixed beef and dairy breeding. The surplus dairy products, mainly cream, are sold in the local towns.

Most of the hogs are raised on the finer textured soils in the southeastern part of the county and on the better drained parts of the bottom lands, where corn and alfalfa can be grown. In these localities nearly all farmers have from 10 to 15 hogs, and some maintain large herds. The hogs are of good breeding, and there are a few purebred herds. Duroc-Jersey, Poland China, and Hampshire are the leading breeds. Practically all the hogs are sold in Omaha. Only a few are raised in the sand hills.

Horses are an important source of income on some ranches, especially in the sand-hill sections, where several ranchers have large herds. Most of the horses are of good grade stock, sired by purebred Percheron stallions. The horses not needed on the farms and ranches are sold to farmers in eastern and southern Nebraska.

Sheep are of minor importance. Several ranchers raise from 100 to 300 sheep annually, but the total number of these animals seldom exceeds 3,000. The most important limiting factor in sheep raising has been the expense involved in building fences adequate to prevent losses from coyotes. The danger of close grazing by sheep, with possible destruction of the grass cover, has also curtailed sheep raising, especially in the sand hills, where the stability of the sand depends almost entirely on the protective grasses.

Several kinds of poultry, mainly chickens, are raised on the farms and ranches. The principal breeds of chickens are Plymouth Rock, Leghorn, and Rhode Island Red. Turkeys are raised in large or small flocks by some farmers and locally are an important source of income. Most of the poultry products are either sold or exchanged for farm supplies in the local towns.

The farming practices on land suitable for hay or grain crops are similar to those prevailing on comparable lands in other counties of north-central Nebraska. Practically all of each crop produced in this county, with the exception of wheat which is grown mainly for cash, is used locally for livestock feed or for consumption in the home. Some of the wild hay from the Clearwater and Beaver Creek Valleys is baled and shipped to outside markets, but most of it is used on the farms where produced or is sold directly from the stacks to local cattlemen. This crop, which occupies as large an acreage as that of all tame-hay and grain crops combined, is followed by corn, oats, rye, alfalfa, wheat, timothy and clover mixed, and barley, ranking in acreage, during most years, in about the order named. None of the grain or tame-hay crops occupies more than a
few thousand acres each, and some of them occupy only a few hundred acres.

The crop yields vary greatly from place to place, according to variations in the amount and distribution of the precipitation. They also vary widely on the different soils. The average annual yield of each crop for the county as a whole, however, remains fairly uniform.

Table 3, compiled from the Federal census data, shows the acreage devoted to the principal crops in 1879, 1889, 1899, 1909, 1919, 1929, and 1934.

<table>
<thead>
<tr>
<th>Crop</th>
<th>1879 Acres</th>
<th>1889 Acres</th>
<th>1899 Acres</th>
<th>1909 Acres</th>
<th>1919 Acres</th>
<th>1929 Acres</th>
<th>1934 Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>727</td>
<td>13,897</td>
<td>10,685</td>
<td>20,441</td>
<td>20,397</td>
<td>20,592</td>
<td>10,397</td>
</tr>
<tr>
<td>Oats</td>
<td>176</td>
<td>1,902</td>
<td>2,719</td>
<td>5,943</td>
<td>4,423</td>
<td>8,917</td>
<td>1,207</td>
</tr>
<tr>
<td>Wheat</td>
<td>718</td>
<td>766</td>
<td>3,199</td>
<td>709</td>
<td>2,970</td>
<td>242</td>
<td>99</td>
</tr>
<tr>
<td>Rye</td>
<td>36</td>
<td>509</td>
<td>622</td>
<td>547</td>
<td>7,968</td>
<td>3,535</td>
<td>1,500</td>
</tr>
<tr>
<td>Barley</td>
<td>39</td>
<td>45</td>
<td>71</td>
<td>110</td>
<td>76</td>
<td>247</td>
<td>33</td>
</tr>
<tr>
<td>Potatoes</td>
<td>347</td>
<td>190</td>
<td>647</td>
<td>328</td>
<td>212</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>Hay (all kinds)</td>
<td>582</td>
<td>14,119</td>
<td>2,812</td>
<td>2,767</td>
<td>55,022</td>
<td>64,291</td>
<td></td>
</tr>
<tr>
<td>Tame hay</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wild hay</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alfalfa 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Includes sorghums for forage.
2 Included in tame hay.

Table 4, compiled from the Nebraska agricultural statistics, shows the average acre yield of the more important crops during the 19-year period 1912 to 1930, inclusive, and the approximate percentage of the land devoted to each crop in 1929.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Average acre yield 1912 to 1930, inclusive</th>
<th>Approximate percentage of land area occupied by crop in 1929</th>
<th>Crop</th>
<th>Average acre yield 1929</th>
<th>Approximate percentage of land area occupied by crop in 1929</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>22.7 Bushels/Lb 6.4 %</td>
<td>Alfalfa hay 2.4 Tons 0.5%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring wheat</td>
<td>16.6 Bushels/Lb 0.9%</td>
<td>Wild hay 0.8 Tons 13.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Winter wheat</td>
<td>13.6 Bushels/Lb 0.2%</td>
<td>Range and pasture 70.4%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oats</td>
<td>25.3 Bushels/Lb 2.6%</td>
<td>Woodland not pastured 1.9%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rye</td>
<td>10.6 Bushels/Lb 1.2%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barley</td>
<td>22.1 Bushels/Lb 1%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potatoes</td>
<td>68.6 Bushels/Lb .8%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Corn, the leading cultivated crop, is planted in May, usually with a lister. It is cultivated three or four times during the season and is laid by in July, after which it receives no further attention until harvest. The crop matures in September or early October. Most of it is husked from the standing stalks, after which cattle and hogs are pastured in the fields. Corn usually follows wheat or oats in the rotation, except on sandy land unsuited to these crops, where it may
follow rye or, in some places, sweetclover. Many farmers plant corn on the same land many years in succession. The seed used is from corn which has been grown in the locality for several years and has become adapted to local climatic and soil conditions.

Most of the oats grown are of the Kherson variety or strains of it, such as Nebraska 21. The seedbed for this crop is usually prepared by disking, although some farmers plow, disk, and harrow the land before planting the grain. The seed is planted with a press drill early in April. Oats mature in July, when they are cut and either shocked or stacked for threshing. This crop usually follows corn, alfalfa, or a small-grain crop in the rotations. Practically all the oats are fed locally to work animals, colts, and calves. The straw has a high feeding value and is usually stacked at threshing time. Very little oats are grown on the more sandy soils or on soils that are not well drained.

Most of the wheat is of the spring varieties including Ceres and Marquis. This crop is planted in the same manner and at about the same time as oats. The total area devoted to wheat has not exceeded 1,200 acres a year since 1920.

Rye is grown chiefly on the more sandy cultivated soils, where it is practically the only small-grain crop. Most of it is grown for grain, and some is used for temporary fall and spring pasture, especially for brood sows and pigs. When grown for grain, rye is seeded and harvested like oats, but the seed is planted in the fall instead of the spring. Rosen rye is the favorite variety. The grain is fed mainly to hogs.

The area in barley seldom exceeds 500 acres. This crop, although nearly as valuable as corn in a feeding ration, does not return such high yields. Moreover, it is poorly adapted to sandy soils, therefore has never been grown extensively here. Most of the barley is of the smooth-bearded varieties, such as Comfort and Glabron. The grain is planted early in the spring in the same manner as oats.

Alfalfa during most years is the leading tame-hay crop. The seed is usually broadcast on plowed, disked, and harrowed stubble land early in the spring. Oats or barley are sometimes used as a nurse crop. Nebraska-grown alfalfa seed is used ordinarily. A stand of alfalfa is allowed to remain as long as the yield is satisfactory. The yields in the uplands decrease more rapidly than those in the bottom lands, therefore most of the alfalfa is grown on the bottom-land soils. This crop is poorly suited to sandy upland soils. Alfalfa hay is fed mainly to cattle, and green alfalfa is an important hog feed on some farms.

Fields of mixed timothy and clover grow on many of the bottom-land farms in the valleys along Beaver and Clearwater Creeks. This crop will thrive on land too moist for good yields of alfalfa. It usually occupies positions where the water table lies within a few feet of the surface of the ground and where the land is too wet for other tame-hay crops or grain. On some farms clover and timothy seed have been sown among the native bottom-land grasses, in order to increase the quantity and improve the quality of the hay.

Wild hay is produced to greater or less extent in all parts of the county, but the largest areas devoted exclusively to this crop are in the bottom lands along Beaver and Clearwater Creeks. Here most of the land is too wet for cultivation, but supports a rank growth of moisture-loving grasses which yield nearly a ton of hay to the acre.
High acre yields of wild hay are also obtained in the more poorly drained parts of the bottom lands along Cedar River and Dry Cedar and Clear Creeks. Throughout the sand hills much wild hay is obtained in the numerous valleys, pockets, and swales, where moisture conditions are most favorable. In such places the hay seldom yields more than one-half of a ton an acre, but it is of finer texture and has a higher feeding value, ton for ton, than most of the bottom-land hay. On those parts of the bottom lands where timothy and clover comprise a large percentage of the vegetation, the hay equals or exceeds in feeding value that obtained on any upland soil.

Commercial fertilizers are not used. Some farmers apply barnyard manure to the more eroded soils, but the supply is seldom sufficient for more than a small part of the farm. When applied to sandy soils on uplands or terraces the manure decomposes slowly in the rather dry surface layers and does not greatly benefit the crops. On the moist soils of the bottom land, hay yields are increased only slightly through the use of manure.

SOILS AND CROPS

The soils of about 96 percent of Wheeler County, irrespective of their topographic position, have developed from sandy deposits and are composed largely of sand to a depth exceeding 4 feet. Throughout the remainder, approximately 4 percent, of the county, the soils have developed from loess or from material composed largely of loess and are silty to a depth near or below 4 feet. All the silty soils, except those in small bodies scattered throughout the sandy lands, which contain an abundance of sand in the lower part of their subsurfaces, occur on the large loess-covered area in the southeastern part of the county. In this area, which is a part of the vast loess area of Nebraska, the soils have been little modified by sand and are silty to a depth ranging from 8 to 10 feet or deeper.

The silty and sandy soils, although differing widely from one another in most characteristics, have, where they occur under comparable topographic and moisture conditions, one feature in common, namely, the color of their topsoils. In situations where the soils have been subjected to the influences of soil building, dominated by the grass vegetation, for a long time, undisturbed by erosion, the topsoils are dark. Light-colored soils are in evidence in places where erosion has been active. The dark color is caused by accumulations of black well-decomposed organic matter derived largely through the decay of grassy vegetation. It prevails, regardless of the character of the parent material, wherever conditions have favored prolonged accumulations of organic matter. In general, the topsoils are darkest where moisture is most abundant and where erosion is least active, as in the bottom lands, in pockets and swales throughout the sand hills, and on the terraces and more nearly level parts of the uplands.

Soils with dark topsoils, although these are common in both the silty and sandy soils, occupy less than one-third of the total area of the county. Over most of the county the soils have been subjected to such continual wind or water erosion or are of such recent origin that they have accumulated very little organic matter and have light-brown, gray, or light-yellow topsoils.
Aside from the similarity in the color of their topsoils, the silty and sandy soils have little in common. They also differ rather widely among themselves in physical characteristics, and to some extent in chemical composition. The more extensive sandy soils are deficient in lime and organic matter and have comparatively low moisture-retaining powers. They are unstable and subject to destructive wind erosion, especially when their cover of native grass is destroyed. Some of the sandy soils, however, contain considerable lime, and an abundance of moisture and organic matter. The latter material stabilizes the sand and prevents destructive wind erosion, even when the land is cultivated. Some areas of the sandy soils are very poorly drained and have developed thin layers of pale-green or bluish-green sticky plastic clay in their subsoils.

The silty soils as a whole are well supplied with lime, although its abundance and the depth to which it occurs varies in different localities. These soils have high moisture-retaining powers and, except on the steeper hillsides, are well supplied with organic matter. None of them is ordinarily subject to destructive wind erosion, even under cultivation. These soils differ among themselves chiefly in the depth, texture, and intensity of darkness of the topsoil. Few of the silty soils are poorly drained, although some of them have very uneven surfaces and are subject to severe water erosion.

Most of the area occupied by the silty soils is used for grain and tame-hay crops. Small bodies and narrow strips, which are poorly drained, severely eroded, or unfavorably situated, are still covered with virgin grasses, but a negligible part remains in wild pasture or hay land. Nearly all these soils are well adapted to any crop commonly grown in the county. The highest yields, especially of most grain crops, are obtained on the terraces and more nearly level parts of the uplands, where erosion is not severe, and where the soils contain an abundance of organic matter and, consequently, nitrogen in their topsoils. Corn, which requires moisture in larger amounts and for longer periods than the other grain crops, yields a little higher on the better drained soils of the bottom lands than on the soils of the uplands or terraces. The same is true of alfalfa, timothy, and clover. Alfalfa, however, does well on rather steeply sloping silty upland soils where the topsoils are shallow and low in organic matter and nitrogen. This is because alfalfa is able to obtain most of its nitrogen from the air. It is often grown on rather steep hillsides where the soil is not well adapted to grain crops. The bottom-land soils, even where well drained, are a little too moist for small-grain crops.

None of the sandy soils, except a few areas in the better drained parts of the bottom lands where corn, alfalfa, and timothy and clover give unusually high yields, is as well suited for grain or tame-hay crops as the silty soils. The darker, better drained, and more stable soils of the uplands and terraces give larger returns when used for corn or rye than when used for native pasture or hay land, and most of them are cultivated. The light-colored unstable sandy soils, which occupy by far the greater part of the county, and all poorly drained soils are used almost exclusively for native pasture or hay land.

In this report the individual soils are placed, on the basis of drainage and moisture content, which largely determine their producing powers and crop adaptabilities, into three broad groups as
follows: (1) Soils of the well-drained uplands and terraces, (2) soils of the excessively drained uplands and terraces, and (3) soils of the bottom lands and poorly drained uplands. These groups correspond rather closely to the use made of the soils under the present farming system. For example, the soils included in group 1 are used mainly for cultivated crops, those in group 2 for native pasture land, and those in group 3 for the production of wild hay. This grouping is not intended to imply that the crops mentioned in connection with any particular group are the only ones which can be grown on the soils of that group. Under a more intensive farming system including, where necessary, artificial drainage, incorporation of organic matter, and control of wind and water erosion, most crops adapted to the climate could be profitably grown on nearly all the soils. Even under the present system, small carefully managed fields on the more sandy, unstable, and droughty upland soils have been made to give larger returns from corn, sweetclover, cane, and millet than can be obtained on similar soils covered with native grasses.

The grouping here used is based not only on drainage, producing powers, and crop adaptabilities of the soils but also on soil characteristics, relief, and character of the material from which the soils have developed. No group of soils is confined to a particular part of the county, although some soils in each group are of very local occurrence.

In the following pages, the individual soils in the different groups are described, and their crop adaptations are discussed; the soil map accompanying this report shows their distribution; and table 5 gives their acreage and proportionate extent.

Table 5.—Acreage and proportionate extent of the soils mapped in Wheeler County, Nebr.

<table>
<thead>
<tr>
<th>Soil type</th>
<th>Acres</th>
<th>Percent</th>
<th>Soil type</th>
<th>Acres</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holdrege silt loam</td>
<td>2,240</td>
<td>0.6</td>
<td>O‘Neill loamy sand</td>
<td>1,224</td>
<td>0.3</td>
</tr>
<tr>
<td>Holdrege very fine sandy loam</td>
<td>1,688</td>
<td>0.3</td>
<td>Rough broken land</td>
<td>2,990</td>
<td>0.3</td>
</tr>
<tr>
<td>Marshall fine sandy loam, sandy-substratum phase</td>
<td>2,304</td>
<td>0.6</td>
<td>Cass loamy sand</td>
<td>41,556</td>
<td>11.5</td>
</tr>
<tr>
<td>Marshall loamy sand, sandy-substratum phase</td>
<td>1,664</td>
<td>0.5</td>
<td>Cass fine sandy loam</td>
<td>13,532</td>
<td>3.7</td>
</tr>
<tr>
<td>Hall very fine sandy loam</td>
<td>1,344</td>
<td>0.4</td>
<td>Cass fine sandy loam, heavy-subsoil phase</td>
<td>2,176</td>
<td>0.6</td>
</tr>
<tr>
<td>Anselmo loamy sand</td>
<td>1,568</td>
<td>0.5</td>
<td>Cass very fine sandy loam</td>
<td>3,230</td>
<td>0.9</td>
</tr>
<tr>
<td>Dune sand</td>
<td>122,048</td>
<td>33.5</td>
<td>Sarpy sand</td>
<td>640</td>
<td>0.2</td>
</tr>
<tr>
<td>Valentine sand</td>
<td>140,056</td>
<td>38.5</td>
<td>Lamsure fine sandy loam</td>
<td>704</td>
<td>0.2</td>
</tr>
<tr>
<td>Valentine loamy sand</td>
<td>40,816</td>
<td>3.0</td>
<td>Wabash silt loam</td>
<td>64</td>
<td>0.1</td>
</tr>
<tr>
<td>Thurman loamy sand</td>
<td>8,722</td>
<td>2.7</td>
<td>Gannett loamy sand</td>
<td>596</td>
<td>0.2</td>
</tr>
<tr>
<td>Thurman fine sandy loam</td>
<td>1,102</td>
<td>0.3</td>
<td>Total</td>
<td>363,520</td>
<td></td>
</tr>
<tr>
<td>Colby silt loam</td>
<td>3,584</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SOILS OF THE WELL-DRAINED UPLANDS AND TERRACES

The soils classed in this group occupy only 3 percent of the county, but they comprise most of the cultivated land. The group includes the Holdrege, Marshall, Hall, and Anselmo soils. The first three have developed from loess, are silty throughout, and have thick, dark topsoils which are well supplied with organic matter. The Anselmo soils are composed mainly of sand but contain an abundance of silt, especially in the upper part of their subsoils. They are low in organic matter and have light-colored topsoils.
The soils of this group are very gently undulating or slightly rolling, and they are well but not excessively drained. None of them is droughty, although the Anselmo soils, owing to their rather high sand content, are not quite so retentive of moisture as the more silty ones. No soil of the group is deficient in lime, so far as crop needs are concerned. The Holdrege and Hall soils contain an abundance of this material. The Hall soils are on terraces, and the other soils of the group are in the uplands.

The greater part of each of these soils is under cultivation. Corn, because of its wide adaptation to different soil and moisture conditions and because of its large yields and high feeding value, is the leading crop on all. Oats, wheat, rye, and barley are also grown and give good yields, except in places where the topsoils contain unusually large quantities of sand and are a little too unstable for small-grain crops. Alfalfa is grown on a larger percentage of the area occupied by these soils than of that occupied by the excessively drained soils of the uplands and terraces. None of the upland or terrace soils, however, is so well adapted for the continued production of alfalfa as are the bottom-land soils, where most of the alfalfa is produced. The alfalfa plant does well, especially on the finer textured soils of the uplands and terraces as long as its roots can obtain moisture from deep soil layers to supplement that furnished by the seasonal rainfall. When the deep-seated moisture supply is exhausted, the plant suffers from drought and yields decline. Alfalfa does not occupy a large acreage on any upland soil in this county.

Holdrege silt loam.—Holdrege silt loam, although the most extensive soil of the well-drained uplands and terraces, covers only 2,240 acres. It occupies flat-topped divides on the loess-covered uplands in the southeastern part of the county. Both surface drainage and underdrainage are well developed, but the soil is not subject to destructive erosion, except around the margins of areas where the land slopes rather steeply to drainageways.

The 9- to 12-inch topsoil consists of very dark grayish-brown mellow silt loam with a high organic-matter content. The upper part of the subsoil, which extends to an average depth of 2 feet, is light-brown heavy but friable silt loam. The next, or third, layer is transitional in character between the one above and the one below. It is composed of floury light grayish-brown silt containing only faint traces of organic matter. None of the layers described contains sufficient lime to effervesce with acid. The fourth layer resembles the third in texture and friability, but it contains an abundance of lime in the form of small soft or hard concretions and in finely divided form, which is common in many soils throughout central and western United States. In general, the material in this layer is somewhat lighter in color than that in any other layer, and, on account of its high lime content, the layer is known as the lime zone. It is 12 or 14 inches thick in Holdrege silt loam. Beneath the lime zone is the light grayish-yellow silty and limy loess, from which the soil has developed. The loess is well supplied with lime, but does not contain so much of this material per unit of volume as the lime zone.

As a whole this soil is uniform, but it presents a few minor variations worthy of mention. Locally, around the shoulders of the divides, erosion has greatly thinned and in places entirely removed
the surface soil, exposing the light-colored underlying material. Such areas, where of sufficient size to warrant mapping, are shown as Colby soils, but the smaller patches are included with Holdrege silt loam. In a few places the light-brown layer immediately beneath the surface layer is very poorly developed or entirely lacking, and the dark topsoil rests directly on the soft light-colored and friable layer just above the lime zone or may even rest on the lime zone itself. The principal textural variation is toward very fine sandy loam, but this occurs very locally and only where the soil is adjacent to areas of unstable sand.

Holdrege silt loam is probably as strong and fertile as any upland soil in the Mississippi Valley. In this county practically all of it is under cultivation, mainly to corn, oats, and alfalfa. Some wheat and small patches of rye are grown. Although very fertile, this soil does not return as high yields as are obtained on the better soils in eastern Nebraska and Iowa, where the precipitation is much greater. In seasons of high rainfall corn and alfalfa yield about twice as much as in normal years. The average yield of corn over a period of years is about 35 bushels an acre, and oats yield about the same. Rye and wheat yield about 20 bushels an acre. Alfalfa, which is the leading tame-hay crop, produces about 3/4 tons an acre, from three cuttings during the summer season. Cattle raising is not practiced extensively, as this soil is too valuable to be used as grazing land. Many farmers, however, fatten cattle purchased from ranchers in the sand hills. The cattle are fed corn and alfalfa for 60 to 90 days and then shipped to the Omaha market. Hogs are raised on nearly every farm, and many farmers have large herds.

**Holdrege very fine sandy loam.**—Holdrege very fine sandy loam occurs in small scattered bodies, most of which are in Mud Creek Precinct. The largest development, comprising about 400 acres, is near Deloit in Clearwater Precinct.

This soil has about the same surface features and drainage conditions as Holdrege silt loam. It is also similar to that soil in all characteristics, except texture of the topsoil. It has received more wind-blow sand and has a slightly more sandy topsoil than the silt loam. The sand content, however, is nowhere sufficient to impair the stability of the soil or to reduce its moisture-holding power.

This soil is well suited to the crops commonly grown, and practically all of it is under cultivation. It is as productive as Holdrege silt loam; in fact the farmers regard both soils with equal favor for general-farming purposes. The very fine sandy loam is of minor importance, on account of its small extent.

**Marshall fine sandy loam, sandy-substratum phase.**—The sandy-substratum phase of Marshall fine sandy loam occupies numerous small bodies around the northern edge of the loessial uplands in the southeast corner of the county. It also occurs in many valleys and pockets throughout the sand-hill section, and seven or eight bodies, with a combined area of about 800 acres, are in the northeast part of the county.

This soil has developed on a thin layer of loess underlain, at a depth ranging from 24 to 40 inches, by sand. The land is nearly level or very gently undulating. Surface drainage channels are not well
developed, but the underlying sand allows all surplus moisture to be carried away, and the soil is everywhere well drained. The loessial material above the sand is highly retentive of moisture, and the soil is nowhere droughty. It is not equipped to hold so much moisture as the Holdrege soils which are developed on a much thicker loessial deposit.

The topsoil, which is about 10 inches thick, consists of very dark colored mellow fine sandy loam containing an abundance of organic material. The rather large content of fine silt and organic matter prevents destructive wind erosion in cultivated fields, even during prolonged periods of dry, windy weather. The subsoil, which is brown in the upper part and light grayish brown in the lower, consists largely of loesslike silt, with only a small admixture of the finer grades of sand. It averages about 25 inches in thickness. The substratum is composed of loose gray sand similar to that beneath the Thurman and Valentine soils. The Marshall soil is everywhere low in lime, as compared with the Holdrege soils, but it does not appear to be deficient in this material so far as crop needs are concerned.

Practically all the land is under cultivation to the same crops as are grown on Holdrege silt loam. Although not quite so retentive of moisture as the Holdrege soils, much of it, especially that occurring in depressions throughout the sand hills, receives considerable moisture as seepage through the sand. In the depressed areas crop yields are as high as on Holdrege silt loam. Elsewhere, as around the margins of the large body of loess in the southeastern part of the county and on the thinly loess covered uplands in the northeastern part, crop yields average from 10 to 15 percent below those obtained on Holdrege silt loam. Although very productive, this soil is of only local agricultural importance on account of its small extent.

**Marshall loamy sand, sandy-substratum phase.**—The sandy-substratum phase of Marshall loamy sand has the same general distribution as the sandy-substratum phase of Marshall fine sandy loam, but it is slightly more extensive than that soil. Most of it occurs in small valleys and pockets throughout areas of more sandy soils. The individual bodies are numerous, but they are small. The surface features and drainage conditions are about the same as on Marshall fine sandy loam, sandy-substratum phase.

This soil differs from the corresponding phase of Marshall fine sandy loam chiefly in that its topsoil is more sandy. This layer, which extends to an average depth of 10 inches, contains an abundance of organic matter and is very dark, but it consists mainly of the fine and medium grades of sand. It contains a small amount of silt, however, which, supplemented by the organic matter, gives the material a loamy texture and helps to prevent excessive wind erosion. The rest of the soil, to a depth of 3 feet, consists largely of silt similar to that beneath Marshall fine sandy loam, sandy-substratum phase, but it is slightly sandier. It is brown in the upper part, where stained by organic solutions washed down from the topsoil, and is very light colored in the lower part. Beneath the silty layer is loose gray sand.

This soil, like the corresponding phase of Marshall fine sandy loam, is low in lime but does not appear to be deficient in this material. It is friable throughout. Owing to the sandy character of the top-
soil and to the slight depth to almost pure sand beneath the subsoil, the soil is not highly retentive of moisture. Its low position with respect to the surrounding sandy soils, however, favors accumulation of the moisture, and the soil does not become droughty even during protracted dry spells.

Nearly all bodies of this soil are under cultivation. Corn is grown chiefly, and some alfalfa, sweetclover, and rye occupy some of the land. Yields of these crops are about the same or only slightly lower than those obtained on Holdrege silt loam. Some oats and wheat are grown, but the topsoil in most places is too sandy to make a sufficiently compact seedbed for these crops.

Although the surface layer of this soil is extremely sandy, it is protected in most places from destructive wind erosion by higher lying land.

_Hall very fine sandy loam._—Hall very fine sandy loam occurs on stream terraces composed largely of silt. It occupies several small bodies, most of which are in the southern part of the county, chiefly in the valleys of Cedar River, Clear Creek, and tributaries to the former stream. A few areas are in Clearwater Creek Valley near Detoit, the largest, comprising about 200 acres, being in this locality.

This soil has developed from gray limy loess similar to that underlying the Holdrege soils of the uplands, but which was carried to its present position by streams and deposited along their courses when they were flowing at higher levels. Later entrenchment of the stream channels left the deposits from 8 to 12 feet above the present bottom lands, and with the accumulation of organic matter the present soil has been produced.

The land is nearly level but has sufficient slope to afford ample surface drainage. Underdrainage is thorough but not excessive. None of the soil is subject to destructive erosion.

This soil resembles the Holdrege soils in most characteristics but differs from them chiefly in that it occupies lower topographic positions. Owing to its small extent it is mapped to include a wider range of texture in the topsoil than any of the Holdrege soils.

The 12- to 16-inch topsoil is friable and, owing to an abundance of organic matter, is very dark. In most bodies of this soil the topsoil has a very fine sandy loam texture. In several of them, including most of those along Cedar River and Clear Creek, the topsoil contains more sand than is typical and approaches fine sandy loam or even loamy fine sand in texture. The upper part of the subsoil is brown or grayish-brown silt loam, and the color becomes lighter with depth. The material in this layer is a trifle more compact than that in the topsoil, but the increased compaction is not noticeable unless the layers are closely compared. The lower part of the subsoil, beginning at an average depth of 30 inches, is light-gray floury and limy silt which continues to a depth exceeding 6 feet. The soil is very retentive of moisture and, aside from the textural variations in its topsoil, is remarkably uniform.

Except where the topsoil is unusually sandy, this soil is well suited to the production of all crops commonly grown. It is more productive than any other soil of the well-drained uplands and terraces, largely because it is more favorably situated to receive run-off from higher levels. Practically all the land is under cultiva-
tion. The very sandy areas are suited mainly to corn and rye. Alfalfa and corn yield a trifle lower than on the bottom-land soils, but yields of other crops, except on the very sandy areas, exceed those obtained on any other soil in the county. Although highly productive, this soil is of only local agricultural importance, on account of its small extent.

**Anselmo loamy sand.**—Anselmo loamy sand resembles Valentine loamy sand, except that it contains a higher percentage of silt which gives it greater stability and a higher moisture-retaining power than that soil. It occupies numerous small bodies, ranging from less than 5 to about 100 acres in size, with only a few exceeding 80 acres. Most of the bodies are in Ericson, Clear Creek, and Mud Creek Precincts. The relief ranges from nearly level to slightly rolling. Surface drainage channels are not established, as all surplus moisture passes downward in the underdrainage.

The topsoil, which averages about 8 inches in thickness, consists largely of sand, but it contains sufficient silt and organic matter to give it a loamy texture. The organic content is not sufficient to greatly darken the material, and the topsoil is much lighter in color than the topsoils of the Thurman soils. In most places it is grayish brown or dark grayish brown and is about the same color or only slightly darker than the corresponding layer of Valentine loamy sand. The rest of the soil, to a depth of about 3 feet, consists of a gray or light grayish-brown mixture of sand and silt. It is much more coherent than the subsoil of the Valentine soils but does not have the smooth silty feel of the Holdrege and Hall subsoils. In most places, pure gray sand occurs below a depth ranging from 3 to 4 feet. None of the soil contains sufficient lime to effervesce when dilute hydrochloric acid is applied.

This soil, although not so well equipped to hold moisture as the silty Holdrege, Hall, and Marshall soils, has a much higher moisture-retaining power than the Thurman and Valentine soils. Practically all the land is under cultivation, mainly to corn. Rye and sweetclover occupy many small fields. The soil is poorly suited to wheat or oats, as the topsoil, although more stable than that of the Valentine soils, drifts rather badly during dry windy weather, especially where not protected by vegetation.

The yield of corn on this soil during average years is about 25 bushels an acre, of rye about 12 bushels, and of alfalfa about 2 tons of hay. Most of the sweetclover is used for pasturage. Although fairly productive of crops to which it is suited, this soil occupies only a small part of the farms on which it occurs and is therefore of little agricultural importance.

**SOILS OF THE EXCESSIVELY DRAINED UPLANDS AND TERRACES**

The soils of the excessively drained uplands and terraces, which occupy 79.6 percent of the total area of the county, supply most of the pasturage, on which the cattle raising of this county so largely depends. The Valentine, Colby, Thurman, and O'Neill soils, in addition to large areas of dune sand and small bodies of rough broken land, which are not classed as soils, comprise this group.

These soils are subject to excessive loss of moisture through drainage. Aside from the Colby soils and the bodies of rough broken land,
they are composed largely of loose porous sand which allows rapid loss of moisture through downward seepage. The Colby soils and rough broken land consist chiefly of limy silt which is highly retentive of moisture, but they occur on slopes where surface drainage is excessive and erosion severe. None of the sandy soils has retained much lime, owing to removal of this material in the underdrainage. Most of them have very low water-retaining power and are rather droughty. The Thurman and O'Neill soils are the only ones of the group that have accumulated sufficient organic matter to have dark topsoils. The O'Neill soil is on terraces, and the rest of the soils are in the uplands. The terrace soil (O'Neill loamy sand) and the Thurman soils of the uplands have nearly level or undulating relief, the Valentine soils are hummocky, as a rule, and the Colby soil, dune sand, and rough broken land are strongly rolling or hilly.

Over most of the area occupied by the soils of this group, the soil materials are so unstable, droughty, low in organic matter and lime, or have such uneven surfaces that they cannot profitably be used for cultivated crops under the present farming system. All members of the group, however, include some land under cultivation, and a few of the soils are well adapted for the production of grain and tame hay. The Colby soils, which are the most stable and have the highest moisture-holding power, are used almost exclusively for cultivated crops. Most of the finer textured areas of the Thurman and O'Neill soils are also under cultivation. Garden patches and widely scattered cultivated fields occur even on dune sand and rough broken land. Aside from these exceptions, all the area occupied by the soils of this group remains with its virgin grass cover and is used chiefly for grazing. Much hay is cut, especially on the Valentine, Thurman, and O'Neill soils.

**Dune sand.**—Dune sand is the name applied to hilly areas of wind-blown sand, which occur extensively throughout the uplands in all except the southeast corner of the county. One of the largest areas, occupying nearly 50 square miles, covers parts of Ericson, Gritta Ridge, and Buffalo Precincts, and large bodies are in Caldwell and Clearwater Precincts.

Although dune sand is not a true soil, it supports a fair grass cover and is valuable for grazing land. It consists of gray incoherent sand of fine or medium grades to a depth ranging from 10 to more than 12 feet. The 1- or 2-inch surface layer may be a trifle browner than the rest of the sand, owing to a small content of organic matter. The sand has resulted from the breaking down of the soft sandstone formations of this section, and it has been deposited in its present position through wind action. The general absence of silt and clay is probably due to the removal of these materials by wind. The sand does not contain lime.

Dune sand differs from Valentine sand, chiefly in that its relief is more pronounced. In most places the sand has been whipped by the wind into irregularly distributed hills and ridges from 40 to 80 feet high. Old and recent blow-outs are on many of the hills, generally on the north or northwest sides. Pockets, valleys, and swales, some of which are occupied by Valentine soils, lie between the hills and ridges.
The dune-sand areas are practically valueless for cultivation. Each year local patches are broken and used for cultivated crops, but removal of the native grasses ruins the land, not only where the vegetation is destroyed but also for a distance of several rods to the lee-ward. At present most of the dune sand is fairly well sodded, and only a little is subject to active wind erosion. The native vegetation includes many valuable pasture, hay, and sand-binding grasses, of which little bluestem, blow-out grass, sand reedgrass, Redfieldia, and needlegrass are the most common. In the spring and summer these grasses will maintain from 70 to 90 head of cattle on each square mile, but in the winter they cannot be depended on for pasturage. When cut for hay they yield about one-fourth of a ton an acre.

Valentine sand.—Valentine sand is the most extensive soil in the county. It covers 140,096 acres, or 38.5 percent of the total area. It is closely associated with dune sand and occupies rather low, rolling, or hummocky areas within the sand hills. Few of the ridges or hummocks exceed 10 feet in height, in contrast to the much higher hills of the dune-sand areas. There is practically no run-off, as all the moisture is rapidly absorbed by the soil.

This soil consists of loose sand to a depth exceeding 5 feet. To a depth of 3 or 4 inches the material contains a small amount of organic matter and in most places is light brown. The topsoil, however, is nowhere so dark or so thick as in the Thurman soils and does not contain sufficient organic matter to stabilize the sand when the land is cultivated. The subsoil is practically devoid of organic matter and is very light colored. This soil does not contain lime.

Valentine sand is of little value for the production of grain or tame hay, because of its unstable character and low organic-matter content. Its porous sandy character and low water-retaining power are also unfavorable to tilled crops. Only scattered fields, most of which are used for corn or sweetclover, are under cultivation. Most of the soil remains with its native covering of grasses and is used for grazing cattle and the production of wild hay. The native grasses consist chiefly of Stipa, or needlegrass, and little bluestem. They will support from 90 to 120 cattle on each section during the grazing season or when cut for hay will yield about one-third of a ton an acre.

Valentine loamy sand.—Valentine loamy sand resembles Valentine sand in all characteristics, except that its topsoil contains a little more organic matter and is slightly thicker and darker than that of the sand type. The organic matter is not sufficiently abundant, however, to hold the sand against drifting when the native sod is destroyed. In cultivated fields Valentine loamy sand rapidly changes to Valentine sand through removal of its organic matter by the wind.

The soil occupies 10,816 acres in Wheeler County. It occurs in numerous, mainly small, bodies, most of which are surrounded by areas of Valentine sand but lie a little below the general level of that soil and have a more nearly even relief. A few bodies occupy slightly elevated positions in the bottom lands, mainly along Beaver Creek.

Only about 10 percent of the land is used for cultivated crops, chiefly corn, sweetclover, and rye, which do fairly well during the
first year or two, but, as the soil rapidly loses its organic matter under cultivation, after a few years it is no more productive than Valentine sand. Most of the land remains in its virgin state. It supports a slightly heavier grass cover than Valentine sand and is a little better than that soil for grazing or hay land. It is of little agricultural importance, because of its rather small extent.

**Thurman loamy sand.**—Thurman loamy sand occupies numerous, mostly small, bodies throughout the sandy uplands. Most of the bodies are within or adjacent to areas of Valentine sand. The largest area, comprising about 800 acres, is in the northeastern part of Clearwater Precinct in the vicinity of Deloit. Few of the other bodies exceed 300 acres in size.

This soil is composed mostly of sand. It resembles the Valentine soils, except that it contains more organic matter and has a much thicker and darker topsoil than those soils. The relief ranges from nearly level to gently undulating. Drainage channels are not established, because the porous sand allows practically no run-off.

The 8- to 12-inch topsoil contains an abundance of organic matter and is very dark. It ranges in texture from sandy loam to loamy sand, the loamy sand predominating. The subsoil is composed mainly of fine and medium grades of sand. In most places the material is very porous and incoherent, but locally it contains a small quantity of silt which loosely holds the sand grains together, especially when the soil is moist. The subsoil is brown in the upper part, where stained by organic matter leached from the topsoil, but it rapidly becomes lighter in color with depth and is light grayish brown at a depth ranging from 30 to 36 inches beneath the surface of the ground. None of the soil contains sufficient lime to cause effervescence when hydrochloric acid is applied, but it does not seem to be deficient in lime so far as crop needs are concerned.

Owing to its high organic-matter content, the topsoil retains moisture fairly well. It is rather unstable, however, when brought under cultivation and is poorly suited to most shallow-rooted crops. Corn, with its large and coarse root system, is not greatly injured by the shifting sands, and most of this soil is used for that crop. Some rye is grown. Crops yield fairly well in seasons of normal or high precipitation. Corn produces about 20 bushels and rye about 15 bushels an acre. In dry years yields are low, largely because the porous sand subsoil is unable to furnish sufficient moisture to the crops after that in the topsoil becomes exhausted.

This soil, although not well suited to cultivated crops, especially in dry years on account of its rather unstable and droughty character, occurs in areas where most of the surrounding soils are so extremely low in organic matter, droughty, and unstable that they are suited only for pasture or hay land. Since some land in these areas is needed to produce grain feed, Thurman loamy sand is usually chosen, and practically all the soil is under cultivation.

**Thurman fine sandy loam.**—Thurman fine sandy loam is an extensive soil which occurs throughout the sandy uplands in small scattered bodies, few of which exceed 80 acres in size. They are most numerous in Mud Creek, Clearwater, and Keuka Precincts.

This soil has about the same surface features and drainage conditions as Thurman loamy sand and, like that soil, is composed largely
of sand. Its topsoil, which is as well supplied with organic matter and as dark and thick as that of the loamy sand, contains an abundance of silt which stabilizes the sand, gives the topsoil high water-retaining power, and prevents destructive wind erosion when the land is cultivated. The subsoil is composed of loose porous sand identical with that in the corresponding layer of Thurman loamy sand. It has low water-retaining power.

All this land is under cultivation. Most of it is used for corn, but all small-grain crops suited to the climate are grown. Yields of corn and rye average about 10 percent higher than on Thurman loamy sand, owing largely to the greater stability and higher moisture-retaining power of the topsoil in the fine sandy loam. The average yield of oats is about the same as that of corn, and barley and wheat yields do not differ greatly from those of rye.

Although fairly productive, this soil has lower water-retaining power and consequently does not produce as high yields of grain or tame-hay crops as the silty upland soils, such as the Marshall and Holdrege. In few places does it occupy more than a small part of the farm on which it occurs, and it is of little agricultural importance.

Colby silt loam.—Colby silt loam is the only silty soil of the group of excessively drained soils of the uplands and terraces. It is confined to the valley slopes and narrower ridges throughout the loess-covered uplands in the southeastern part of the county.

The relief is prevailingly rather steeply sloping, and the soil has been subjected to considerable erosion which has greatly thinned and in some places removed the upper layer, but only a negligible part of the land is as yet too rough for cultivation.

The topsoil, which averages 6 inches in thickness, ranges from dark grayish brown to very dark grayish brown. It consists largely of silt but contains a rather high percentage of very fine sand. The material is ordinarily friable, but it becomes moderately compact if worked when wet. In most places it contains a moderate supply of organic matter, but this decreases rapidly with depth and is practically absent below a depth ranging from 14 to 18 inches. Below a depth of 10 or 12 inches the subsoil is light-gray floury silt with a high lime content.

The soil presents some local variations, chiefly in the thickness and texture of the topsoil. This layer is invariably thicker and darker on the more gradual slopes than on the steeper slopes. In small patches and narrow strips, especially at the bases of slopes where colluvial material has accumulated, the topsoil may contain an abundance of organic matter washed from higher levels and may attain a thickness of 10 or 12 inches. In these localities the topsoil is generally very dark and does not differ materially from the corresponding layer of the Holdrege and Marshall soils. On the steeper hillsides, where erosion is most severe, the topsoil is removed in spots and the light-colored parent loess is exposed. Locally around the margins of this soil, adjoining areas of more sandy land, the topsoil has received considerable wind-blown sand and is slightly coarser, approaching very fine sandy loam in texture. These variations, however, are not sufficiently extensive to warrant separation on a map of the scale used in this survey.
Although this soil has an uneven surface and the land is subject to rather severe erosion if not carefully managed, the silty texture gives it a higher moisture-retaining power than any other soil of this group. This soil does not return such high yields of most crops as the Holdrege and Marshall soils of the smoother uplands, but it is more productive than any of the sandy upland soils in the county, and practically all of it is under cultivation. Corn, as on all the cultivated soils, occupies the leading acreage and yields about 25 bushels an acre during an average year. Wheat, oats, rye, barley, and alfalfa are grown. Alfalfa yields about as high as on Holdrege silt loam, but small-grain yields range from 5 to 10 percent below those obtained on that soil. Unless the Colby soil is carefully managed, the thin topsoil, most of which lies above the average depth of tillage, is rapidly removed by erosion when the soil is cultivated, and the land may become so gullied that it cannot be farmed.

Included with Colby silt loam on the soil map, owing to their small extent and local distribution, are several small bodies of Colby fine sandy loam, most of which are on the sandy divide between Cedar River and Clear Creek in the southeastern part of Clear Creek Precinct. Few of them exceed 60 acres in size, and most of them are much smaller. Their combined area is only about 200 acres. In these bodies the loessial material, which probably lies at a considerable depth beneath the Valentine soils and dune sand over much of the sandy uplands, has been modified at the surface but is not deeply covered by sandy deposits. The 6- or 8-inch topsoil is composed largely of loose gray sand and ranges in texture from fine sandy loam to loamy sand. The rest of the soil consists of very light colored, limy, and practically sand-free silt similar to that beneath Colby silt loam. All these included areas are under cultivation, but they occupy only a small part of the farms on which they occur and are of no great agricultural importance. Most of them are used for corn, because the topsoil, as a rule, is a little too sandy for small-grain crops. Corn yields are about the same as those obtained on typical Colby silt loam.

O'Neill loamy sand.—O'Neill loamy sand is confined to a few small bodies on sandy terraces along Cedar River and Beaver and Clearwater Creeks. The terraces are nearly level and lie 10 or 12 feet above the bottom lands. Surface drainage channels are not established, but underdrainage is thorough throughout and in most places is excessive, owing to the porous character of the terrace material.

The topsoil, which extends to an average depth of 10 inches, is a very dark grayish-brown loose mixture of medium, fine, and very fine sand, containing different but generally low amounts of silt and clay. In most places the texture is loamy sand, and the material is rather incoherent, especially under cultivation. Locally it may contain sufficient fine mineral clay to stabilize the sand and give the material a fine sandy loam texture. The topsoil contains an abundance of organic matter, as indicated by its dark color.

The subsoil, which extends to a depth beyond 4 feet, is composed of loose incoherent sand. It is dark brown in the upper 8 or 10 inches of the layer which is stained by organic solutions washed down from the topsoil, but it is gray or very light brown below
an average depth of 20 inches. Neither the topsoil nor the subsoil contains sufficient lime to cause effervescence when acid is applied.

Practically all of this land is under cultivation. Its unstable topsoil renders it poorly suited to small-grain crops, except rye, which is grown to a slight extent for grain and for late-fall and early-spring pasture. Corn occupies about 90 percent of the land, and most of the remainder not in rye is used for sweetclover and for farm gardens. Owing to its porous sandy character, the soil has a low moisture-retaining power, and in dry years all crops produce low yields, but in seasons of normal or high precipitation corn and rye yield about the same as on Thurman loamy sand of the uplands. Sweetclover in all except the driest years yields a ton or more of hay an acre.

A loamy sand, which differs somewhat from O'Neill loamy sand, occupies a few small bodies on sandy terraces along Cedar River and Clear Creek. Its total area does not exceed 250 acres, and for this reason it has been included with O'Neill loamy sand in mapping. It has about the same relief and drainage conditions as typical O'Neill loamy sand and is identical with that soil in all other characteristics except the color and thickness of the topsoil. This layer is thinner and lighter colored in the included soil which is composed largely of gray incoherent sand from the surface downward. The topsoil, which in few places exceeds 5 inches in thickness, contains barely sufficient organic matter to give it a brown or light-brown color. Practically all this included soil is under cultivation. The same crops are grown on it as on typical O'Neill loamy sand, but yields are a trifle lower. In counties where this light-colored soil is more extensive, it is classed as Sparta loamy sand.

Rough broken land.—Rough broken land occupies a few small bodies in the southern parts of Keuka and Mud Creek Precincts. This land was formerly Colby silt loam, but it has been so severely carved and gullied by erosion that it is unsuited to cultivation. In most places the topsoil has been almost or entirely removed, and exposures of the white limy loess are numerous.

All this land is used for grazing purposes. It is covered with a good growth of nutritious pasture grasses, chief among which are big bluestem and grama. These grasses will support a cow or a horse on each 2 or 3 acres during the summer grazing season.

SOILS OF THE BOTTOM LANDS AND POORLY DRAINED UPLANDS

The soils of the bottom lands and poorly drained uplands include the Cass, Sarpy, Lamoure, and Wabash soils of the bottom lands and the Gannett soil of the uplands. The greater part of each soil in this group is characterized by a high water table and rather poor underdrainage. In most areas the water table rises to the surface of the ground, in places creating small patches of marshy land, especially during early spring or following prolonged periods of rainy weather. Some of the bottom-land soils in the valleys of Clearwater Creek and Cedar River, however, are sufficiently well drained for certain cultivated crops.

The high moisture content of these soils has promoted a luxuriant growth of grass and rapid decay of vegetation. All soils of the group, except the Sarpy which occurs on the most recently deposited
alluvial sediments, have very dark—many of them almost black—topsoils, owing to an abundance of well-decayed organic matter. The Lamoure and Wabash soils are composed largely of silt or mixtures of silt and clay, and the Cass, Sarpy, and Gannett soils consist chiefly of loose porous sand, especially in their subsoils. Aside from the Wabash and Gannett soils, which are rather low in lime, the soils of this group are very limy.

Owing to poor drainage, the greater part of the area occupied by these soils is used for the production of wild hay. The native grasses nearly everywhere will produce from three-fourths to 1 ton of hay an acre, and, in many fields where timothy and clover seed have been sown among the wild grasses, yields of hay exceeding 1¾ tons an acre have been obtained. Hay from the native grasses alone on these soils is much coarser and has a somewhat lower feeding value than hay produced on the better drained soils of the uplands and terraces, but its high yield tends in large measure to offset its inferior quality. When mixed with a large quantity of timothy and clover, the hay from the poorly drained soils is as nutritious, ton for ton, as any produced in the county.

Where drainage is adequate the soils of this group are used for corn and alfalfa, which return higher yields than on any other soils in the county. Practically none of these soils is used for small-grain crops. These crops grow well where the soil is not too wet for cultivation, but they mature late, yield low, and frequently produce weak stems which break and fall during windy weather.

**Cass loamy sand.**—Cass loamy sand is the most extensive soil of this group. It occurs on the flood plains along all the streams throughout the sandy uplands. The largest developments are in the broad sandy bottoms along Beaver and Clearwater Creeks. The relief is nearly level or very gently undulating in most places. Locally it may be a little hummocky, but in few places does the range in relief in any particular locality exceed 2½ feet.

This soil has developed from sandy material carried in by the streams and deposited on their flood plains or blown in from the higher lying Valentine soils and the dune-sand areas. The water table is everywhere within 6 feet of the surface of the ground, even during dry seasons. It rises in the spring and following prolonged periods of rainy weather, causing small patches of land in the lower situations to become marshy. Practically none of the soil is subject to overflow from the streams.

This soil as a whole is a little too moist for the profitable production of grain and tame-hay crops, except such as are able to adjust their root systems to the moist conditions. Most of it lies higher and is better drained than the other bottom-land soils of the county. Rather large areas, mainly along Clearwater Creek, are under cultivation.

The topsoil, which averages about 10 inches in thickness, consists chiefly of loose fine sand, but it contains so much well-decayed grass remains that it is everywhere very dark and in places is almost black. The subsoil, which is moderately limy, is composed of incoherent gray sand containing numerous rust-brown streaks, splochtes, and stains. In most places this layer extends to a depth exceeding 3 feet with little change, but locally, in the more poorly drained situa-
tions, it contains a horizontal layer of pale-blue or pale bluish-green wet sticky clay from 2 to 4 inches thick.

If adequately drained practically all this soil could be used for the production of grain and tame-hay crops, particularly corn, sweetclover, and alfalfa. Artificial drainage would, over much of the soil, necessitate such an elaborate system of long deep ditches as to be impractical. Under present conditions timothy and clover do well, even in the rather poorly drained localities, and many farmers either have plowed the land for pure stands of these crops or have sown timothy and clover seed among the native grasses. Corn or alfalfa occupy nearly all the higher lying and better drained areas, where they return higher yields than are obtained on any of the upland or terrace soils. During most years, corn yields about 45 bushels and alfalfa about 3½ tons an acre. Some sweetclover is grown, mainly for pasture. This soil is a little too moist, especially in the subsoil, for good yields of small grains. In addition the topsoil is composed largely of sand which does not form a sufficiently compact seedbed. It is a little too unstable for small-grain crops.

Most of this soil remains with its native covering of grasses and is used for wild-hay land. The virgin areas support luxuriant growths of big bluestem and needlegrass, where drainage is adequate, and canary grass, sloughgrass, and pony grass in the lower places. During average years these grasses will yield about three-fourths of a ton of hay on each acre. In localities where considerable timothy and clover grow among the native grasses, hay yields exceeding 1 ton an acre are common.

**Cass fine sandy loam.**—Cass fine sandy loam differs from Cass loamy sand chiefly in that its topsoil contains more silt and is a little firmer and more stable than the corresponding layer in the loamy sand. It occupies bottom lands along streams throughout the more sandy parts of the county, where it is intricately associated with Cass loamy sand. Most of it lies slightly lower, is more poorly drained, and supports a heavier grass cover than the loamy sand. The hay from the wetter situations is coarser, however, and has a lower sale value than that obtained from places where moisture is not so abundant. The heavier yields of hay on Cass fine sandy loam are offset by the superior quality of the hay obtained on Cass loamy sand. The recognition of this relationship has caused many farmers to feed the hay produced on the wetter soil and to sell that obtained on the drier one. Some farmers have greatly improved the quality of the grasses on Cass fine sandy loam by the addition of timothy and alsike clover, both of which seem to thrive in rather poorly drained localities.

Only a small part of this soil, including that in the higher lying and better drained situations, is under cultivation. Where adequate drainage is assured, the soil is admirably suited to corn and alfalfa and, as a rule, returns slightly higher yields of these crops than does Cass loamy sand. Most of it is used for the production of native hay.

**Cass fine sandy loam, heavy-subsoil phase.**—The heavy-subsoil phase of Cass fine sandy loam includes all the Cass soils in which the upper part of the subsoil is abnormally compact. It occupies numerous small bodies in the sandy bottom lands, mainly along Clearwater and Beaver Creeks. Few bodies exceed 80 acres in size,
and most of them cover less than 40 acres. Practically all of them occupy slightly depressed situations within areas of other Cass soils. All the land of this phase is poorly drained. Much of it occurs in or near areas which are temporarily marshy, and the water table in few places is more than 3 feet beneath the surface of the ground.

This soil varies from place to place. The topsoil ranges from less than 6 to about 12 inches in thickness, averaging somewhat thinner than that in the other Cass soils. In most of the bodies it consists of almost black fine sandy loam with a high organic-matter content. The texture of the topsoil ranges from very fine sandy loam to loamy sand. In some spots accumulations of so-called "alkali" have destroyed most of the organic matter. Here the upper part of the topsoil is gray, and the lower part is darker.

The upper layer of the subsoil, which ranges from 6 to about 12 inches in thickness, is composed largely of sand, but it contains some silt and clay and an abundance of organic matter. It is everywhere more compact than the material above or below and is as dark or darker than the topsoil. The density and color of the material differ somewhat in different localities. The layer is usually darkest—in many places jet black—but only moderately compact where it underlies a comparatively thick and dark-colored topsoil, whereas in many places it is brown and extremely dense beneath the lighter colored and thinner topsoils of the alkaline spots. Its compaction and dark color are due to an accumulation of clay and organic matter washed down from the topsoil.

The material beneath the compact layer is loose gray sand containing rust-brown stains and, locally, bluish-green clay seams. It is similar to that which composes the subsoil of the other Cass soils. In most places the entire soil is limy, especially that part below a depth of 8 or 10 inches.

On account of its poor drainage, none of this land is suited to cultivated crops. It supports a rank growth of water-loving grasses and is used for native-hay land, except some of the alkaline spots on which vegetation is rather sparse. The grasses on most areas will produce slightly over three-fourths of a ton of hay an acre in average years. The hay is rather coarse, but it makes good winter feed for cattle and horses, especially if it contains some clover and timothy.

**Cass very fine sandy loam.**—Cass very fine sandy loam occupies small scattered bodies surrounded by other Cass soils on the sandy bottom lands along all the main streams. The largest developments, few of which exceed 200 acres in size, are along Beaver and Clearwater Creeks. Most of the bodies occupy less than 80 acres.

This soil, in common with all Cass soils, is composed largely of sand. It occupies lower positions than the other Cass soils, except the heavy-subsoil phase of Cass fine sandy loam, and, although seldom covered with water, it is usually saturated, especially during the early part of the growing season.

The 10-inch topsoil is very friable but is finer textured than that of the other Cass soils, owing to a higher percentage of silt and clay mixed with the sand. It contains an abundance of black well-decayed organic matter which gives the material a dark color and, together with the fine mineral constituents, produces a very fine sandy loam or loam texture. The subsoil consists of loose rust-
streaked gray sand similar to that in the other Cass soils. It is almost continually saturated with water.

Practically all this soil is used for native-hay land. It supports a dense growth of coarse moisture-loving grasses which yield about 1 ton of hay an acre in average years. The hay is not so marketable as that obtained from better drained soils and is used chiefly as feed for cattle during the winter.

Sarpy sand.—Sarpy sand occupies several small bodies, nearly all of which are in the Cedar River bottom lands, mainly on the south side of the stream. The bodies lie near or adjacent to the stream channel, and few of them exceed 10 acres in size.

This soil consists of loose gray sand from the surface downward. The immediate surface layer, to a depth of 3 or 4 inches, contains a little organic matter, which makes it slightly darker than the rest of the soil, and, owing to poor drainage, the sand below a depth of 12 or 14 inches is, in most places, more or less stained with rust brown.

The relief is nearly level. This soil lies from 2 to 3 feet above the stream channel, and the lower part is almost continually saturated. The topsoil is extremely unstable and subject to drifting when the native grasses are destroyed.

All this soil is included in pasture or hay land. It supports a fairly dense growth of nutritious grasses which will yield about one-half of a ton of hay an acre. It comprises only a small part of the farms on which it occurs and is of little agricultural importance.

Lamoure fine sandy loam.—Lamoure fine sandy loam occupies several small bodies in the bottoms of Clearwater Creek southwest of Deloit and occurs here and there in the bottom lands along Clear Creek near Pible Lake. Few of the bodies exceed 160 acres, and most of them are less than 80 acres in size. All areas of this soil are within or adjacent to areas of sandy Cass soils.

This soil has developed from fine-textured sediments composed largely of silt or silt and clay mixtures, containing only a small percentage of sand. The occurrence of silty material within areas of bottom-land soils which are predominantly sandy, is not clearly understood. Most of the silt, although greatly affected in appearance by poor drainage, resembles loess. It may have been carried to its present position as sediment from loessial upland areas and thinly covered with sand. On the other hand, it may represent fine material which has been removed from the sand by the assorting power of the streams and deposited in ox bows, ponds, or other places throughout the bottom lands wherever the water was unusually sluggish.

The relief is nearly level, and the soil lies only a few feet above the stream channels. It is not subject to overflow but, owing to seepage from the higher lying sandy uplands, is almost continually saturated to a depth ranging from 20 to 30 inches. During wet seasons the water table rises and in spots produces marshy conditions.

The 8- to 12-inch topsoil is very dark or almost black friable fine sandy loam. The subsoil is light colored and very limy, and in most places it contains numerous rust-brown, white, and dark-gray seams, streaks, and splotches. To a depth of about 3 feet
it consists chiefly of silt but contains sufficient sand to give it a slightly gritty feel. The rest of the subsoil is composed of loose rust-streaked sand similar to that beneath the Cass soils.

Practically all of this soil is included in hay land. It supports a luxuriant growth of coarse moisture-loving grasses which yield about a ton of hay an acre in average years. The soil is of such small extent and local occurrence that it is of little importance in the agriculture of the county.

Wabash silt loam.—Wabash silt loam occupies a few short narrow strips on the valley floors of intermittent drainageways in the southeastern corner of the county. The land is smooth, except that part occupied by the drainage channel which has vertical banks from 3 to 5 feet high. Both surface drainage and underdrainage are good, except for a short time during and immediately following a heavy rain, when water may overflow the narrow valley floor.

This soil has developed from silt washed from the adjoining loessial uplands and deposited in the valleys. It consists largely of the topsoil from areas of Holdrege soil and is very dark to a depth exceeding 3 feet. The moist condition prevailing in the bottoms has favored the rapid growth and decay of vegetation, and the topsoil has accumulated much organic matter in addition to that carried in from higher land. This layer, which ranges from 12 to 18 inches in thickness, consists of almost black friable silt loam or very fine sandy loam. The rest of the soil is only slightly lighter in color than the topsoil, but it is more compact, especially in the upper foot or two, which contains considerable clay and has a silty clay loam texture. The compaction, although noticeable, is only moderate and does not interfere with root development or the free movement of soil air and moisture. Below an average depth of 3 feet the subsoil is very friable. It remains dark to a depth exceeding 5 feet, where it grades into either gray or pale-red loess, depending on the depth of the valley. The red loess occurs only in the deeper valleys.

This soil differs from the Lamoure soil chiefly in that its subsoil is darker and less limy. It is not deficient in lime, however, and in most places below a depth of 5 feet contains an abundance of this material.

Wabash silt loam, where well drained and not subject to overflow, is one of the most productive soils in Nebraska, especially for corn and alfalfa. Practically all of it in Wheeler County is under cultivation and is used for these crops. Yields, especially of corn, are rather uncertain, owing to the danger of overflow, but in favorable years corn yields from 50 to 60 bushels an acre, and alfalfa about 4 tons of hay.

Gannett loamy sand.—Gannett loamy sand occupies small bodies in the lower parts of many pockets and swales throughout the dune-sand and Valentine soil areas. The bodies are most numerous in Francis and Fremont Precincts. Few exceed 10 acres in size, and most of them occupy only a few square rods.

Bodies of this soil have no surface drainage outlets and are locally known as wet hay meadows. The moisture received by them as seepage from the surrounding higher land or as precipitation is forced to seek outlet through downward percolation. Most of the land remains wet or very moist the greater part of each year.
The topsoil is very dark—in places almost black—loose loamy sand ranging from 8 to 14 inches in thickness. In a few bodies it contains so much organic matter in various stages of decay that it is rather spongy and appreciably light in weight. The subsoil consists largely of loose gray sand similar to that beneath the Valentine soil and dune-sand areas, except that it contains numerous rust-brown splotches, spots, and streaks, owing to poor drainage. It is further modified in nearly all bodies by a horizontal layer, ranging from 2 to 10 inches in thickness, of pale bluish-gray or pale greenish-gray sticky plastic clay. This layer may lie at any depth between 2 and 6 feet. It is known by soil scientists as the glei layer.

Gannett loamy sand resembles Cass loamy sand. As a rule it is more poorly drained than the Cass soil, and its subsoil is in general more stained with iron. The glei layer is more often present and is usually thicker in the Gannett soil than in the Cass soil.

The grass cover on the Gannett soil is about the same as that on Cass loamy sand, and hay yields average about the same. On account of its small extent, the Gannett soil is of little agricultural importance and is all included in pasture or hay land.

SOILS AND THEIR RELATIONSHIPS

The soils of Wheeler County as a whole are immature. All the county, except a few square miles of loess-covered land in the eastern and southeastern parts, is in the sand-hill section of the State. In this section the soils are composed largely of gray incoherent quartzitic sand, and the more extensive soils consist almost entirely of it. The sand is everywhere extremely resistant to weathering and, over most of the area of its distribution, is rather unstable and subject to considerable wind erosion. The greater part of it is low in organic matter and lime, and it has made little progress toward soil development.

In the loess-covered parts of the county the soils have been little affected by wind, but in the southeastern part, where the loess is most extensive, much of the land has been subjected to rather severe water erosion which has created numerous shallow but rather steep-sided drainageways in the loose loessial deposit. Here the run-off on the valley slopes removes the organic matter and other products of soil development faster than on the more nearly level land. As the run-off is greater on steep slopes than on level areas, less water is available for the growth of grasses. Since the grasses are largely responsible for the processes of soil development in this area, less soil is formed on the slopes. It is for this reason and because of the greater erosion that the parent loessial material is at or near the surface of the ground on the steeper slopes.

All the soils have developed under a grassy vegetation, but the luxuriance of the grass growth and the amount of organic matter returned to and retained by the soil when the grasses decay differ widely in different soils, according to variations in moisture conditions and the severity of wind or water erosion. As previously mentioned, the more extensive soils of the sand hills and the sloping soils of the loess-covered uplands are, owing, in part, to wind and water erosion, low in organic matter. They are consequently rather light in color. Light-colored soils, resulting from a low content of organic
matter, also occur locally on the more sandy terraces and bottom lands, especially in places where the sands have been very recently deposited. Soils with dark surface layers are the rule wherever the parent soil material has lain in its present position undisturbed by erosion for a considerable period. They occur throughout the more nearly level and less eroded parts of the loessial uplands, or loess-covered terraces, and throughout the sand-hill parts of the county wherever the soils have been protected from excessive wind erosion during their development.

The darkest soils are in the bottom lands and in some of the pockets and swales throughout the sand hills. Most of them have developed under excessive moisture which has promoted an unusually rank growth of grass and rapid decay of vegetation. Here the A horizons nearly everywhere contain at least 4 or 5 percent of organic matter and are very dark—in many places almost black. In local spots, comprising the lower lying and more marshy areas, they are composed largely of organic matter and plant remains and are appreciably light in weight. The B horizons of the poorly drained soils are, as a rule, low in organic matter and light in color but generally contain rust-brown streaks, spots, and splotches, owing to poor drainage. In many places, especially in the more sandy soils they also contain a thin glei horizon of pale bluish-green sticky clay which is probably the result of the high water table, anaerobic conditions, and the presence of proteoxides of iron.

The more nearly level, though well-drained, loess-derived soils of the uplands and terraces have reached the most advanced stage of development, as governed by the climatic and vegetative environment. Their topsoils are not quite so rich in organic matter as those in some of the more poorly drained soils, but they contain an abundance of this material and are very dark grayish brown. The subsoils are dark brown in the upper part and become gradually lighter in color with depth. They have developed under good drainage and aeration and do not have the rust-brown streaks, spots, and splotches or the glei horizon characteristic of the Wiesenboden.

Wheeler County is in a section where the mean annual precipitation, about 22 inches, is insufficient to penetrate the well-drained finer textured soils to a greater depth than about 4 feet. In such soils the readily soluble salts, chiefly lime carbonate, accumulate at about this depth, forming a layer of higher lime content than occurs in any other part of the soil profile. This lime zone is not present in well-drained sandy soils or in well-drained loess-derived soils which rest on sand within a depth of 4 feet. Because of their comparatively low resistance to percolation by water, these soils have greatly increased the efficiency of the process of removal of carbonates and are leached of their lime to a depth exceeding 9 feet.

Nearly all the poorly drained soils are limy, regardless of their texture or thickness. These soils, however, are continually receiving dissolved carbonates in the run-off from higher levels, and the lime which they contain is rather evenly distributed throughout the soil profile. None of them has a definite lime zone.

Following is a description of a profile of Holdrege silt loam, a Chernozem soil, observed on a well-drained smooth-topped divide on the loessial uplands in the southeastern corner of the county. This soil has formed on a thick loessial deposit, under good drainage and
in the absence of injurious erosion. Its features are believed to be the result of normal soil development, as governed by the regional climate and vegetation.

The 7-inch surface layer is very dark, almost black when wet, friable silt loam. To a depth of about three-fourths of an inch the material is structureless or mulchlike. The material in the next 3 inches is faintly laminated, and the rest of the surface layer is composed of soft irregular-shaped granules about one-eighth of an inch in diameter. From 7 to 18 inches the soil material is dark grayish-brown granular silt loam. It has a slightly higher clay content than the layer above, and the granules are a trifle firmer. They average larger than those in the overlying layer, ranging up to one-fourth of an inch in diameter. From 18 to 40 inches the material is grayish-brown silty clay loam of cloddy structure and poorly developed prismatic form. It is a trifle denser than that in any other layer of the soil profile, but the increased compaction is scarcely noticeable. From 40 to 48 inches the material is light grayish-brown cloddy or structureless silt loam which retains the poorly developed prismatic form but is very friable and seems to be transitional in character between the overlying and underlying layers. Between 48 and 72 inches is the lime zone. Here the prismatic form is not discernible, and the material is structureless. The material in this layer consists of very light grayish-brown friable silt loam containing an abundance of lime in spots, splotches, soft and hard concretions, and in finely divided form. The lime zone is underlain by grayish-yellow floury loess which is very limy but contains only a few spots in which the carbonates are visibly concentrated.

All transitions in color, texture, and structure between the different layers are gradual. The upper part of the soil profile is well supplied with organic matter which, to a depth of about 7 inches, is rather evenly mixed with the mineral mass, but below this depth it occurs chiefly as a film or coating on the surfaces of the structure particles. The film decreases in thickness with depth, and below a depth of 40 inches the soil is practically devoid of organic matter. Insect casts are numerous between depths of 6 and 21 inches. In the layer of maximum density there are many borings in the shape of crooked rodlike forms about one-fourth of an inch in diameter and of various lengths. The borings appear to be old root, worm, or insect holes which have become filled with soil material. They are in general a trifle lighter or darker in color than the matrix in which they lie.

All the Holdrege and Hall soils of this county have profiles similar to the one described, with the exception of slight differences in the texture, thickness, and compaction of the different layers. These soils have developed from loessial deposits exceeding 5 feet in thickness, and they have well-developed lime zones. The Hall soils occupy terraces.

The Marshall soils have developed from loessial material and resemble the Holdrege and Hall soils, especially in their upper soil horizons. The loessial material, which is unusually thin in the localities where these soils occur, rests on sand above the depth of moisture penetration, and the soil material has been leached of its lime.
The absence of a zone of lime enrichment has made it necessary to place these soils with the Prairie group rather than the Chernozem. The Colby soil is very immature. It has developed from loess of considerable thickness, but it occupies steep slopes where run-off is rapid, and it therefore has accumulated very little organic matter. The topsoil ordinarily is fairly dark, but in few places is it more than 5 or 6 inches thick. Over much of the Colby soil it is directly underlain by unweathered or only slightly weathered limy loess. In many spots the topsoil has been entirely removed by erosion, and the almost white parent loess is exposed.

The other soils of the uplands and terraces are composed largely of sand, from which all lime has been leached. The O'Neill and Thurman soils, which are fairly stable, have reached a rather advanced stage of development. The thin topsoils are dark, owing to an abundance of organic matter, and the upper subsoil layers are well oxidized and of a brownish color. The lower part of the subsoil consists of loose gray sand. The Thurman soils are in the uplands, and the O'Neill soils are on terraces.

The Anselmo and Valentine soils are low in organic matter and light in color from the surface downward. They consist mainly of sand, although the Anselmo soil contains sufficient silt to make it fairly coherent. The Valentine soils are very unstable. None of these soils shows definite layers, or horizons, of true soil development.

The soils of the bottom-lands or flood-plains are very young, having developed on rather recently deposited stream sediments. They range from light to dark in color and from sand to silt in texture, depending on the character and organic-matter content of the sediments composing them. All, except the Wabash soil, are moderately limy, but none has a lime zone. The topsoils of most of them are very dark, owing to large accumulations of organic matter produced by the rapid growth and decay of vegetation under the moist bottom-land conditions. The Sarpy soil, however, which is composed of the most recently deposited sand, is light colored, even at the surface.
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