Soil Survey
of
Rock County, Nebraska

By
W. D. LEE, in Charge, F. A. HAYES, and S. R. BACON
United States Department of Agriculture
and
R. L. GEMMELL
Nebraska Soil Survey

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

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - Price 40 cents
## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>County surveyed</td>
<td>4</td>
</tr>
<tr>
<td>Climate</td>
<td>7</td>
</tr>
<tr>
<td>Agriculture</td>
<td>9</td>
</tr>
<tr>
<td>Soils and crops</td>
<td>15</td>
</tr>
<tr>
<td>Soils adapted to grain farming</td>
<td></td>
</tr>
<tr>
<td>Thurman loamy fine sand</td>
<td>17</td>
</tr>
<tr>
<td>Thurman fine sandy loam</td>
<td>18</td>
</tr>
<tr>
<td>O'Neil loamy fine sand</td>
<td>19</td>
</tr>
<tr>
<td>O'Neil fine sandy loam</td>
<td>20</td>
</tr>
<tr>
<td>O'Neil sandy loam, upland phase</td>
<td>20</td>
</tr>
<tr>
<td>Ewing loamy fine sand</td>
<td>21</td>
</tr>
<tr>
<td>Ewing fine sandy loam</td>
<td>22</td>
</tr>
<tr>
<td>Ewing fine sandy loam, deep phase</td>
<td>22</td>
</tr>
<tr>
<td>Marshall fine sandy loam, sandy-substratum phase</td>
<td>23</td>
</tr>
<tr>
<td>Waunakee loam</td>
<td>24</td>
</tr>
<tr>
<td>Holt fine sandy loam</td>
<td>24</td>
</tr>
<tr>
<td>Boyd clay loam</td>
<td>25</td>
</tr>
<tr>
<td>Soils adapted to hay farming</td>
<td>26</td>
</tr>
<tr>
<td>Case loamy fine sand</td>
<td>27</td>
</tr>
<tr>
<td>Case loamy fine sand, heavy-subsoil phase</td>
<td>27</td>
</tr>
<tr>
<td>Case fine sandy loam</td>
<td>28</td>
</tr>
<tr>
<td>Case loam</td>
<td>29</td>
</tr>
<tr>
<td>Case and Valentine loamy sands, undifferentiated</td>
<td>29</td>
</tr>
<tr>
<td>Gannett loamy fine sand</td>
<td>30</td>
</tr>
<tr>
<td>Sarpy fine sand</td>
<td>30</td>
</tr>
<tr>
<td>Lamoure fine sandy loam</td>
<td>31</td>
</tr>
<tr>
<td>Soils adapted to grazing</td>
<td>31</td>
</tr>
<tr>
<td>Valentine sand</td>
<td>32</td>
</tr>
<tr>
<td>Valentine loamy sand</td>
<td>33</td>
</tr>
<tr>
<td>Sparta sand</td>
<td>33</td>
</tr>
<tr>
<td>Boyd clay loam, steep phase</td>
<td>33</td>
</tr>
<tr>
<td>Boyd loamy sand, steep phase</td>
<td>34</td>
</tr>
<tr>
<td>O'Neil loamy sand, upland phase</td>
<td>34</td>
</tr>
<tr>
<td>Holt loamy fine sand</td>
<td>35</td>
</tr>
<tr>
<td>Dune sand</td>
<td>35</td>
</tr>
<tr>
<td>Rough broken land</td>
<td>36</td>
</tr>
<tr>
<td>Soils and their interpretation</td>
<td>37</td>
</tr>
<tr>
<td>Map</td>
<td></td>
</tr>
</tbody>
</table>
SOIL SURVEY OF ROCK COUNTY, NEBRASKA

By W. D. LEE, in Charge, F. A. HAYES, and S. R. BACON, United States Department of Agriculture, and R. L. GEMMELL, Nebraska Soil Survey

INTRODUCTION

Rock County, situated in north-central Nebraska, is in the black soil region of the United States. It has a continental climate characterized by rather low, though well-distributed, rainfall and a moderate mean annual temperature, with cold winters and warm summers. The native vegetation consists almost entirely of grasses, with some forest growth in a few of the stream valleys. The climatic conditions are not altogether favorable for diversified farming, and most of the soils are either too coarse and unstable or are too poorly drained for cultivated crops. They are used for wild-hay or pasture land.

The county is part of a constructional plain ranging from nearly level to hilly, which has developed largely on light-colored sandstone of Tertiary age, but which is nearly everywhere mantled by sand or a mixture of sand and gravel, of varying thickness. Niobrara River, which forms the northern boundary, has cut through the sands, gravel, and Tertiary bedrock and is deeply entrenched in the underlying somewhat blue shale known as Pierre shale. The severe erosion coincident with this entrenchment has produced several narrow strips of extremely rough and broken land on the valley sides along the river and some of its tributaries.

Throughout most of the southern three-fourths of the county and over part of the northern one-fourth, the sand has been whipped by the wind into dunes ranging from 20 to 100 feet in height. These rather unstable dune-covered areas, known as “sand hills”, include numerous valleys, pockets, and swales, many of which lie near the ground water level and contain small lakes, ponds, and marshes.

Throughout the greater part of a large roughly triangular shaped area of sandy land, extending southeastward from the north-central part of the county, the water table lies near the surface of the ground and the soil remains saturated or extremely moist during most of each year.

Although this county is in the Chernozem soil region of the United States, its more extensive soils are so unstable and have been subjected to such constant wind erosion that they have accumulated very little organic matter and are prevailingly light in color. Practically none of these light-colored soils is suited for cultivated crops. The poorly drained soils are dark, and some of them are well suited to certain tame-hay crops, but they are much less extensive than the light-colored soils, and practically none of them can be

¹ Report written by F. A. Hayes.
profitably used for grain production. The only soils containing an abundant supply of organic matter and in addition are sufficiently stable and well drained for the production of grain crops occupy small nearly level bodies, chiefly in the northern one-fourth of the county. In most of these bodies the soil is rather sandy and somewhat droughty, but in some it is composed largely of silt or clay and is highly retentive of moisture. The combined area of all bodies in which the soils are suited to grain crops is not large, and these soils are of minor importance in Rock County.

On the bases of soil characteristics and other features that affect agriculture, the soils may be grouped in three broad classes, according to their most general use, namely, grazing, hay farming, and grain farming.

The group of soils adapted to grazing, which occupies 72.6 percent of the area of the county, includes all the Valentine and Sparta soils, the rougher and more sandy types of the Boyd and Holt soils, and the upland phase of O'Neill loamy sand, in addition to dune sand and rough broken land, which are land types not classed as soils. With the exception of the Valentine and Sparta soils, which are nearly level or rolling, all members of the group have strongly rolling or extremely rough and broken relief. Dune sand is the second most extensive land type, and it consists almost entirely of loose gray sand; the Valentine and Sparta soils also are composed largely of sand; the Holt soil and rough broken land have developed on the light-colored (Tertiary) sandstone of the region; the Boyd soils on the bluish-colored Pierre shale; and the upland phase of O'Neill loamy sand is composed largely of gravel. No member of this group has developed much true soil material, and practically all these soils include numerous outcrops of the unweathered or only slightly weathered geological material from which they are forming. Sufficient organic matter has accumulated in the O'Neill, Holt, and Boyd soils to make their surface layers rather dark in most places, but the other members of the group are characterized by moderately to extremely light-colored surface layers.

The greater part of the area occupied by this group of soils is used for pasture land in connection with the raising of livestock, chiefly beef cattle.

The soils of the group adapted to hay farming occupy 20.7 percent of the area of the county and include the Cass, Sarpy, Lamonre, and Gannett soils, of which the Cass are by far the most extensive. In all these soils, except the Sarpy, which are light colored, large quantities of well-decayed organic matter have accumulated, and the topsoils are thick and dark. Aside from the Lomoure soils, which are silty or clayey, these soils are composed largely of sand, although in some of them the sand immediately beneath the topsoil is cemented with clay and organic matter, forming a moderately or extremely compact layer in the upper part of the subsoil. In some spots the soils of this group are very alkaline.

The greater part of the area occupied by the soils of this group is too wet to be used for grain crops, but these soils rank among those most productive of native hay in Nebraska, and they all sup-
port a rank growth of moisture-loving grasses which in normal years will yield from three-fourths to 1 ton of hay an acre. Some of them are also well suited, in places, to tame-hay crops, including red clover, alsike, white clover, and mixtures of timothy and clover.

The soils suited for grain production occupy only 6.7 percent of the area of Rock County. They include the Thurman, Ewing, Marshall, Waukesha, and O'Neill soils (with the exception of O'Neill loamy sand, upland phase), and the finer textured and more nearly level areas of the Boyd and Holt soils. All these soils are in the uplands, except the typical O'Neill soils and Waukesha loam, which occupy terraces. They have nearly level or rolling relief, and both surface drainage and underdrainage are adequate. Most of them are in the northern part of the county.

The surface layers of the soils in this group are not quite so dark as those of the group adapted to hay, but they are much darker than the corresponding layers in any of those in the grazing group. The soils of this group, as a whole, are rather sandy and somewhat droughty, but they all contain some fine material mixed with the sand, which enables them to retain considerable moisture and prevents excessive wind erosion, provided they are carefully managed. The Thurman and typical O'Neill soils have developed on extremely sandy parent materials and are sandy throughout; the Marshall and Waukesha soils have developed on thin layers of loesslike silt underlain by sand and are fine textured only in the upper part of the soil profile; the upland phase of O'Neill sandy loam has developed over gravel and is extremely porous, especially in the subsoil; the Boyd soils, which have formed on the bluish-gray Pierre shale, have dense clayey subsoils; and the Holt soils are underlain by the light-colored bedrock of Tertiary age, which underlies the region.

The greater part of the area occupied by the soils of this group is used for corn, chiefly because corn does better than any other crop and also because it is needed for feed, but only the Marshall, Waukesha, and Holt soils are highly productive, even of corn. Oats and rye, in the order named, follow corn in acreage. Rye does fairly well on all the soils, but most of them are a little too sandy for high yields of oats.

Fruit and vegetable crops are of little importance on any soil in the county.

All the soils contribute their products to the production of cattle. Much wild hay and tame hay are sold for cash, but the greater parts of all crops are fed to beef cattle, which are the chief sources of revenue. No crop, other than hay and a small quantity of wheat, is shipped out of the county. The beef cattle are of good breeding, and most of them are raised locally. They are usually sold as feeders when 2 or 3 years old in the Omaha or Kansas City markets, and practically no cattle are fattened on grain. Horses are raised for sale on most of the farms and ranches, and the raising of horses is rapidly increasing in importance. These animals are of heavy draft types, mostly Percherons. Owing to the scarcity of corn, only a few hogs are raised.
Rock County is in north-central Nebraska (fig. 1). It is nearly rectangular, although its northern boundary is formed by Niobrara River and is somewhat irregular. The county is about 47 miles long from north to south and 52 miles wide. It comprises 998 square miles, or 638,720 acres. Bassett, the county seat, is about 165 miles west of Sioux City, Iowa.

The county is part of a former nearly level or rolling constructional plain on which stream and wind erosion have produced three physiographic divisions known to the Nebraska Geological Survey as the Holt table, the prairie plains, and the sand hills. They extend eastward into Holt County, where they are typically developed, but in Rock County most of the land surface has been so greatly modified by wind-blown sands that the Holt table and the prairie plains are poorly represented. Generally speaking, the Holt table covers approximately the northern one-fifth of the county. The relief in this section is that of an undulating or gently rolling plain modified in its western part by areas of hilly dune sand and in the northern part by the high Niobrara River terrace and narrow strips of rough land in the deep narrow valleys of Niobrara River and its tributaries. These streams have removed the surface deposits, composed largely of sands and gravels; have cut through the uppermost bedrock of the region, a gray soft sandstone of Tertiary age; and their lower valley slopes are now formed on a thick shaly formation known as Pierre shale. The valley sides are deeply gullied and constitute the roughest land in the county, but the narrow valley floors are nearly level.

The high Niobrara River terrace lies from only 10 to 30 feet below the general level of the Holt table. It extends across the county as a strip, ranging from 1 to 4 miles in width, between the main body of the table and the breaks bordering Niobrara River, and it is continuous, except where broken by strips of rough land along tributary creeks. Its relief is only a little more even than that of the Holt table proper, and were it not for its slightly lower position the terrace could scarcely be distinguished from the tableland. Its southern boundary is obliterated in many places by wind-blown sand.

The prairie plains area is just south of the Holt table. It comprises only about 15 percent of the county, occurring as an irregular-shaped but somewhat triangular body having its western apex in the vicinity of Bassett and extending eastward and southeastward into Holt County. Where typically developed, as in Holt County, this area has many of the features of sandy bottom lands, but it is much broader than would seem possible were it formed by the existing
drainage system. It occupies the greater part of several townships and in many places attains a width of more than 15 miles. The local relief in few places exceeds 5 feet. A few permanently flowing streams occur in this area, but they are small, rather tortuous, and in few places are entrenched more than 3 or 4 feet. There is an intricate system of scarcely perceptible swales through which water slowly works its way to the permanent drainageways in early spring and following long periods of rainy weather. The water table is constantly within a depth of 5 feet, and during the spring it rises sufficiently to produce a wet condition over most of the land. Even during dry periods marshes, ponds, and small shallow lakes are a characteristic feature of the landscape.

Northwestward from Holt County and extending into Rock County, the main body of the prairie plains area gradually becomes narrower, owing to the encroachment of the sand hills, although long branching tongues, ranging from one-fourth mile to more than 2 miles in width, extend back into the sand hills, many of them to a distance of several miles. The branches and tongues connect at many places, though at irregular intervals, creating an intricate network of lowland strips surrounding isolated hummocks, hills, and ridges of the typical sand hills.

The prairie plains, as previously mentioned, terminate in Rock County, and here few typical developments exceed 2 miles in width. They occur chiefly along a tributary of Elkhorn River which rises near Bassett and flows eastward joining the river in Holt County, and typical but much narrower developments lie along Elkhorn River. Elsewhere in Rock County the prairie plains area consists of a network of lowland strips of various widths surrounding higher bodies of wind-blown sand.

The sand-hill division occupies about 65 percent of the county, covering all the area outside the prairie plains and Holt table divisions and also occurring extensively as tongues and isolated outliers within these divisions. This division is best developed in the southern half of the county. Throughout it, wind has been the controlling factor in determining the relief which ranges from gently undulating to hilly. Over the greater part of this division the loose incoherent sand has been piled by the wind into dunes, ranging from 30 to 70 feet in height, which give the land a decidedly hilly appearance. Around the margins of the hilly areas are lower lying and, in most places, enclosed valleylike depressions and pockets. The land surface in the shallower depressions ranges from rolling to hummocky, but that in the deeper depressions is nearly level. The deeper pockets are poorly drained, as a rule, and many of them contain marshes and lakes.

Alluvial lands, including soils on the terraces and bottom lands, occur within each physiographic division. The largest developments are those comprising the high Niobrara River terrace previously described. Narrower strips of either terrace or bottom land, ranging from a few rods to about one-half mile in width, occur along Niobrara, Elkhorn, and Calamus Rivers and Holt, Skull, and Bloody Creeks. With the exception of the high Niobrara terrace, which ranges from 100 to 150 feet above Niobrara River, all the terraces and bottom lands are rather low. In few places are the terraces
more than 15 feet and the bottom lands more than 8 feet above the normal level of the streams along which they occur. The alluvial land is nearly level.

The main elevations of record in Rock County are along the Chicago & North Western Railway in the northern part, where the elevation at Bassett is 2,326 feet above sea level and at Newport is 2,234 feet. The average elevation of the Holt table is about 2,330 feet, and the prairie plains range from 25 to 50 feet lower. The sand hills in the southern half of the county average about 2,300 feet above sea level. The upland slopes gradually toward the south and east.

Drainage conditions are variable. Most of the land has little surface run-off, and drainage channels are poorly established or absent, but the soils are so sandy and porous that underdrainage is excessive, especially throughout the greater part of the sand hills and over much of the Holt table. The prairie plains and the lower lying depressions within the sand hills are poorly drained, and parts of the narrow flood plains along the rivers and creeks also have poor drainage, especially during early spring. The only land which has been subjected to severe water erosion is on the slopes leading to Niobrara River and its tributaries, including Long Pine, Short Pine, Sand, Coon, Laughing Water, Rock, Willow, Oak, and Ash Creeks. These creeks are swift-flowing and are deepening their channels rather rapidly. Niobrara River also flows rather swiftly, but Elkhorn and Calamus Rivers and their tributaries have low gradients and are not deeply entrenched.

Well water of good but medium-hard quality is readily obtained in most sections. The only places where it is difficult to obtain an abundant supply of well water are in the valleys of Niobrara River and its tributaries and on parts of the high Niobrara terrace. In these localities the Pierre shale formation is exposed or lies near the surface of the ground, and only a scanty supply of rather alkaline water is available in this formation. Wells on the Holt table range from 70 to 90 feet in depth and those throughout the sand hills from 150 to 170 feet. In the prairie plains area, water suitable for livestock lies within a depth of 10 or 15 feet, but most of the farm wells in this area extend to a depth ranging from 40 to 60 feet, where the water is free from impurities. There are numerous artesian wells in parts of the sand-hill division, especially in Blaine and Lay Precincts, where wells of this kind range from 180 to 200 feet in depth. They penetrate a layer of bedrock of Tertiary age, beneath which the water is held under pressure. Springs occur along nearly all streams. Most of those in the northern part of the county, at or near the contact zone of the Pierre and Tertiary formations, flow freely, but throughout the rest of the county most of them seep rather slowly from water-filled sands.

Rock County is in the prairie region of the United States, but a rather dense growth of native forest, consisting of willow, cottonwood, bur oak, western yellow pine, red cedar, basswood, walnut, elm, and ash trees occurs in the valleys of Niobrara River and its tributaries. The trees are used chiefly for firewood and posts. The native grasses in the more sandy parts of the upland consist largely

---

of *Stipa*, or needlegrass, *Redfieldia*, and sandgrass. The finer textured soils of the uplands generally support considerable grama, big bluestem, and little bluestem, and on the poorly drained prairie plains sloughgrass, panic grass, and other water-loving grasses grow luxuriantly.

Rock County was organized from a part of Brown County and established in 1888. The early settlers came largely from the East Central States. The Federal census reported 3,083 inhabitants in the county in 1890. According to subsequent census records, the population has fluctuated considerably, but by 1930 it was only 3,366, all classed as rural. The average density is given as 3.4 persons a square mile. Settlement is densest in the northern one-fourth of the county and sparsest in the sand hills. Bassett and Newport, with 635 and 273 inhabitants, respectively, are towns in the northern part, which are local markets and distributing points for farm supplies and produce. These towns are among the most important shipping points for baled hay in Nebraska.

Transportation facilities are fair. A main line of the Chicago & North Western Railway, from Omaha, Nebr., to Lander, Wyo., extends east and west across the northern part. Bassett and Newport are on this line. There is no other railroad in the county. Gravel surfaced highways cross in north-south and east-west directions, but most of the other roads are of earth construction. In the northern part most of the roads follow land lines, except in the rougher sections, where they conform to the relief. Most of them are kept in good repair. In the sand hills throughout the southern part, it is impractical to lay out roads on land lines on account of the absence of surfacing materials, the uneven relief, and the small amount of traffic. They all follow valleys wherever these are conveniently situated. Travel between the valleys is laborious over constantly shifting sands. The more traveled sand-hill roads, especially the mail routes, cross fences through "auto gaps", but most of the roads have gates on all property lines.

Rural mail delivery routes or star mail routes reach nearly all sections. Telephones are on most farms in the northern part but are less common in the sand hills. There is a well-developed public-school system.

**CLIMATE**

The climate is continental and temperate, with rather wide seasonal variations in temperature between winter and summer, but as a whole it is well suited to the raising of livestock and the production of feed crops, although many of the soils are poorly suited to grain. The springs are cool, with considerable rainy weather; the summers are long, with moderate precipitation and warm days and nights; the autumns are long and pleasant, with only occasional rains; and the winters are characterized by frequent low temperatures, usually accompanied by snow. Differences in the relief are not sufficient to cause appreciable differences in climate.

Table 1, compiled from the records of the Weather Bureau station at Newport, gives the normal monthly, seasonal, and annual temperature and precipitation, which data are regarded as fairly representative for the county as a whole.
### Table 1.—Normal monthly, seasonal, and annual temperature and precipitation at Newport, Rock County, Nebr.

[Elevation, 2,234 feet]

<table>
<thead>
<tr>
<th>Month</th>
<th>Mean temperature °F.</th>
<th>Precipitation (Inches)</th>
<th>Total amount for the driest year (1928)</th>
<th>Total amount for the wettest year (1922)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter</td>
<td>22.7</td>
<td>1.71</td>
<td>.53</td>
<td>1.91</td>
</tr>
<tr>
<td>March</td>
<td>34.1</td>
<td>1.04</td>
<td>1.78</td>
<td>2.68</td>
</tr>
<tr>
<td>April</td>
<td>47.7</td>
<td>2.23</td>
<td>1.85</td>
<td>3.68</td>
</tr>
<tr>
<td>May</td>
<td>58.2</td>
<td>3.45</td>
<td>2.23</td>
<td>2.99</td>
</tr>
<tr>
<td>Spring</td>
<td>46.7</td>
<td>6.72</td>
<td>4.26</td>
<td>8.57</td>
</tr>
<tr>
<td>June</td>
<td>67.4</td>
<td>4.03</td>
<td>3.01</td>
<td>4.02</td>
</tr>
<tr>
<td>July</td>
<td>73.9</td>
<td>3.73</td>
<td>2.71</td>
<td>4.40</td>
</tr>
<tr>
<td>August</td>
<td>71.9</td>
<td>3.05</td>
<td>.70</td>
<td>2.11</td>
</tr>
<tr>
<td>Summer</td>
<td>71.1</td>
<td>10.81</td>
<td>6.42</td>
<td>10.53</td>
</tr>
<tr>
<td>September</td>
<td>62.9</td>
<td>2.10</td>
<td>1.64</td>
<td>4.05</td>
</tr>
<tr>
<td>October</td>
<td>59.4</td>
<td>1.73</td>
<td>1.63</td>
<td>2.63</td>
</tr>
<tr>
<td>November</td>
<td>58.7</td>
<td>.65</td>
<td>1.46</td>
<td>.94</td>
</tr>
<tr>
<td>Fall</td>
<td>49.7</td>
<td>4.48</td>
<td>4.73</td>
<td>8.22</td>
</tr>
<tr>
<td>Year</td>
<td>47.5</td>
<td>23.72</td>
<td>15.96</td>
<td>20.33</td>
</tr>
</tbody>
</table>

The average date of the last killing frost is May 10 and of the first is October 4, which indicates an average frost-free season of 147 days, ample for the maturing and harvesting of all crops commonly grown. Killing frosts have occurred as early as September 18 and as late as May 24. During the 20 years from 1895 to 1914, there were more than 5 years in which killing frosts occurred 10 or more days earlier in the fall than the average date and 3 years in which they were 10 or more days later in the spring.⁸

The precipitation fluctuates greatly from year to year, and the mean annual rainfall is 23.72 inches. It was less than 85 percent of the mean annual in about one-fourth of the years from 1895 to 1914, inclusive.⁴ About 78.5 percent of the mean annual precipitation falls from April to September, inclusive, or during the principal part of the growing season. In summer, most of the precipitation occurs as heavy thundershowers, but torrential rains are rare. Droughts are not common during May and June, but in the latter part of July and during August dry periods sometimes do considerable damage to crops, especially those on soils underlain by sands or gravels.

From about October 1 to April 1 the prevailing wind is from the northwest, and during the rest of the year it is from a southerly direction. Strong winds are common, but tornadoes are rare.

---


AGRICULTURE

Prior to the first permanent settlements, which were made in the early seventies, the area now included in Rock County was occupied mainly by Indians, trappers, and hunters, who subsisted largely on wild game, fish, and fruit. The early settlers were chiefly cattlemen who were attracted to this section by the luxuriant growth of native grasses and the abundant water supply. The establishment of Fort Niobrara in Cherry County to the west, during 1880, and the completion of the railroad across Rock County, in 1881, greatly stimulated immigration, and within the next few years practically all the land was homesteaded.

Many of the early homesteaders were not aware that the sandy soils which cover most of the county are better suited for pasture and hay land than for grain crops, and much of the land was broken for corn, wheat, and oats without regard to soil conditions. Throughout the uplands, grain yields, as a rule, were very low, especially on soils composed largely of sand or underlain by gravel, and in most places the crops were so greatly injured by drought or shifting sand that yields were negligible. Grain yields, except locally, were also low in the Elkhorn River bottom lands, on account of the high water table. Nearly all crops in the lowlands did well while in the seeding stage, but their root systems soon reached the saturated and poorly aerated subsoils, and growth was greatly curtailed, owing to insufficient oxygen. Good yields of grain crops were obtained in the uplands only on the finer textured, more stable, and more drought resistant soils, which are comparatively inextensive, and in the bottoms only on the better drained soils. Observing these phenomena, the early settlers rapidly adjusted their farming operations to the requirements of the soils, with the result that the production of grain has remained of secondary importance, compared with cattle raising and the production of native hay.

The Federal census reports the value of all crops produced in Rock County in 1929 as $802,610. Dairy products, excluding those used for home consumption, were produced to the value of $197,555, and poultry and eggs to the value of $124,504. The total value of all domestic animals, chickens, and bees on the farms was $1,736,271 on April 1, 1930. Cattle represent about 80 percent of this amount; horses, mules, and colts about 11 percent; and hogs only about 4 percent. The remaining 5 percent represents the value of sheep, chickens, and bees.

According to the Federal census, nearly 35 percent of the farm land was classed as cropland in 1935, practically all the rest being in native pasture or hay land. Of the cultivated crops, tame hay, chiefly timothy and clover mixed, is grown most extensively, but this crop occupies only about 4 percent of the total area of the county during most years. Corn ranks next, occupying about 3½ percent. Other cultivated crops, including rye, oats, wheat, barley, sweet clover, potatoes, garden vegetables, and fruits, are grown on the better soils for feed or family use, although none of them occupies more than 1 percent of the total area in average years.

Table 2, compiled from Federal census data, gives the acreage devoted to the principal crops grown in this county in 1889, 1890, 1909, 1919, and 1929. These figures show the trend of agriculture,
### Table 2.—Acreage of principal crops in Rock County, Nebr., in stated years

<table>
<thead>
<tr>
<th>Crop</th>
<th>1889 Acres</th>
<th>1899 Acres</th>
<th>1909 Acres</th>
<th>1919 Acres</th>
<th>1929 Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>16,731</td>
<td>13,082</td>
<td>18,653</td>
<td>22,451</td>
<td>20,516</td>
</tr>
<tr>
<td>Oats</td>
<td>1,388</td>
<td>1,239</td>
<td>3,031</td>
<td>3,064</td>
<td>26,955</td>
</tr>
<tr>
<td>Wheat</td>
<td>1,744</td>
<td>3,224</td>
<td>587</td>
<td>1,593</td>
<td>2,413</td>
</tr>
<tr>
<td>Rye</td>
<td>1,065</td>
<td>398</td>
<td>716</td>
<td>4,269</td>
<td>3,551</td>
</tr>
<tr>
<td>Barley</td>
<td>125</td>
<td>97</td>
<td>61</td>
<td>22</td>
<td>129</td>
</tr>
<tr>
<td>Potatoes</td>
<td>583</td>
<td>337</td>
<td>640</td>
<td>452</td>
<td>312</td>
</tr>
<tr>
<td>Hay (all kinds)</td>
<td>24,603</td>
<td>83,355</td>
<td>190,077</td>
<td>147,107</td>
<td>141,056</td>
</tr>
<tr>
<td>Tame hay</td>
<td>74</td>
<td>1,098</td>
<td>143,078</td>
<td>117,135</td>
<td>1,858</td>
</tr>
<tr>
<td>Alfalfa hay</td>
<td>67,390</td>
<td>192,257</td>
<td>143,078</td>
<td>117,135</td>
<td>1,858</td>
</tr>
<tr>
<td>Timothy and (or) timothy and clover mixed</td>
<td>489</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweetclover</td>
<td>146</td>
<td>905</td>
<td>507</td>
<td>46</td>
<td>2,927</td>
</tr>
</tbody>
</table>


Crop yields differ greatly from year to year, according to differences in the amount and distribution of the precipitation and in the length of the frost-free season. They also differ widely on the different soils, but over the county as a whole the yearly average yields of the different crops over long periods are fairly uniform. Table 3, compiled from the Nebraska agricultural statistics, shows the average acre yield of several crops during the 15-year period 1916–30 and the approximate percentage of the land devoted to each crop in 1930.

### Table 3.—Average acre yield of several crops in Rock County, Nebr., 1916–30, and approximate percentage of land occupied by each crop in 1930

<table>
<thead>
<tr>
<th>Crop</th>
<th>Average acre yield</th>
<th>Area of county occupied by crop in 1930</th>
<th>Crop</th>
<th>Average acre yield</th>
<th>Area of county occupied by crop in 1930</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bushels</td>
<td>Percent</td>
<td>Alfalfa hay</td>
<td>Tons</td>
<td>Percent</td>
</tr>
<tr>
<td>Corn</td>
<td>16.5</td>
<td>3.5</td>
<td></td>
<td>1.75</td>
<td>0.24</td>
</tr>
<tr>
<td>Winter wheat</td>
<td>13.1</td>
<td>0.64</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oats</td>
<td>20.6</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The returns derived from livestock and livestock products are the chief sources of revenue. According to Federal census data, the value of cattle alone far exceeded that of all crops in 1930, and the total value of livestock and its products was more than twice as great as that of crops. Table 4, compiled from the Federal census reports, gives the number and value of domestic animals and poultry in 1900, 1910, 1920, and 1930.

### Table 4.—Number and value of domestic animals and poultry in Rock County, Nebr., in stated years

<table>
<thead>
<tr>
<th>Kind of animal</th>
<th>1900</th>
<th>1910</th>
<th>1920</th>
<th>1930</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Value</td>
<td>Number</td>
<td>Value</td>
</tr>
<tr>
<td>Cattle</td>
<td>29,540</td>
<td>$764,774</td>
<td>29,357</td>
<td>$1,468,422</td>
</tr>
<tr>
<td>Swine</td>
<td>3,250</td>
<td>3,866</td>
<td>4,264</td>
<td>5,392</td>
</tr>
<tr>
<td>Horses</td>
<td>3,488</td>
<td>4,985</td>
<td>4,800,762</td>
<td>5,022</td>
</tr>
<tr>
<td>Mules</td>
<td>3,153</td>
<td>4,345</td>
<td>4,644</td>
<td>5,022</td>
</tr>
<tr>
<td>Sheep</td>
<td>6,457</td>
<td>932</td>
<td>4,204</td>
<td>1,749</td>
</tr>
<tr>
<td>All poultry</td>
<td>22,285</td>
<td>87,030</td>
<td>26,466</td>
<td>11,220</td>
</tr>
</tbody>
</table>

*Chickens only.
The farmhouses, as a rule, are moderately good. Most of them are one-story wooden structures, but they are usually kept painted and in good repair. Only a few are equipped with modern conveniences. On most farms the barns and other outbuildings are large enough to house all crops except the hay, which is generally stacked in the field. The average improvements are better throughout the prairie plains and on the Holt tableland than in the sand hills. The Nebraska agricultural statistics show that 11 farmhouses had modern heating plants, 44 had running water, 36 were equipped with electricity, and 164 had radios in 1930. Most of the farms and ranches are fenced and cross-fenced, mainly with barbed wire. The work animals include heavy draft horses and mules, although some farmers use tractors and trucks in performing the heavier work. The Federal census reports 82 gas tractors, 96 gas engines, 77 trucks, and 485 automobiles on the farms in 1930. The farm machinery is of the most modern and labor-saving types. On the better farming lands, gang or sulky plows, disks, harrows, drills, listers, corn planters, binders, and full equipment for harvesting hay are common. Throughout the prairie plains and sand hills, elaborate hay-harvesting machinery, including gang mowers, rakes, and bucks, is used on many ranches, and in addition, several ranchers own hay balers. Only the more expensive farm machinery is sheltered.

In general, farm labor is plentiful and has been unusually cheap, especially during the last few years. Monthly farm wages in 1931 ranged from $20 to $80 with board and lodging; day labor was plentiful at $1 or $1.25; and corn shuckers received 1½ to 2 cents a bushel for shucking corn. Only a few farmers hire help.

The Federal census reports 610 farms in the county in 1935, occupying 604,989 acres, or 94.2 percent of the total area. More than half the farms range in size from 500 to 5,000 acres, and the average size is 991.8 acres. A few ranches exceed 5,000 acres.

In 1935, owners occupied 24.7 percent, part owners 25.6 percent, managers 0.5 percent, and tenants 49.2 percent of the farm acreage. Cash rent was paid for 38.7 percent of the acreage in tenant farms, and 61.3 percent of the land was rented for a share of the products. Under the share system the owner receives one-third of the grain and usually one-half of the hay. All seed, labor, and machinery are furnished by the tenant. Under the cash system the tenant pays from $2 to $4 an acre for the better grade of farm land and from $55 to $100 a section (640 acres) for pasture land. Many tenants pay a lump sum for the use of the pasture land, and most of them give a share of the crops for the hay land. The selling price of individual farms and ranches ranges widely, depending on the character of the soil, relief, drainage, improvements, and location with respect to markets.

The land as a whole is better suited for pasture or hay than for grain crops. Less than 5 percent of it is used for growing grain, chiefly corn, all of which is consumed locally. A part of the hay is sold for cash, but the utilization of the pasturage has necessitated the production of livestock, which is the leading source of revenue.

The raising of beef cattle is the chief branch of the livestock industry. These animals, most of which are raised locally, are of high quality. Grade Herefords and Shorthorns predominate. Some ranchers have purebred herds, and all herds of range cattle are
headed by a purebred bull. On account of the scarcity of corn, only a few of the beef cattle are fattened on grain. Young calves are usually fed some oats during the winter, but most of the cattle not ready for shipment in the fall are carried through the winter on native hay. A small amount of grain or cottonseed cake may be added to the hay ration during periods of very severe weather. The common practice is to run the cattle on the range in the summer and feed them hay in the winter until they are 2 or 3 years old, when they are shipped to the Omaha or Kansas City markets as feeders. Many ranchers ship in young cattle for summer grazing and sell them in the fall. The animals usually gain about 200 pounds during the grazing season—May 1 to October 1. Most of the ranches are capable of supporting from 80 to 120 head of cattle a section the year around.

Dairy products are an important source of income in this county. Most farmers and ranchers keep from 5 to 10 milk cows, most of which are of mixed beef and dairy breeding, and sell their surplus cream in the local towns.

Horses, for a few years prior to 1932 declined greatly in value, and horse raising became of little importance, but this industry has revived greatly during the last year and will probably gain in importance during the next few years, as the high cost of gasoline-driven machinery, together with the high tax on motor fuel, is resulting in an increased use of horses throughout the State. The abundance of cheap pasturage and hay, together with the high prices which can now be obtained for horses, is resulting in a rapid expansion of the horse-raising industry. Nearly all the horses are raised to maturity on grass and hay, and grain is fed only during the most severe winter weather.

Sheep raising is of minor importance. Several ranchers raise from 100 to 300 sheep annually, but the total number of these animals seldom exceeds 6,000. Practically no sheep are shipped in for summer grazing. The most important limiting factor in sheep production has been the expense involved in building fences adequate to prevent losses from the depredations of coyotes. The danger of close grazing by sheep, with the possible destruction of the grass cover, has also curtailed their production, especially in the sand hills where the stability of the sand depends almost entirely on the protecting grasses.

A few hogs are raised for home consumption on most farms and ranches, but there are no large herds. Hog raising is unimportant on account of the limited corn supply. Most of the surplus hogs are sold to local butchers, and only a few are shipped out of the county.

Chickens are a valuable asset on most farms. The local demand for poultry products is good, and poultry raising receives considerable attention. Most farmers and ranchers have 50 or 60 chickens, and some have purebred flocks of several hundred. The principal breeds are Plymouth Rock, Leghorn, and Rhode Island Red. Many farmers maintain their flocks by raising baby chicks purchased from hatcheries in the larger cities. Most of the surplus poultry products are sold or exchanged for farm supplies in the local towns.
Agricultural practices on the hay and grain lands are similar to those prevailing in other counties throughout north-central Nebraska. Wild hay is by far the most important crop. It ranks next to livestock as a source of revenue on most of the farms and ranches and is the chief source of ready cash throughout the greater part of the large prairie plains area. According to the Nebraska agricultural statistics, the average yield of wild hay exceeds 0.6 ton an acre. This average is a little high for the drier and more sandy hay-producing soils, but it is greatly exceeded on soils of the moist prairie plains area where yields ranging from 0.8 to 1 ton an acre are common. Most of the wild hay in the prairie plains area is cut from rank-growing grasses and is rather coarse.

The tame-hay acreage, although much smaller than that of wild hay, greatly increased during the decade 1919–29. Only 3,021 acres were devoted to this crop in 1919, whereas 23,837 acres were reported for 1929. This rapid increase is owing largely to the market demand for hay of finer quality than that commonly obtained from the rank-growing native grasses of the moist situations. The greater part of the tame hay is mixed timothy and clover, but on a few farms hay is cut from pure stands of red clover, white clover, alsike, alfalfa, and sweetclover. Some ranchers have sown timothy and clover seed among the wild grasses, thereby improving the quality of the native hay, as additions of tame grasses or legumes not only improve the quality of the hay but also increase the yield. Studies of prairie hay in north-central Nebraska by research workers at the Nebraska Agricultural Experiment Station have shown that the increase in yields brought about by clovers is accompanied by a great increase in the protein content of the hay. In a report on these studies it is stated:

In one instance medium red clover increased the yield of a meadow 143 percent and the total amount of protein in the hay 279.7 percent; in a second meadow an increase in yield of 54 percent brought about an increase of 77.4 percent in the amount of protein. Mammoth red clover in these meadows increased the yields of hay 243 and 38.9 percent, and of protein 407.6 and 112.8 percent, respectively. Alsike, sweet, and white clover brought about similar increases in the yield of protein.

Hay harvesting requires from 2 to 8 weeks, depending on the weather, the quantity of tame hay in the meadows, and labor conditions. Haying operations ordinarily begin during the latter part of July in meadows containing a high proportion of tame grasses and end some time in September in meadows composed largely of native grasses. Practically all the hay is stacked in the field, and a large part is later baled and hauled to Bassett or Newport for shipment. The unbaled hay is fed to cattle and horses during the winter.

Grain crops are of little importance, on account of the small acreage of land suitable for the production of grain. Corn, the principal grain crop, is planted between the first and the middle of May, usually in furrows with a lister. It is cultivated three or four times during the season, two-row cultivators being in common use. The last cultivation is usually given in July, after which the corn receives no further attention until harvest, except removal of the more injurious weeds by hoeing. The crop matures in September or early in

---

October, depending on the season. Most of it is husked from the standing stalks, after which cattle and horses are pastured in the fields during the winter. On many farms part of the corn is cut for fodder. Only dent varieties of corn are grown. Most of the farmers select their own seed, either in the fall when husking or from the crib early in the spring.

Oats are the leading small-grain crop. Only a few of the soils are well adapted to this crop, but it is needed as feed for horses and growing livestock. Most of the oats grown is of the early maturing types. The Kherson variety and strains of it, such as Nebraska No. 21, which is a light-colored high-yielding strain developed by the Nebraska Agricultural College, are grown chiefly. The land to be used for oats is usually disked and the grain is sown broadcast or planted with a press drill late in March or early in April. Early seeding usually results in the highest yields. Oats mature in July and are cut with a binder or header, depending on the length of the stems. They are later shocked or stacked for threshing. Practically all the oat crop is fed on the farms where produced. Oat straw is almost as valuable as prairie hay for feeding; and horses and cattle are usually given access to the straw stacks during the winter. Smut sometimes lowers oat yields, especially during prolonged periods of rainy or cloudy weather, but this disease is not serious and can be controlled by spraying the seed before planting with a solution of equal parts of formaldehyde and water.\(^6\)

Rye, which is a valuable feed crop and well adapted to the sandy soils of this county, ranks next to oats in acreage among the grain crops. This crop is planted in the same manner as oats, but in the fall instead of spring. The crop usually makes a good growth before heavy frosts occur, remains dormant during the winter, resumes growth in early spring, and matures in July. It is cut with a binder or header and is either shocked or stacked for threshing. Some of the rye is used for temporary fall and spring pasture. Rosen is the best variety for this section of the State.

Barley and wheat are grown in only a few fields on the finer textured soils. They are planted in the same manner as oats and rye, respectively. Practically all the wheat is sold, but the barley is used for feed.

Systematic crop rotation is not practiced. At 3- or 4-year intervals most farmers plant rye or oats on land formerly used for corn, but practically no legumes are grown on the grain land. Sweetclover, which has an unusually wide adaptation, should be grown more extensively in rotation with grain. This crop thrives on soils which are either sandy or clayey and wet or dry. It not only adds organic matter to the soil, but, in common with other legumes, has the power of fixing atmospheric nitrogen in nodules on its roots. It is also a good soil binder and is especially valuable on soils susceptible to wind or water erosion.

No commercial fertilizers are used. A large quantity of manure is produced, but, in general, little care is taken to preserve it, and much of its fertilizing value is lost by leaching before it is placed on the land. Most of the manure is hauled in the fall or spring and is spread

on the land to be used for corn or small grain. On many farms it is applied to the more sandy parts of the fields in order to increase the organic-matter content of the soil and to retard erosion. On rented farms little care is used in applying the manure where it is most needed, and most of it is spread on land adjacent to the barnyard.

SOILS AND CROPS

The outstanding and most widely distributed feature of the soils in Rock County is their sandiness. Most of the more extensive soils also have a low content of organic matter and of lime, and they have thin light-colored topsoils which are unstable when cultivated. In addition, numerous narrow strips of soil are severely eroded, and large and small areas of soils have poor surface drainage and a high water table, one or another of these soil conditions, occurring in various stages of development, over nearly all parts of the county. Any one of these conditions, where well developed, is injurious to grain crops, but none of them is especially harmful to the native grasses which are adapted to the local soil and moisture conditions. Nearly all the land will support a fair or heavy growth of nutritious grasses, but only about 5 percent of it is used for grain crops. About 75 percent of the rest, most of which is too sandy, too rough, or too poorly drained for profitable production of grain, is used for grazing, and about 25 percent for either wild- or tame-hay land.

The largest areas of grazing land are in the hilly dune sand areas which cover most of the southern two-thirds of the county, and many bodies occur as isolated outliers throughout the northern one-third. Practically none of the dune sand has a true soil layer exceeding 2 inches in thickness, and over most areas the gray sand extends to the surface of the ground with little or no evidence of soil development. Much of the thin sandy and light-colored Valentine soils, which occupy gently rolling or hummocky situations within and around the margins of the hilly dune sand areas, is used for grazing, and in addition there is considerable grazing land on the severely eroded breaks along Niobrara River and its tributaries in the northern part of the county. Not all the soils in this section are sandy. Some of them are silty, and a few are composed largely of clay; but their topsoils are everywhere thin or absent, and the land is so gullied as to be of value only for pasture.

The hay land, by far the greater part of which is used for wild hay, occupies about 22 percent of the county. It occurs chiefly in the north-central and northeastern parts throughout the large and somewhat triangular shaped prairie plains area previously described. Much wild hay is also cut in the deeper valleys, swales, and pockets within the dune sand areas and from the Valentine soils, where these are not used for grazing. Aside from the areas of Valentine soils, which are similar to dune sand, except in surface features, practically all the hay land is poorly drained. The water table is everywhere within a slight depth, even during dry periods. It rises in early spring or following prolonged rainy spells, and the surface of the ground often remains wet for several weeks. The high moisture supply has favored rapid growth and decay of a luxuriant grass vegetation, and most of these soils are much better supplied with
organic matter than soils in the grazing areas. In most places they have very dark and, locally, almost black topsoils, owing to an abundance of well-decayed grass remains. Most of the soils in the hayland group are sandy.

Grain land, which occupies only about 5 percent of the county, occurs wherever the land is not too sandy, rough, or poorly drained for grain crops. Most of it is on the tableland in the northern part, where it occupies numerous bodies of various sizes, most of which are within or adjoining areas of land used for grazing. Small scattered fields used for grain also occur in the prairie plains and throughout the sand hills. Most of the grain land is rather sandy, but it is composed of soils which have accumulated sufficient organic matter to make their topsoils much darker and a little more stable than those in most of the soils used for grazing. It is better drained than most of the land used for hay. The subsoil layers, as a rule, consist chiefly of gray sand, but most of them contain a noticeably larger quantity of silt and clay than the corresponding layers of the soils adapted to grazing, and are, consequently, a little more retentive of moisture. Only a few of the soils used for grain crops are fine textured throughout.

Although the soils used for grain crops are more stable, as a whole, and more retentive of moisture than most of those used for grazing, only a few of them are adapted to a wide variety of grain crops or return high yields, even of such varieties as can be grown on them. Some feed, in addition to pasturage and hay, is needed, especially for the work animals, hogs, and calves, and most of the land which will yield larger feed returns when used for grain than when used for hay or grazing land is planted to grain crops. Corn is the grain most extensively grown. This crop does best on well-drained silty soils having high moisture-storing capacity, but it can adjust itself fairly well even to extremely sandy and rather unstable soils, provided these soils have adequate drainage and a good supply of organic matter. The large and deep root system of corn is better adapted than the root system of most small grains to the sandy and rather droughty conditions prevailing in most of the grain-producing soils of the county. The rather coarse roots are also less injured by drifting sand than are the finer roots of small-grain crops. In average years, corn occupies about 60 percent of the grain-producing land.

Small grains are poorly adapted to most of the soils and are grown chiefly on the finer textured, more stable, and better drained soils. Oats and rye, which are grown much more extensively than any other small-grain crop, occupy less than 6,000 acres each in average years.

In this report, the individual soils of the county are grouped, on the basis of the crops for which they are most extensively used and for which they give the largest returns under the present farming system, in three broad groups, namely, grazing, hay farming, and grain farming. This grouping does not imply that the crops mentioned in connection with any particular group are the only ones that can be grown on the soils of that group. Under a more intensive farming system, involving, 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 present conditions, small well-managed
fields throughout the more sandy uplands have been made to produce profitable yields of sweetclover, sorgo, and millet, all of which gave larger feed returns than the original native grasses. Likewise, most of the poorly drained prairie plains soils are well adapted to truck crops, including celery, asparagus, watermelons, and cantaloupes, as is shown in small farm gardens on these soils. These crops, however, are grown by only a few farmers for family use or to supplement their feed and food supply, and they do not influence the general farming system.

The grouping of the soils into these three classes, according to their best use, is based not only on soil and crop adaptations but also on those soil characteristics which are responsible for these adaptations and on the surface features and drainage conditions of the soils. None of these soil groups is confined to any particular part of the county, but some of the soils in each group are of rather local occurrence.

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

**Table 5.—Acreage and proportionate extent of the soils mapped in Rock 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>Thurman loamy fine sand</td>
<td>10,688</td>
<td>1.7</td>
<td>Cass loam</td>
<td>10,240</td>
<td>1.6</td>
</tr>
<tr>
<td>Thurman fine sandy loam</td>
<td>4,480</td>
<td>0.7</td>
<td>Cass and Valentine loamy sands,</td>
<td>34,048</td>
<td>5.3</td>
</tr>
<tr>
<td>O'Neill loamy fine sand</td>
<td>2,620</td>
<td>0.3</td>
<td>undifferentiated</td>
<td>5,504</td>
<td>0.9</td>
</tr>
<tr>
<td>O'Neill fine sandy loam</td>
<td>3,136</td>
<td>0.5</td>
<td>Gannett loamy fine sand</td>
<td>1,600</td>
<td>0.2</td>
</tr>
<tr>
<td>O'Neill sandy loam, upland phase</td>
<td>3,994</td>
<td>0.6</td>
<td>Sarpy fine sand</td>
<td>1,512</td>
<td>0.2</td>
</tr>
<tr>
<td>Ewing loamy fine sand</td>
<td>3,668</td>
<td>0.6</td>
<td>Lamoure fine sandy loam</td>
<td>216,676</td>
<td>33.9</td>
</tr>
<tr>
<td>Ewing fine sandy loam</td>
<td>2,112</td>
<td>0.3</td>
<td>Valentine sandy</td>
<td>8,266</td>
<td>1.3</td>
</tr>
<tr>
<td>Ewing fine sandy loam, deep phase</td>
<td>1,344</td>
<td>0.2</td>
<td>Valentine loamy sandy</td>
<td>7,872</td>
<td>1.2</td>
</tr>
<tr>
<td>Marshall fine sandy loam, sandy substratum phase</td>
<td>765</td>
<td>0.1</td>
<td>Boyd clay loam, steep phase</td>
<td>2,406</td>
<td>0.4</td>
</tr>
<tr>
<td>Waukesha loam</td>
<td>794</td>
<td>0.1</td>
<td>Boyd loamy sand, steep phase</td>
<td>448</td>
<td>0.1</td>
</tr>
<tr>
<td>Holt fine sandy loam</td>
<td>3,264</td>
<td>0.5</td>
<td>O'Neill loamy sand, upland phase</td>
<td>3,530</td>
<td>0.6</td>
</tr>
<tr>
<td>Boyd clay loam</td>
<td>448</td>
<td>0.1</td>
<td>Holt loamy fine sand, upland phase</td>
<td>1,472</td>
<td>0.2</td>
</tr>
<tr>
<td>Cass loamy fine sand</td>
<td>46,268</td>
<td>7.2</td>
<td>Dune sand</td>
<td>212,032</td>
<td>33.2</td>
</tr>
<tr>
<td>Cass loamy fine sand, heavy-sub soil phase</td>
<td>7,158</td>
<td>1.1</td>
<td>Rough broken land</td>
<td>10,560</td>
<td>1.7</td>
</tr>
<tr>
<td>Cass fine sandy loam</td>
<td>26,816</td>
<td>4.2</td>
<td>Total</td>
<td>638,720</td>
<td></td>
</tr>
</tbody>
</table>

**SOILS ADAPTED TO GRAIN FARMING**

The soils of the group adapted to grain farming, although more numerous than those in either the grazing or hay-farming groups, are much less extensive. The group includes Thurman loamy fine sand, Thurman fine sandy loam, O'Neill loamy fine sand, O'Neill fine sandy loam, O'Neill sandy loam, upland phase, Ewing loamy fine sand, Ewing fine sandy loam, upland phase, Marshall fine sandy loam, sandy-substratum phase, Waukesha loam, Holt fine sandy loam, and Boyd clay loam, making a total of 12 soils, but these soils occupy less than 7 percent of the total area of the county. All of them are in the uplands, except the typical O'Neill and the Waukesha soils which are on terraces. Their relief ranges from nearly level to rolling, and they have adequate surface drainage and underdrainage. Most of them occur throughout the northern part of the county north of Elkhorn River.
The soils belonging to this group have accumulated rather large amounts of organic matter and have darker and thicker topsoils than occur in the soils of the grazing group. They are rather sandy, as a whole, and several of them are composed largely of sand, but they all contain some finer mineral material mixed with the sand, especially in the topsoils, and this, together with the organic matter, prevents excessive wind erosion, provided reasonable care is taken in managing the land. A few of these soils have silty or even clayey subsoils and are very retentive of moisture, but most of them are underlain by porous sands or gravels and are rather droughty. Only the Boyd and Holt soils are well supplied with lime.

Although the combined area of all soils classed with this group is about 7 percent of the county, only about two-thirds of this area, or about 5 percent of the county, is actually used for grain crops, and the rest is included in building sites, farm gardens, small fields of forage or tame hay, or native-pasture or hay land.

Corn during most years occupies about 60 percent of the land used for grain crops, oats about 20 percent, rye about 17 percent, and the rest is included in small fields of wheat and barley. None of these crops returns high yields on the soils of this group, as a whole, except in the most favorable years. Corn with its large root system does better than any other crop, especially on the sandy soils, and in addition it has a higher feed value than small grains, hence its greater acreage. Oats are a better feed crop than any other small grain, especially for work animals and calves, and for this reason they are grown more extensively than rye. Rye is better adapted to the sandy soils than any of the grain crops commonly grown, except corn, and, because it is valuable for hog feed and late fall pasture, it ranks next to oats in acreage. Wheat and barley, which occupy only a few small fields, are grown only on the less sandy soils of the group.

Thurman loamy fine sand.—Thurman loamy fine sand is the most extensive upland soil belonging to this group, although none of the soils of the group has a large total area.

This soil occurs throughout the uplands, wherever almost pure fine sand or medium sand has acquired a very dark surface layer through the prolonged accumulation of organic matter. It occupies scattered bodies of various sizes and shapes, chiefly in the northern half of the county, although local developments occur in the southern half. The largest bodies, none of which exceeds 1,000 acres, are in Kirkwood, Harrison, and Thurman Precincts.

The relief is nearly level or very gently undulating. Drainage channels are not well developed, because practically all the precipitation is rapidly absorbed by the porous sand.

The topsoil, which ranges from 7 to 12 inches in thickness, is dark grayish-brown or very dark grayish-brown loamy fine sand. The upper part of the subsoil is pale brown and about 10 inches thick. It consists largely of fine sand but also contains some silt and clay, in most places in sufficient quantity to weakly bind the sand grains together and to give the material slight coherence, or "body." The rest of the soil mass is incoherent gray sand similar to that beneath the Valentine soils and dune sand. Neither the topsoil nor the subsoil is limy.
Thurman loamy fine sand has rather low moisture-retaining power, and, were it not for the high organic-matter content of the topsoil and the small amount of silt and clay in the upper part of the subsoil, it would be too droughty for grain crops. The organic matter, together with the silt and clay, makes the soil fairly stable, but it does not entirely prevent the sand in cultivated fields from drifting.

About 70 percent of the land is under cultivation, and the rest is included in native pasture and hay land. In average years, corn occupies about 90 percent of the cultivated land. This crop, which is planted rather deeply, is not greatly injured by drifting sand, and, because it is needed for feed, it is naturally the leading crop. Small fields of rye, oats, and sweetclover are grown on the cultivated land not used for corn. None of these crops gives as high yields as on the finer textured soils of this group. In dry windy seasons the yields are often very low, especially yields of oats, which are frequently injured while in the seedling stage by shifting sands. The average acre yield of corn over a period of years is about 18 bushels and of rye or oats is about 12 bushels. Sweetclover, when cut for hay, yields about 11/2 tons an acre, but most of this crop and much of the rye is used for pasture. The uncultivated areas are in native pasture and hay land, for which this soil is well suited.

**Thurman fine sandy loam.**—Thurman fine sandy loam has the same general distribution as Thurman loamy fine sand with which it is in many places closely associated, but it is less extensive than that soil. Some of the largest and most typical bodies are in Kirkwood Precinct, but few of them exceed 640 acres in size. This soil differs from Thurman loamy fine sand only in that its topsoil has a little higher content of silt and clay and is, therefore, more stable and a little more retentive of moisture. All the land is under cultivation.

The same crops as are grown on Thurman loamy fine sand are grown on this soil, but with increased yields. Corn, which is by far the leading crop, yields from 15 to 25 percent higher and oats and rye about 50 percent higher on the fine sandy loam than on the loamy fine sand soil. In wet years yields on Thurman fine sandy loam are nearly as high as those on the sandy-substratum phase of Marshall fine sandy loam, but in dry seasons they are much lower, on account of the more open and porous character of the subsoil in the Thurman soil than that in the Marshall soil.

**O’Neill loamy fine sand.**—O’Neill loamy fine sand is the most extensive soil in this group developed on terraces. It occurs in bodies of various sizes, chiefly on the high Niobrara River terrace in the northern part of the county. One of the largest areas, comprising about 800 acres, is 2 1/2 miles north of Biltoft School in Long Pine Precinct. The relief is nearly level, except in a few places where wind action has produced slight depressions and low rounded ridges, but even in such places the differences in elevation do not exceed 2 feet.

This soil is similar to Thurman loamy fine sand in soil characteristics, but it lies from 10 to 30 feet below the general level of that soil and its relief is a little more even. The topsoil, which averages about 10 inches thick, consists of very dark grayish-brown loose loamy fine sand. The upper 8- or 10-inch layer of the subsoil is
brown loamy sand, and the rest is gray sand. The entire soil mass is low in lime.

The organic matter in the topsoil, together with a small amount of silt and clay in both the topsoil and the upper part of the subsoil, enables these layers to hold considerable moisture, but the lower part of the subsoil has low moisture-retaining powers, and the soil, as a whole, is rather droughty. It is a fairly stable soil when carefully managed, however, and it is all topographically suited to the use of farm machinery. About 65 percent of the land is under cultivation, chiefly to corn, although small fields of rye, sweetclover, and oats are grown on many farms. All crops yield about the same as on Thurman loamy fine sand. The uncultivated areas are included in pasture and hay land.

O'Neill fine sandy loam.—O'Neill fine sandy loam occupies only a few bodies in this county. Most of them are on the high Niobrara River terrace in the northern part. The largest, comprising about 500 acres, is near Mariaville in Kirkwood Precinct. The other bodies are much smaller and are widely scattered.

This soil differs from O'Neill loamy fine sand, with which it is closely associated, only in that its topsoil is a little finer in texture. It is identical in all soil characteristics with Thurman fine sandy loam, but it occupies slightly lower positions. In fact, all the O'Neill and Thurman soils in this county are much alike, except for slight differences in the texture of their topsoil layers and in their relief and position. The O'Neill soils occupy nearly level terraces, whereas the Thurman soils are on the undulating or gently rolling uplands.

Practically all of O'Neill fine sandy loam is under cultivation and, in common with all the O'Neill and Thurman soils, is used largely for corn, though to some extent for oats, rye, and sweetclover. It has about the same producing power as Thurman fine sandy loam. In average years, corn and oats each yield about 20 bushels an acre and rye about 17 bushels. Most of the sweetclover grown on this soil is used for pasture.

O'Neill sandy loam, upland phase.—O'Neill sandy loam, upland phase, occupies 6 or 7 small bodies on the nearly level or gently undulating tableland in the central part of Kirkwood Precinct north of Newport. The largest, comprising about 640 acres, is on the west side of Ash Creek, and a slightly smaller body is east of this stream. None of the other areas exceeds 300 acres.

This soil has developed from local exposures of gravel, ranging from fine to coarse, which is present at various depths and in numerous places throughout the tableland in the northern part of the county, but which in most places lies at too great a depth to exert any influence on the soils. The topsoil consists largely of sand and gravel, but it contains a large quantity of silt, clay, and organic matter, which gives it considerable coherence and a very dark color. It ranges from 8 to about 14 inches in thickness. The upper part of the subsoil, which is about 12 inches thick, is brown fine- or medium-textured material containing only a small percentage of silt or clay. With increasing depth the gravel becomes gradually coarser and lighter in color to a depth below 4 feet. This soil is thoroughly leached of its lime.
The topsoil is stable and highly retentive of moisture. The upper part of the subsoil retains moisture fairly well, but the lower part has low moisture-holding power, and the soil as a whole is rather droughty. Only about 65 percent of the land is under cultivation. Corn is the principal crop, occupying about 70 percent of the cultivated land, and the remaining 30 percent is used largely for oats, although some rye and sweetclover are grown.

All crops on this soil must depend for their moisture supply almost entirely on that which can be stored in the topsoil and upper subsoil layers. They yield well, provided the rainfall is ample and well distributed during the growing season, but they usually suffer from drought during prolonged dry periods. The average yield of corn over a period of years is about 18 bushels an acre, of oats about 20 bushels, and of rye about 12 bushels. Both oats and rye often mature before the moisture stored in the upper two soil layers during the winter months is exhausted. The uncultivated parts of this soil are used for native pasture and hay, for which purpose they are about equal to Valentine loamy sand.

Associated with this soil and occurring in the same general locality are three or four bodies having a loam texture, but, owing to their small extent, they are not shown separately on the soil map. The largest, comprising about 300 acres, is 1 mile southeast of Mariaville. The total area of this loam soil does not exceed 400 acres. It differs from the rest of O'Neill sandy loam, upland phase, only in the slightly finer texture of its topsoil layer. It is all under cultivation and is used for the same crops as those grown on the cultivated parts of the more sandy soil, but with slightly increased yields.

**Ewing loamy fine sand.**—Ewing loamy fine sand occupies several small widely scattered bodies throughout the tablelands in the northeastern part of the county and in the sand hills throughout the west-central and southwestern parts. None of the areas exceeds 300 acres in extent, and most of them range from less than 10 acres to about 50 acres. This soil, as a rule, lies a little below the general level of the surrounding land. Its relief is nearly level, and surface drainage channels are not established, but all surplus surface water is rapidly absorbed and, although all the soil has rather slow underdrainage, practically none of it becomes too wet for cultivation, even during seasons of high precipitation.

This soil has developed from gravelly deposits similar to those underlying the upland phases of the O'Neill soils, but the upper part of its subsoil everywhere contains more clay, probably carried down from the topsoil by percolating waters, than occurs in the corresponding part of any upland phase of the O'Neill soils. The topsoil, which is about 10 inches thick, consists of loose and rather incoherent loamy fine sand containing an abundance of organic matter and scattered gravel. It is very dark and does not differ materially from a topsoil of corresponding texture in either the Thurman or O'Neill soils. The upper layer of the subsoil, which ranges in thickness from 10 to about 20 inches, is everywhere much more compact than any other layer in the soil profile, and in many places it attains the density of a claypan. It is rather variable in color and composition. Throughout most of the soil the material in this layer is brown and consists largely of fine to coarse gravel,
the interstitial spaces being filled with a mixture of silt, clay, and fine sand or very fine sand. The finer material firmly binds the gravel together, and the layer becomes extremely hard and compact, especially when the soil is dry. Throughout a part of the soil the binding material is much more abundant than the gravel and is also rather light in color. In such localities the heavy layer is composed largely of a gray or grayish-brown mixture of sand, silt, and clay, containing only a few, in some places no, gravel. Between these two extremes are many variations in the color of the upper subsoil layer and in the relative proportions of fine and coarse materials which it contains. As none of these variations is extensive, the areas are not shown separately on the soil map. The material beneath the heavy layer consists of loose gravel or mixtures of coarse sand and gravel to a depth below 6 feet. This soil does not contain free lime.

Practically all of Ewing loamy fine sand, except a few of the smaller and more poorly located bodies, is under cultivation. The topsoil is rather unstable when the native grasses are destroyed, but it has high moisture-retaining power, owing to the abundance of organic matter, and it does not drift badly, provided care is taken in managing the land. The heavy layer in the subsoil prevents excessive downward loss of moisture, and the soil is not droughty. Probably 90 percent of the land is used for corn and most of the rest for oats and rye. Crop yields, although somewhat lower than on the Marshall and Waukesha soils, usually exceed those obtained on the Thurman or O'Neill soils. The average acre yield of corn is about 22 bushels, of oats 25 bushels, and of rye about 18 bushels.

**Ewing fine sandy loam.**—Ewing fine sandy loam is similar to Ewing loamy fine sand in all soil characteristics except texture of the topsoil, the topsoil layer of Ewing fine sandy loam having a little more silt and less sand than that of Ewing loamy fine sand. The subsoils of the two soils are similar and subject to the same variations, and practically no differences in surface features or drainage conditions exist between the two soils. Both soils occur in the same general localities, but Ewing fine sandy loam is less extensive. It occupies numerous small bodies. One of the largest, comprising about 300 acres, is south of the Chicago & North Western Railway in Harrison Precinct.

Practically all this soil is under cultivation and is used for the same crops in about the same acreage ratios as Ewing loamy fine sand. It is more stable than the loamy fine sand, owing largely to the finer texture of its surface layer, and it does not require such careful handling to prevent injurious wind erosion. For this reason it is considered superior to Ewing loamy fine sand for general farming, but both soils are about equally productive when carefully managed.

**Ewing fine sandy loam, deep phase.**—Ewing fine sandy loam, deep phase, is one of the less extensive soils in the county. It occupies only a few small scattered bodies, most of which are in Thurman, Harrison, and Bassett Precincts.

The 12-inch topsoil, which is well supplied with organic matter, is very dark friable fine sandy loam. The upper, approximately 8-inch, layer of the subsoil is dark grayish-brown friable sandy loam or
loam. Below this layer the material changes rather abruptly to light-gray or light grayish-brown moderately compact sandy clay loam which extends to a depth below 6 feet with little change. Neither the topsoil nor subsoil is limy. Soil of this phase differs from the other Ewing soils chiefly in the finer texture of its entire subsoil, the fine-textured material being much thicker than in any other Ewing soil, a little less compact, and a little lighter in color. This soil somewhat resembles Holt fine sandy loam, but its subsoil is considerably more compact than the corresponding layer in the Holt soil and is not limy, whereas the subsoils of the Holt soils are in general very limy.

The relief is nearly level. Most bodies of this soil are surrounded by higher lying areas of Valentine and Thurman soils, from which considerable moisture is received through seepage. Surface drainage is not established, but underdrainage is good, and none of the land is too wet for grain crops.

Soil of this deep phase is well adapted to all the crops commonly grown in this county, and it is one of the most productive soils, although it is of little agricultural importance on account of its small extent. Many of the bodies are too small or too inconveniently located to warrant using them for grain crops, and only about 70 percent of the land is under cultivation. The same crops are grown as on the Marshall and Waukesha soils, and yields compare favorably with yields obtained on those soils. As on all soils of this group, corn occupies the largest acreage.

**Marshall fine sandy loam, sandy-substratum phase.**—A few small scattered bodies of soil shown on the accompanying map as Marshall fine sandy loam, sandy-substratum phase, occur in the western part of the county, chiefly in Harrison Precinct. The soil in these bodies is much more sandy, especially in the lower part of the subsoil, than that of typical Marshall fine sandy loam of eastern and southeastern Nebraska. It lies farther west than the main areas of Marshall soils. As it has most of the characteristics of those soils, however, and is developed from material of loessial origin, it is classed with them in this county. The 10- to 14-inch topsoil is very dark. It is composed largely of silt and very fine sand, but it contains a noticeable amount of fine sand and an abundance of organic matter. The material is stable and is not subject to disastrous drifting, even during prolonged periods of dry windy weather. The subsoil, to a depth of about 3 feet, is composed of loose floury silt. It is grayish brown in the upper part, where it is stained by organic solutions from the topsoil, and very light gray or almost white in the lower part. This material rests on incoherent gray or grayish-brown sand or on a mixture of sand and gravel, which continues to a depth below 8 feet with little change. No part of the soil or of the underlying sand contains sufficient lime to effervesc when dilute hydrochloric acid is applied.

The relief is nearly level, in most places slightly depressed. Drainage channels are not established, but all the surplus surface water is rapidly absorbed, and the land is well drained.

This soil has developed on small remnants of a thin deposit of loess, which apparently once covered much more of northern Nebraska than at present. The former loess deposit probably connected
eastward across Holt County with the main body of the loess in Knox and Antelope Counties and extended westward beyond Ainsworth in Brown County, but it is now represented by only a few widely scattered outliers in Holt, Rock, and Brown Counties.

Marshall fine sandy loam, sandy-substratum phase, is one of the most productive of the soils used for general farming in the county. In eastern Nebraska, where it is more extensive, it is generally regarded as the best upland soil. Here it is of only local agricultural importance, on account of its small extent. This soil is well adapted to any crop commonly grown, but, in common with all soils suited to cultivation, it is used chiefly for corn, followed by oats, rye, and sweetclover, ranking in acreage in the order named. The average yield of corn over a period of years is about 30 bushels an acre, oats yield about the same as corn, and rye yields range from 15 to 25 bushels, depending on the season. Most of the sweetclover is used for pasture. All the land is under cultivation.

Waukesha loam.—Waukesha loam occupies a few small bodies, most of which are on the Niobrara River terrace in the northeastern part of the county. The largest area, comprising about 180 acres, is 1½ miles east of Haugen Bridge on one of the lower terraces; a slightly smaller body is on the east side of Willow Creek north of Mariaville; and none of the other bodies exceeds 160 acres in size.

The relief ranges from nearly level to gently undulating, and the soil has good surface drainage and underdrainage. No part of it is subject to excessive erosion. The topsoil, which averages about 14 inches thick, is composed of about equal parts of silt and the finer grades of sand, together with an abundance of organic matter which gives it a very dark color. This layer is underlain by a 20-inch layer of brown friable fine sandy loam or very fine sandy loam, with a high silt content. The subsoil becomes gradually lighter colored and more sandy with depth but in few places gives way to loose gray sand within a depth of 3 feet.

Waukesha loam is probably the best soil for general farming in this county. The high silt content of the topsoil and the subsoil, together with the abundance of organic matter in the topsoil, makes this soil very retentive of moisture. It is adapted to all crops commonly grown, and practically all of it is under cultivation. The principal crops are corn and oats, although wheat and alfalfa, both of which do well, are produced on a few farms. Crop yields average about 10 percent higher than those obtained on Marshall fine sandy loam, probably owing to the lower position and consequently more favorable moisture supply in the Waukesha than in the Marshall soil. Waukesha loam is of local distribution and occupies such a small part of the farms on which it occurs that it is of little agricultural importance.

Holt fine sandy loam.—Holt fine sandy loam occupies several scattered bodies on the tablelands and high Niobrara River terrace in the northeastern part of the county, mainly in Kirkwood and Long Pine Precincts. One of the largest bodies, comprising about 400 acres, is on the divide between Willow and Rock Creeks, and only a few of the other bodies exceed 160 acres in size.

The 8- to 12-inch topsoil is dark-brown or dark grayish-brown mellow fine sandy loam or loam, which is well supplied with organic
matter. The upper part of the subsoil, which is about 14 inches thick, is similar in texture to the topsoil, but it is poorly supplied with organic matter and is grayish brown in color. The rest of the soil mass is composed of very light gray loose sand which rests, at a depth of about 3 feet, on almost white loosely cemented weathered sandstone, from which the soil has developed.

Although the profile described is typical of the greater part of this soil, there are several variations. In many places the topsoil, although very dark, may be much thinner or thicker than typical, depending on the relief. On steep slopes it does not exceed 6 inches in thickness and in spots has been entirely removed, exposing the underlying light-colored subsoil. The reverse of this condition exists in many places near the bases of long gradual slopes where the topsoil in some places attains a thickness of 18 or 20 inches through the addition of dark soil material washed down from higher levels. In a few places the subsoil is poorly developed or absent, and an 8- or 10-inch layer of dark topsoil may be separated from the parent sandstone by a 3- or 4-inch lighter colored sandy subsoil. The greater part of the soil is very limy, especially in the subsoil layer, but in many places practically no lime occurs either in the soil or in the underlying sandstone. These variations, although numerous, are not shown separately on the soil map, on account of their patchy character and local occurrence.

The relief of Holt fine sandy loam ranges from steeply sloping to nearly level, but most of the soil occurs on gently undulating divides or long gradual slopes. Drainage is good, but erosion, except on the steeper slopes, is not excessive.

This soil is adapted to any crop commonly grown, and about 85 percent of it, including most of the larger bodies, is under cultivation. Corn, oats, and rye, ranking in acreage in the order named, are the leading crops. Yields are about the same as those obtained on Marshall fine sandy loam. The uncultivated parts of the soil, including the less accessible areas and those too small to be profitably farmed, are included in native-pasture or hay land.

Boyd clay loam.—Boyd clay loam occurs in a few small bodies on the slopes and adjacent uplands along Niobrara River. It has developed from the same bluish-gray shaly formation from which Boyd clay loam, steep phase, has developed, and it occurs in close association with that soil. Boyd clay loam occupies the less eroded situations, such as the longer and more gradual slopes and small patches with nearly level relief, where the run-off has not been sufficiently rapid to gully the land or to prevent the development of soil. Most of the land is topographically suited to cultivation, but it is composed of clay which is rather difficult to till, and only about 70 percent of it is farmed.

The 8- to 12-inch topsoil is very dark grayish-brown, in many places almost black, heavy clay loam well supplied with organic matter. The subsoil in most places is poorly developed or absent, owing to the resistance of the underlying shale, and in most places the topsoil rests directly on the unweathered or only slightly weathered shale formation. The shale contains an intricate network of seams and cracks of various widths filled with finely divided lime. Considering its heavy texture this soil is remarkably friable, owing partly to the manner in which the lime is distributed and partly to
the addition of silty and sandy material washed or blown from higher lying soils and mixed with the clay.

The cultivated parts of this soil are used for the same crops as are grown on Marshall fine sandy loam. In normal or wet years crop yields are almost as high as on that soil, but in dry years yields are generally low, because the high clay content causes the soil to shrink and crack, thereby breaking the crop roots and exposing them to drought. The uncultivated areas are used for pasture and hay land. The native grasses will support a cow or horse on each 2 or 3 acres, or, when cut for hay, will yield about one-third ton an acre. The native hay is composed largely of grama and wheatgrass and is of excellent quality.

SOILS ADAPTED TO HAY FARMING

The group of soils adapted to hay farming occupies about 22 percent of the total area of the county. It includes Cass loamy fine sand, with a heavy subsoil phase, Cass fine sandy loam, Cass loam, Cass and Valentine loamy sands, undifferentiated, Sarpy fine sand, Lamoure fine sandy loam, and Gannett loamy fine sand. The greater part of these soils is too wet to be used for grain crops. With the exception of Gannett loamy fine sand, these soils occur in the poorly drained prairie plains area and in the intricate system of valleys connected with this area. The Gannett soil occurs in low pockets and swales, locally known as wet hay valleys, within the sand hills.

The decayed remains of a rank vegetal growth, produced by the abundant moisture supply, has given the soils of this group darker topsoils than occur in any other soil in the county. In most of the soils the subsoils, which are saturated with water much of the time, are composed of incoherent gray sand, but in some the sand immediately beneath the topsoil is cemented with clay and organic matter, forming a moderately or extremely dense claypanlike layer in the upper part of the subsoil. In others the subsoil consists of friable or only moderately compact sandy clay to a depth ranging from 3 to 4 feet. Nearly all the subsoils and many of the topsoils are limy. Most of the soils include local spots in which alkali is sufficiently abundant to injure vegetation.

The soils of this group rank among the most productive soils for native hay in Nebraska. They support rank growths of a great variety of high moisture requiring grasses, chief among which are reed canary grass (Phalaris arundinacea), sloughgrass (Spartina michauxiana), pony grass (Calamagrostis neglecta), bluejoint (C. canadensis), and slender meadow grass (Puccinellia aroides). During normal years these grasses will yield from three-fourths to 1 ton of hay an acre. The native hay is a little coarser textured and has a somewhat lower feeding value than the hay produced on better drained soils in this and other counties of Nebraska, but its high yield tends, in large measure, to offset its inferior quality. Some farmers have improved the quality of the native hay on their lands by sowing timothy and alsike in the hay meadows, and during recent years an increasing number of them have been plowing the land in the better drained situations and establishing pure stands of mixed timothy and clover. This crop, according to the Federal census, slightly exceeded corn in acreage in 1929. About 85 percent of the
area occupied by the soils of the hay-farming group remains in its virgin state.

**Cass loamy fine sand.**—Cass loamy fine sand occupies a larger area than any other soil classed with the group of soils adapted to hay farming, but no soil of this group is as extensive as the Valentine soils or dune sand of the group of soils adapted to grazing. This soil occurs as irregular-shaped bodies of different sizes and as disconnected strips of various lengths and widths in most of the valleys throughout the southern three-fourths of the county, and also occupies a few small bodies in the northern one-fourth. Some of the largest areas are between the Chicago & North Western Railway and Elkhorn River in the eastern part.

The relief ranges from level to very gently undulating in most places. Locally it may be a little hummocky, but differences in relief in few places exceed 2 feet. The soil as a whole is a little more elevated and consequently a little better drained than most of the other soils belonging to this group, but it lies several feet below the soils of the other two groups, with which it is in many places closely associated, and it naturally receives considerable moisture in the form of seepage from those soils. This moisture, together with that received through precipitation, maintains a rather high water table and makes the soil as a whole a little too wet for the profitable production of grain or tame-hay crops, except such as are able to adjust their root systems to the moist conditions.

The topsoil, which averages about 12 inches thick, consists chiefly of loose fine sand, but contains so much well-decayed grass remains that it is almost black. The subsoil is composed of incoherent gray sand, in most places extending to a depth below 3 feet, although locally it may contain one or two horizontal layers of silty or clayey material, which in few places exceeds 2 inches in thickness. These heavier layers are, in general, light colored and in many places have a green tinge, but they may be almost black. Areas of this soil having the layers of heavier material occur in the more poorly drained situations.

If it were adequately drained, practically all this soil could be used for grain and tame-hay crops, particularly corn, sweetclover, alfalfa, and clover and timothy mixed, but artificial drainage, if effective, would necessitate such an elaborate system of long, deep ditches as to be impractical in most localities. Under present conditions, mixed timothy and clover does well in many places and corn gives fair yields in a few widely scattered fields where natural drainage is best established, but probably 85 percent of this soil is at present poorly adapted to cultivated crops and is used in its virgin state for native-hay land. It supports a heavy growth of grasses, including big bluestem and needlegrass in the higher lying situations and reed canary grass, sloughgrass, and pony grass in the lower places. These grasses will yield about one-half ton of hay on each acre in normal years.

**Cass loamy fine sand, heavy-subsoil phase.**—Cass loamy fine sand, heavy-subsoil phase, as mapped in this county, includes all the Cass soils in which the upper part of the subsoil is more compact than typical. Soil of this phase is not extensive. It occurs in numerous, mainly small, bodies throughout the east-central part of the county. Most of the areas occupy the lowest positions within areas of other Cass soils. One of the largest, comprising about 640 acres, is along
Elkhorn River, about 2 miles southwest of Eaton Lake, and a slightly smaller body is about 3 miles northwest of the lake. Few of the remaining bodies exceed 160 acres in size, most of them ranging between 5 and 20 acres.

All of this land is poorly drained. Much of it occurs around or near lakes, ponds, or marshy areas, and the water table in few places is more than 3 feet beneath the surface of the ground.

Soil of this phase is variable. The topsoil ranges from less than 6 to about 12 inches in thickness, with an average of about 8 inches, which is somewhat thinner than the corresponding layer in the other Cass soils. Over the greater part of this soil the topsoil consists of very dark—in places almost black—loamy fine sand with a high organic-matter content. In several of the bodies, however, the texture ranges from loamy sand to very fine sandy loam or loam within a few rods. In local spots "alkali" accumulations have destroyed most of the organic matter, and the upper part of the topsoil is gray, but the lower part is darker. Elsewhere the immediate surface layer is fairly dark, but the lower part of the topsoil has been largely leached of its organic constituents and consists of almost white incoherent sand.

The upper layer of the subsoil, which ranges from 6 to about 12 inches in thickness, is composed largely of sand but contains some silt and clay and an abundance of organic matter. It is everywhere more compact than the overlying topsoil and as dark or darker, although the density and color differ somewhat in different localities. In most places this layer is very dark, in places jet black, but it is only moderately compact where it underlies a dark-colored topsoil, whereas it is generally brown and extremely dense or claypanlike beneath the lighter colored topsoil of the alkaline spots. Its compaction and dark color are undoubtedly due in both situations largely to organic matter and clay washed down from the surface soil. The material beneath the compact layer is loose gray sand similar to that composing the entire subsolos of the other Cass soils. The subsoil and, in places, the topsoil, are very limy.

None of this land is suited to cultivated crops on account of its poor drainage, but it all, except the alkaline spots on which vegetation is rather sparse, supports a rank growth of water-loving grasses and is used for native-hay land. The grasses in many places will produce from three-fourths to 1 ton of hay an acre, depending on the precipitation. The hay is a little coarser and has a slightly lower feeding value than that obtained from most of the other hay-producing soils, but the higher yield in large measure tends to offset the inferior quality.

Cass fine sandy loam.—Cass fine sandy loam is used almost exclusively for native-hay land. It occupies bodies and strips comparable in size and shape to those of Cass loamy fine sand and has the same general distribution as that soil but is less extensive. Practically all of it occurs in the prairie plains division of the county or in wet valleys throughout the sand hills. Most of the bodies adjoin those of Cass loamy fine sand, and the two soils are almost identical, except in texture of the topsoil. This layer in Cass fine sandy loam contains a little less sand and more silt and clay than the corresponding layer in Cass loamy fine sand, and the fine sandy loam occupies slightly lower positions than the loamy fine sand, especially where the
two soils are contiguous. Cass fine sandy loam is consequently a little wetter and supports a slightly heavier grass cover, but the grasses on the wetter land are coarser and have a lower feeding value than those where moisture is not so abundant. The slightly increased yields of hay on Cass fine sandy loam are offset by the superior quality of the hay obtained on Cass loamy fine sand. The recognition of these relationships has caused some farmers to sell more of the hay produced on Cass loamy fine sand and to retain for cattle feeding more of that obtained from Cass fine sandy loam.

Cass loam.—Cass loam occurs in close association with Cass fine sandy loam and Cass loamy fine sand, but it is less extensive than either of these soils. Most of it is in Newport, Center, and Bassett Precincts, where it occupies small scattered bodies or narrow strips adjoining or surrounded by some other Cass soil. In common with the other Cass soils it is composed largely of sand. It occupies some of the lowest positions throughout the prairie plains and sand-hill valleys, and, although seldom covered with water, it is almost continually saturated, especially during the early part of the growing season.

The topsoil, which is about 10 inches thick, is finer in texture than that of the other Cass soils, and it contains 50 percent or more of silt and clay, intimately mixed with a large quantity of fine sand or medium sand and an abundance of black well-decayed organic matter, giving the material a loamy texture and very dark color. The subsoil consists of loose gray sand similar to that in the other Cass soils.

Practically all this soil is used as native-hay land. It supports a dense rank growth of coarse moisture-loving vegetation, chiefly slough-grass, which will yield about 1 ton of hay an acre in normal years. This hay is not so marketable as that obtained from better drained soils and is used chiefly as feed for the local cattle during the winter.

Associated with this soil are scattered small patches, in which the upper part of the subsoil is much more compact than typical, resembling in places a claypan. A few of these patches include spots in which alkali is sufficiently abundant to practically prevent the growth of coarse grasses, and the ground is either bare or supports a growth of wire grass, locally mixed with some grama. Where sufficiently large, these patches are shown on the soil map as bodies of Cass loamy fine sand, heavy-subsoil phase. The smaller areas are included with Cass loam.

Cass and Valentine loamy sands, undifferentiated.—Cass and Valentine loamy sands, undifferentiated, include bodies in which the Cass and Valentine soils are about equally distributed but occupy such numerous and small patches that they cannot be shown separately on a small-scale map. The bodies are widely scattered throughout the southern three-fourths of the county, most of them occurring within or adjoining bodies of typical Cass or Valentine soils. They are of irregular shape and range in size from less than 100 to slightly more than 640 acres. The Valentine soils, chiefly Valentine loamy sand, occupy the higher situations, occurring on small hummocks and mounds with gradually sloping sides and of irregular size and shape. Few of the mounds exceed 30 inches in height or 200 feet in their longer dimension. They are completely surrounded by an intricate network of shallow swales, ranging from 50 to 150 feet in width, which are occupied by Cass loamy fine sand.
These undifferentiated soils throughout are composed largely of fine or medium sand, but the soil in the swales has accumulated an abundance of well-decayed grass remains and has a very dark topsoil ranging from 8 to 12 inches in thickness. The soil on the mounds is low in organic matter and has a rather light colored topsoil which in few places is more than 5 inches thick. The subsoil in both situations is loose gray sand. The water table, even during the drier seasons, lies within a depth of 6 feet. It rises in the spring and, in the swales, may remain for several weeks within 2 feet of the surface of the ground.

This type of land is used almost exclusively for native hay. The grass growth is naturally ranker in the swales, where moisture conditions are most favorable, than on the low mounds and hummocks, but all the higher lying soil supports a good grass cover. This soil, as a whole, will yield a little more than one-half ton of hay an acre during normal years. It does not occupy a large total area and is of only local agricultural importance.

**Gannett loamy fine sand.**—Gannett loamy fine sand occurs in numerous widely scattered small bodies occupying low swales and pockets in the sand hills. The areas have no surface drainage outlets, and all moisture received by them is forced to seek outlet through downward seepage. Most of this soil remains wet or very moist the greater part of each year.

The topsoil is very dark, locally almost black, loamy fine sand ranging from 8 to 14 inches in thickness. It is well supplied with organic matter, which accounts for its dark color. The subsoil consists largely of loose gray sand similar to that beneath the Valentine soils and dune sand, except that it contains numerous rust-brown splottes, spots, and streaks, owing to poor drainage. In many places it is further modified by a horizontal layer, ranging from 2 to 8 inches in thickness, of bluish-gray or greenish-gray clay, which may occur at any depth between 2 and 6 feet. This clay layer is not present in all bodies of this soil. Gannett loamy fine sand closely resembles Cass loamy fine sand in many characteristics, but its subsoil is more iron stained, as a rule, and in more places contains clay layers than does the subsoil of the Cass soil.

Gannett loamy fine sand supports about the same type of grass cover as Cass loamy fine sand and has about the same hay-producing value (acre for acre) as that soil, but it is of little agricultural importance on account of its small extent.

**Sarpy fine sand.**—Sarpy fine sand occupies small bodies and narrow strips within or adjacent to Niobrara River, few of which exceed 60 acres in extent. Most of them are much smaller.

Practically all of Sarpy fine sand has developed from recently deposited river sands which have not yet accumulated much organic matter. In some places this soil resembles river wash, but it is more stable and is not so greatly influenced by each slight rise in the stream.

The 5- to 7-inch topsoil consists of grayish-brown incoherent fine sand or medium sand, the fine sand predominating. It is underlain, to a depth exceeding 4 feet, by material of similar consistence though slightly coarser in texture and lighter in color. The surface layer, to a depth of 2 or 3 inches, in most places contains some organic matter and is a little darker than the rest of the topsoil, but the organic content is not sufficient to prevent soil drifting when the native
vegetation is destroyed, and it disappears if the soil is overgrazed or cultivated. This soil is not limy.

Areas of Sarpy sand are nearly level. This land lies from 3 to 4 feet above the normal level of the river and, although subject to occasional overflow, is not covered with water except during high stages of the stream, and then only for a few hours. The subsoil is moist but not poorly drained.

Less than 15 percent of this soil is used for cultivated crops, chiefly corn, and most of the rest is used for native-hay land, although a rather large proportion supports a scattered to dense growth of willow and cottonwood trees and is included in pasture land. Although the organic-matter content is very low, the moisture supply is abundant, and corn yields about 20 bushels an acre on the cultivated areas in most years. Hay yields are about the same as those obtained on the soil classed as Cass and Valentine loamy sands, undifferentiated.

Lamoure fine sandy loam.—Lamoure fine sandy loam occurs in many small widely scattered bodies in valleys or basins, chiefly in the eastern and southwestern parts of the county. Most of it occurs within or adjoining bodies of Cass loamy fine sand or Cass fine sandy loam. Few of the bodies exceed 15 acres in size.

Most of this soil has developed on silty or clayey sediments which have accumulated in depressions on the prairie plains or in sand-hill valleys, probably through surface wash from more elevated positions, but in the areas on the flood plains of Niobrara River and Skull and Bloody Creeks the soil has undoubtedly developed on silty material deposited by these streams during stages of overflow. Practically all the land lies somewhat below the general level of the surrounding soils and is poorly drained.

The topsoil is very dark or black friable fine sandy loam ranging from 8 to 14 inches in thickness. The subsoil is light colored and very limy. To a depth of about 3 feet it consists chiefly of silt or clay, but it everywhere contains sufficient fine and medium sand to give it a gritty feel. The rest of the subsoil is composed of loose gray sand similar to that beneath the Cass soils. The water table is within 3 feet of the surface of the ground much of each year, and the subsoil is continually very moist and in many places saturated.

This soil supports a heavy growth of moisture-loving grasses and is all included in hay land, for which it is as well suited as Cass fine sandy loam, although it is of little importance in this county on account of its small extent.

SOILS ADAPTED TO GRAZING

The group of soils adapted to grazing occupies 72.6 percent of the land in the county. One or another of these soils occurs wherever the relief or drainage is unsuited to the use of farm machinery or the soil is more poorly adapted for hay and grain crops than for pasture land. The group includes Valentine sand, Valentine loamy sand, Sparta sand, Boyd clay loam, steep phase, Boyd loamy sand, steep phase, O'Neillo sandy loam, upland phase, and Holt loamy fine sand, in addition to the miscellaneous land types—dune sand and rough broken land—which are not classed as soils.
All the soils of this group include some land which is under cultivation or is used for hay. Garden patches and widely scattered cultivated fields of a few acres each may occur even in the dune sand and rough broken land areas. Much hay is cut, especially on the Valentine soils and dune sand, but the greater part of all these soils and miscellaneous land types remains in its virgin state, and about 85 percent of the area occupied by the group as a whole is used for native pasture land.

All these soils occur in the uplands, with the exception of Sparta sand which occupies a terrace position. They have a wide range in topographic and soil features.

Areas of the Holt and Boyd soils, rough broken land, and dune sand range from hilly to extremely rough and broken, and the other soils are nearly level or rolling. The Holt soil and rough broken land include exposures of hard light-colored bedrock, and the steep phases of the Boyd soils have exposures of dense bluish-gray shale. Dune sand and the other soils of the group are composed largely of incoherent sand. The upland phase of O'Neill loamy sand contains an abundance of coarse gravel in the subsoil and in many places in the topsoil. This soil and the Holt and Boyd soils have accumulated sufficient organic matter to make their surface layers much darker than the corresponding layers of the other grazing soils, but the intensity of the darkness varies with the relief, the hilly Holt and Boyd soils in few places being as dark as the more nearly level upland phase of the O'Neill soil.

All the soils of this group support moderate or heavy growths of nutritious pasture and hay grasses. The less stable sands support a fair growth of Redfieldia and Muhlenbergia; where the sands are a little more stable little bluestem and needlegrass make good growths; and on the finer textured though severely eroded soils grama and junegrass are dominant.

Valentine sand.—Valentine sand is the most extensive soil in the county. It is closely associated with dune sand and occurs in all parts of the county. In the southern part most of it is in the drier valleys and pockets between ridges and hills of dune sand, but in the northern part it occupies extensive and rather uniform bodies. The largest areas are in the northern and western parts of the county.

Valentine sand differs from dune sand chiefly in that its relief is lower and a little more even. The Valentine soil supports a little heavier grass cover than dune sand, and this feature, together with its lower and more protected position, makes it a little more stable. The relief is generally rolling or hummocky, although in many places it is nearly level, but it is not characterized by the high dune-like hills such as occur in typical dune sand areas.

The soil material, to a depth below 5 feet, consists of gray incoherent sand. The upper part, to a depth of 4 or 5 inches, has accumulated a little organic matter and in most places is slightly darker than the rest of the soil, but the organic content is nowhere sufficient to prevent drifting when the native sod is destroyed. This soil has no surface drainage, and the precipitation rapidly percolates into and through the porous sand, and this has resulted in the removal of all the lime.

Valentine sand is of little value for cultivated crops, on account of its low organic-matter content, low water-retaining power, and un-
stable character when cultivated, and the greater part of it is included in pasture land, although much of that part in the valleys throughout the sand hills is used for native-hay land. This soil has a slightly higher grazing and hay-producing value than dune sand.

Valentine loamy sand.—Valentine loamy sand differs from Valentine sand chiefly in that its topsoil is a little better supplied with organic matter and is a trifle thicker. This soil occurs in close association with Valentine sand and dune sand, but it is much less extensive than either of those soils. Most of it occupies small widely scattered bodies in valleys, where it is surrounded by Valentine sand. Few of the bodies exceed 200 acres in size. This soil has no surface drainage, but all surplus moisture rapidly seeps away through the porous sand.

The higher organic-matter content of its surface layer makes this soil a little more stable than Valentine sand, and some farmers have broken the sod for cultivated crops. Fair yields of corn and rye are obtained during the first 2 or 3 years, but after the grass roots decay not enough organic matter remains to maintain the stability of the sand, and the cultivated areas soon become areas of gray blow sand which has no value, even for pasture land, until the native grasses have been reestablished.

Practically all this soil remains with its native-grass cover, which consists of a rather heavy growth of needlegrass, big bluestem, and little bluestem. The land has a somewhat higher grazing and hay-producing value than Valentine sand. In normal years the grasses on about 6 acres will support a cow or horse during the summer grazing season, or when cut for hay will yield about one-third of a ton an acre. Most of this soil is used for pasture, but it is of little agricultural importance on account of its small extent.

Sparta sand.—Sparta sand occupies several rather large bodies on the high Niobrara River terrace in the northern part of the county. It is similar to Valentine sand, differing from that soil only in that it occupies a slightly lower position and has a more even surface than most of the Valentine sand areas, but even these differences are scarcely noticeable in some places, especially around the outer margin of the high terrace, where Sparta sand merges gradually with Valentine sand. In such localities the boundary between the two soils as shown on the soil map is largely arbitrary. In most places where the two soils join, Sparta sand lies from 3 to 4 feet below Valentine sand and has very little relief, whereas Valentine sand ranges from gently rolling to hummocky.

Sparta sand is composed almost entirely of fine sand or medium sand, with a low organic-matter content, and it is very unstable when the grass cover is destroyed. It is not suited to cultivated crops, and practically all of it is included in grazing land, for which it has about the same value as Valentine sand. It is of only moderate agricultural importance on account of its local distribution.

Boyd clay loam, steep phase.—Boyd clay loam, steep phase, occupies narrow strips on the lower valley slopes along Niobrara River and its tributaries. It has developed on the lowest exposed bedrock in the county—the extremely fine textured bluish-gray Pierre shale. Where subjected to the prolonged influence of weathering and soil-forming processes, as on long gradual slopes and nearly level areas.
this shale has given rise to a heavy dark-colored clayey soil mapped as Boyd clay loam, but throughout most of its area in this county this soil occupies such steep slopes that little or no soil could be formed, and in such localities it is mapped as a steep phase of Boyd clay loam.

Nearly all this soil is severely eroded. In a few places the surface features are as rugged as those of rough broken land, but the relief, although unfavorable to the use of farm machinery, averages less harsh than that of the rough broken land areas, and this soil contains no exposures of the light-colored sandstone, which are characteristic of rough broken land.

All this land is used as grazing land. It supports about the same species of trees as grow on rough broken land, but the forest growth is less dense and more stunted and the grass cover is slightly heavier and more uniform, consequently, the land has a little higher grazing value. It is, however, of minor agricultural importance on account of its small extent.

**Boyd loamy sand, steep phase.**—Boyd loamy sand, steep phase, differs from the steep phase of Boyd clay loam only in that its surface layer is more sandy. It occupies only a few narrow strips on the lower parts of the steep valley slopes along Niobrara River. It occupies about the same topographic position as the steep phase of Boyd clay loam, but, unlike that soil, it has been covered to a depth ranging from 6 to 14 inches by loose fine sand which has washed or rolled down from the higher lying rough broken land areas. In many places the sand has accumulated a fair quantity of organic matter and, to a depth of about 4 inches, is dark colored, but over the greater part of this soil the sand is low in organic material and rather light colored, even on the surface. In many places it contains gravel and angular fragments of the higher lying sandstone. The material beneath the sandy layer is unweathered or only slightly weathered bluish-gray Pierre shale similar to that composing the steep phase of Boyd clay loam.

All this soil is used as grazing land. It supports a much denser and more uniform grass cover than any other steeply sloping soil in the county because of its more favorable moisture supply. The sandy surface mulch rapidly absorbs all precipitation and the underlying shale retards loss of moisture through seepage.

In addition to the grass cover, which consists largely of needlegrass and big bluestem, the land supports a scattered growth of elm, ash, and bur oak trees.

**O’Neill loamy sand, upland phase.**—O’Neill loamy sand, upland phase, occurs in the northern part of the county, where it occupies several small bodies in Kirkwood and Long Pine Precincts, the largest of which, comprising about 500 acres, is between the heads of Short Pine and Sand Creeks. Only a few of the other bodies cover as much as 300 acres, and most of them range between 20 and 160 acres in size.

This soil has a very dark topsoil, about 10 inches thick, which is composed largely of incoherent sand. The subsoil, which extends to a depth exceeding 5 feet, consists of brownish-gray gravel. The topsoil layer contains an abundance of well-decomposed organic matter, which accounts for its dark color, but it contains practically no silt or clay and is very unstable when the grass cover is destroyed. The subsoil is extremely porous and droughty, and it contains no lime.
All areas of this soil are topographically suited to cultivation, as the greater parts of them have nearly level or very gently rolling relief. None of the land is farmed, however, on account of its unstable and droughty character. It supports a rather sparse vegetal cover, composed largely of bunchgrass, and does not have a high value even for grazing land.

Locally within areas of O'Neil loamy sand, upland phase, are a few small bodies and patches, in which the soil material is composed largely of brownish-gray gravel from the surface downward. Such bodies are shown on the soil map by gravel symbols within areas of the typical soil. They are of value only for grazing.

**Holt loamy fine sand.**—Holt loamy fine sand occupies several small bodies in the northeastern part of the county, chiefly in Kirkwood Precinct and the eastern part of Long Pine Precinct. The largest area, comprising about 300 acres, is on the east side of Rock Creek, and the other bodies, although rather numerous, are much smaller.

Most of this soil occupies gradually sloping to rather steep valley sides, but a part of it is nearly level or gently rolling. The soil has developed from light-colored soft limy sandstone similar to that from which rough broken land was carved but under conditions more favorable for soil development.

The topsoil is dark-brown or almost black loose loamy fine sand ranging from 9 to 12 inches in thickness. It is high in content of organic matter but is very low in content of silt and clay. In places it contains much fine gravel. The upper part of the subsoil, which extends to a depth of about 20 inches, is brown or light-brown incoherent fine sand. The lower part is composed largely of loose gray sand which extends to a depth of about 30 inches, where it rests on the unweathered or slightly weathered light-colored sandstone. Fragments of this sandstone may occur throughout the entire soil mass and in many places are numerous in the lower part of the subsoil. In a few places, on some of the steeper slopes, the sandstone outcrops.

Most of this soil is topographically suited to cultivation, but it is a little too droughty for most cultivated crops and when brought under cultivation is very unstable. Practically all of it remains with its native-grass cover and is used for grazing (chiefly) and for hay land. It is equal to Valentine loamy sand for native-hay and pasture land.

**Dune sand.**—Dune sand is a name applied to the material in the rougher parts of the sand hills. It is not a true soil but is of value for pasture land and is, therefore, included with the group of soils adapted to grazing. It occurs in nearly all parts of the county, but the largest and most uniform areas are in the southern part. It is nearly as extensive as Valentine sand.

Dune sand consists of fine or medium grades of gray incoherent sand, the medium sand predominating. It contains some organic matter but not enough to prevent drifting when the covering of grasses is removed. The color and texture of the material show very little change to a depth of several feet, and the lower part differs little from the upper, except in its smaller content of organic matter. The material is unusually retentive of moisture, considering its sandy character. It contains no lime.
Dune sand has been derived through disintegration of the soft sandstone formations of the region, and has been deposited in its present position by the wind. The general absence of fine material is probably due to the removal of such material by the wind during the continual shifting of the dunes.

The surface features are rather variable. In the typical sand hills, which occur in the southwestern and extreme southern parts of the county, the relief is that of a monotonous succession of irregularly distributed hills and ridges with intervening valley swales and pockets, although in places many hummocks and old and recent blow-outs give variety to the landscape. The most common occurrence of the blow-outs is on the northwestern exposures. Throughout most of the rest of the county dune sand occurs chiefly as numerous hilly areas of various sizes surrounded by lower lying land. In Blaine and Lay Precincts the lower land consists largely of a connected system of wet or dry hay valleys. The relief in the hilly areas does not differ materially from that in the typical sand hills.

Dune sand lacks surface drainage, because all moisture falling on the ground is rapidly absorbed by the porous sand and seeps away in the underdrainage. A few creeks are in the southwestern part of the county, and streams or lakes are in several of the valleys throughout Blaine and Lay Precincts, but all surface waters occur in soils other than dune sand.

The dune sand areas are practically without value for cultivation, although a few attempts are made to farm the land. The sand drifts so easily that removal of the native grasses is almost certain to ruin the land, not only where the vegetation is destroyed but also for some distance to the windward. At present most of the dune sand is fairly well sodded, and very little is subject to active wind erosion. The native vegetation includes many valuable pasture grasses of which little bluestem (Andropogon scoparius), blow-out grass (Muhlenbergia pungens), sandgrass (Calamovilfa longifolia), Redfieldia flexuosa, and needlegrass (Stipa comata) are most common. In spring and summer, the grasses afford good grazing and will maintain from 70 to 90 head of cattle to the square mile, but in winter they cannot be depended on. When cut for hay they will yield about one-fourth ton an acre. The preservation of the native grass growth is the foundation of the only agricultural development apparently possible on dune sand under present conditions. Drifting sand along old roads and near water tanks plainly shows the disastrous effects of disturbing the sand-binding roots. Care should be taken to prevent and control fires which burn off the protective covering of grasses.

Rough broken land.—Rough broken land is not a typical soil, but it is valuable for pasture land and is, therefore, included with the group of soils adapted to grazing. As mapped in this county it includes a few severely eroded and deeply gullied areas occupying the upper valley slopes and adjacent uplands along Niobrara River and its tributaries. The largest body, comprising about 4 square miles, is along Long Pine and Short Pine Creeks in Brinkerhoff Precinct.

Rough broken land is unsuited to the use of farm machinery, as practically all of it is steeply sloping in one direction or another, and precipitous bluffs occur in many places. The light-colored soft
sandstone of Tertiary age is everywhere within a depth of 18 inches, and the material above it is composed largely of sand or gravel derived through disintegration of this rock. Little or no true soil has been formed, owing to the steepness of the slopes. In many places the sandstone is exposed.

The greater part of this land is covered with a fairly dense mixed growth of western yellow (bull) pine (Pinus ponderosa), red cedar (Juniperus virginiana), mossycup (bur) oak (Quercus macrocarpa), ash, and elm trees, many of which are large enough for railroad ties and small-dimension lumber. However, they are used only for posts and firewood. The stand of trees is in few places sufficiently thick to entirely prevent the growth of grass, and all the land is used for grazing. In the less-shaded places and in many small open patches there is a dense growth of grama.

SOILS AND THEIR INTERPRETATION

The soils of Rock County, as a whole, are immature. Most of them owe their distinguishing characteristics more to local parent materials and drainage conditions than to the broader environmental influences of the region in which they occur. This county is in the Chernozem soil region of the United States, and all the soils, except those in severely eroded situations or on recently deposited materials, have developed under the grass vegetation characteristic of this region. Most of the county is covered by wind- or water-laid quartzitic sands and gravels, which are not only extremely resistant to weathering and the formation of soil, but in most places have been subjected to such poor drainage or such constant wind erosion that soil development has been greatly retarded.

The only soils which appear to have developed under conditions favorable for deep soil development occur in small scattered bodies with nearly level or gently rolling relief on the tablelands, chiefly in the northern part of the county. In these bodies, the combined area of which is probably less than 10 percent of the total area of the county, the soils have formed on such widely different parent materials as loess and sand. They have apparently developed under good drainage, in the absence of salts, destructive wind erosion, or other influences of a strictly local character and, as a result, have reached a more advanced stage of development, as determined by the regional climate and vegetation, than any other soils in the county.

Following is a description of a profile of Thurman fine sandy loam, which is regarded as typical of these soils, so far as stage of development is concerned. The profile described was observed in a nearly level area near the head of Ash Creek in the northeastern part of the county. This soil has developed on sand.

A. 0 to 10 inches, very dark grayish-brown single-grained fine sandy loam.
B. 10 to 21 inches, brown or dark-brown single-grained loamy fine sand of moderate coherency.
B1. 21 to 40 inches, gray or grayish-brown incoherent fine sand or medium sand.
C. 40 inches +, the parent sand which differs from the material in the B1 layer only in that it is a little lighter in color.
None of the horizons is sharply defined in color, texture, or coherence, and no part of the soil mass effervesces when dilute hydrochloric acid is applied.

Marshall fine sandy loam, sandy-substratum phase, which has developed on a thin layer of loess overlying sands in the western part of the county, has a profile very similar to that of Thurman fine sandy loam, except that the subsoil is composed largely of silt instead of sand. The B1 layer ranges in texture from silt loam to loam. The B2 layer has a high silt content in its upper part, but at a depth ranging from 3 to 4 feet it generally consists of almost pure sand not unlike that in the Thurman soil. None of the Marshall soil is limy.

The absence of a zone of lime enrichment (soil lime) in these soils so far west as Rock County is owing largely to their high sand content. They have developed under a mean annual precipitation no greater than that in many other counties of the State, where practically all the more mature soils are characterized by a pronounced zone of lime enrichment in the lower part of the solum. In Rock County, however, most of the soils, even the finer textured ones, contain considerable sand and are rather porous, allowing easy and rapid penetration of water, which greatly increases the efficiency of the precipitation in removing the readily soluble salts and in preventing the formation of a zone of lime concentration. This does not imply that all the soils are low in lime. Some of the immature soils contain an abundance of this material. This lime, however, is not the result of soil development, but is a part of the geological material from which the soils are developing and, owing to insufficient time, poor drainage, or excessive run-off, has not yet been entirely removed from the solum.

Practically all the other soils are relatively immature. Throughout most of the southern three-fourths of the county and part of the northern one-fourth the sandy material, except in the deeper and moister valleys, is thinly covered with grass, is rather unstable, and has been more or less subjected to pronounced wind erosion, even within the memory of the early settlers. The soils, where developed sufficiently to be regarded as such, are prevailingly light in color, owing both to the scarcity of organic matter and to the unfavorable conditions for retaining this material. Dune sand, which is the chief material of the sand hills, consists of hilly areas of almost pure gray sand. This sandy material supports a sparse grass cover but has been so shifted about by the wind that it has not accumulated much organic matter or been otherwise sufficiently modified by soil-forming agencies to be regarded as soil. The Valentine soils are less hilly than dune sand, support a little heavier grass cover, and have accumulated enough organic matter to slightly darken their surface layers, but the rest of the solum is almost pure gray sand which has made little or no progress toward soil development. Any calcareous material which may have been present in the sands composing the Valentine soils or dune sand has been removed.

Over large areas, including the low-lying hay flats, or prairie plains, in the north-central and east-central parts of the county, and numerous valleys throughout the sand hills, the sand deposits are characterized by poor drainage and a high water table. Here, the Cass soils predominate. Owing to favorable moisture conditions,
these soils have a heavy grass cover and have accumulated enough organic matter to make their surface layers very dark, in many places almost black; but the sands in the lower part of the solum remain saturated much of each year and the subsoils have made little progress toward maturity of development. In most places they owe their characteristics chiefly to the wet condition, but in some localities to both moisture and alkali.

Throughout the greater part of the area occupied by the wet hay flats, the Cass subsoils consist of incoherent gray sand containing numerous ferruginous stains and some lime, but, in many places, they have developed a moderately compact Solonchaklike Bs layer, ranging from 6 to 12 inches in thickness, in which an abundance of organic matter and some clay has accumulated, probably through leaching from the topsoil. Bodies in which this layer occurs are shown on the soil map as a heavy-subsoil phase of Cass loamy fine sand. The material in the heavy layer is as dark as, and in places darker than, the material in the A horizon. It is everywhere highly calcareous, the lime occurring in soft white spots, splotches, or seams, and in finely divided form. This layer lies directly beneath the topsoil which is moderately calcareous. It is underlain by incoherent rust-stained sand which may or may not be limy.

Locally, throughout the wet hay flats, are small patches, few of which exceed a few square rods, in which the presence of excess salts has undoubtedly been the controlling factor in determining the character of the soil. In these patches, most of which are surrounded by the heavy-subsoil phase of Cass loamy fine sand, the soil profile is similar to that of a Solonetz soil, except that it is more sandy. The topsoil consists of a layer of almost black structureless fine sandy loam or loamy fine sand, from 6 to 10 inches thick. The second layer is composed of thoroughly leached and almost white sand, and it ranges from less than 3 inches to slightly more than a foot in thickness, owing to lack of continuity in the third layer on which it rests. The third layer is brownish-gray extremely dense sandy clay or clayey sand, ranging from 6 to 10 inches in thickness. It is not continuous but consists of many irregularly ellipsoidal blocks having larger horizontal than vertical dimensions and lying in the same general plane. All the blocks have well-rounded edges and corners, even on their under sides. They are separated by a network of seams and cracks ranging from one-half inch to 3 inches in width, which are filled with leached sand extending downward from the overlying layer. Many of the blocks exceed 18 inches in their longer horizontal dimension. Most of them rest on incoherent rust-stained sand similar to that beneath the other Cass soils of the wet hay flats. In some places the blocks are entirely surrounded by the white leached sand.

The vigor of reaction with dilute hydrochloric acid differs greatly in the different horizons of the Solonetzlike soil in this county. In most places the topsoil and the sand beneath the dense layer react weakly, the blocks of the dense layer react strongly even on their upper surfaces, but the white sand of the highly leached layer will not effervesce either in its upper part or at the point where it touches the blocks. Owing to its local occurrence and small extent, this soil is not shown separately but is included with the heavy-subsoil
phase of Cass loamy fine sand on the accompanying map. Profiles similar in all essential features to the one described were also observed southeast of O’Neill and north of Dora Lake in Holt County.

Table 6 gives the results of mechanical analyses of samples of Ewing fine sandy loam.

**Table 6.—Mechanical analyses of Ewing fine sandy loam from Rock County, Nebr.**

<table>
<thead>
<tr>
<th>Sample no.</th>
<th>Description</th>
<th>Fine gravel</th>
<th>Coarse sand</th>
<th>Medium sand</th>
<th>Fine sand</th>
<th>Very fine sand</th>
<th>Silt</th>
<th>Clay</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Percent</td>
<td>Percent</td>
<td>Percent</td>
<td>Percent</td>
<td>Percent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>378419</td>
<td>Surface soil, 0 to 6 inches</td>
<td>0.9</td>
<td>7.6</td>
<td>18.0</td>
<td>40.7</td>
<td>14.5</td>
<td>11.0</td>
<td>7.3</td>
</tr>
<tr>
<td>378420</td>
<td>Subsurface soil, 6 to 12 inches</td>
<td>1.5</td>
<td>5.9</td>
<td>15.1</td>
<td>34.1</td>
<td>18.0</td>
<td>12.5</td>
<td>13.2</td>
</tr>
<tr>
<td>378421</td>
<td>Subsoil, 12 to 27 inches</td>
<td>1.4</td>
<td>2.4</td>
<td>5.4</td>
<td>7.5</td>
<td>20.4</td>
<td>33.4</td>
<td>30.5</td>
</tr>
<tr>
<td>378422</td>
<td>Subsoil, 27 to 40 inches</td>
<td>14.7</td>
<td>23.0</td>
<td>19.9</td>
<td>22.1</td>
<td>8.0</td>
<td>5.3</td>
<td>7.0</td>
</tr>
<tr>
<td>378423</td>
<td>Subsoil, 40 to 60 inches</td>
<td>.0</td>
<td>7.0</td>
<td>43.7</td>
<td>39.6</td>
<td>6.0</td>
<td>.8</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Table 7 gives the results of pH determinations on two soil profiles. These determinations were made in the laboratories of the Bureau of Chemistry and Soils by the hydrogen-electrode method.

**Table 7.—pH determinations on soil profiles of Ewing fine sandy loam and Boyd clay loam in Rock County, Nebr.**

<table>
<thead>
<tr>
<th>Soil type and sample no.</th>
<th>Depth (Inches)</th>
<th>pH</th>
<th>Soil type and sample no.</th>
<th>Depth (Inches)</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ewing fine sandy loam:</td>
<td></td>
<td></td>
<td>Boyd clay loam:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>378419</td>
<td>0-6</td>
<td>6.8</td>
<td>378424</td>
<td>0-3</td>
<td>7.8</td>
</tr>
<tr>
<td>378420</td>
<td>6-12</td>
<td>6.2</td>
<td>378425</td>
<td>3-15</td>
<td>6.7</td>
</tr>
<tr>
<td>378421</td>
<td>12-27</td>
<td>6.4</td>
<td>378426</td>
<td>15-30</td>
<td>7.7</td>
</tr>
<tr>
<td>378422</td>
<td>27-40</td>
<td>6.4</td>
<td>378427</td>
<td>30-51</td>
<td>7.7</td>
</tr>
<tr>
<td>378423</td>
<td>40-60+</td>
<td>7.0</td>
<td>378428</td>
<td>51-72+</td>
<td>7.8</td>
</tr>
</tbody>
</table>
Accessibility Statement

This document is not accessible by screen-reader software. The U.S. Department of Agriculture is committed to making its electronic and information technologies accessible to individuals with disabilities by meeting or exceeding the requirements of Section 508 of the Rehabilitation Act (29 U.S.C. 794d), as amended in 1998. Section 508 is a federal law that requires agencies to provide individuals with disabilities equal access to electronic information and data comparable to those who do not have disabilities, unless an undue burden would be imposed on the agency. The Section 508 standards are the technical requirements and criteria that are used to measure conformance within this law. More information on Section 508 and the technical standards can be found at [www.section508.gov](http://www.section508.gov).

If you require assistance or wish to report an issue related to the accessibility of any content on this website, please email [Section508@oc.usda.gov](mailto:Section508@oc.usda.gov). If applicable, please include the web address or URL and the specific problems you have encountered. You may also contact a representative from the USDA Section 508 Coordination Team.

Nondiscrimination Statement

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA’s TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the
Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at http://www.ascr.usda.gov/complaint_filing_cust.html and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by:

(1) mail: U.S. Department of Agriculture
    Office of the Assistant Secretary for Civil Rights
    1400 Independence Avenue, SW
    Washington, D.C. 20250-9410;

(2) fax: (202) 690-7442; or

(3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.