

# SOIL SURVEY OF BOONE COUNTY, NEBRASKA.

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## DESCRIPTION OF THE AREA.

Boone County, Nebr., lies in the northeastern part of the State. Albion, in the central part of the county, is about 130 miles northwest of Omaha. With the exception of the southern boundary, which is somewhat irregular, the county is rectangular in outline. It is 24 miles wide east and west and has an average length of about 28 miles north and south. It comprises an area of 692 square miles, or 442,880 acres.

The greater part of the county lies within the Loess Hills region of northeast Nebraska. It is near the western boundary of this region, however, and includes a small part of the Sand Hills region. Physiographically the county consists of an almost level to steeply rolling or hilly plain, cut by numerous strips of flat alluvial lands, and modified in the northwest corner by a small area of sand hills. The topographic relief is not conspicuous, but minor relief has been produced by stream erosion and wind action.

The upland covers about 85 per cent of the county. It may be separated into two main divisions, the eroded loess plain or Loess Hills and the Sand Hills.

The eroded loess plain covers the entire county, with the exception of a small area in the northwest corner. It represents a remnant of the original loess plain that once covered much of eastern Nebraska. In this county it has been so modified by erosion that only the higher hill crests and broader divides remain to mark the level of the former loess mantle. The surface ranges from almost flat to hilly, but the greater part is rolling.

The comparatively level areas are not extensive; they occupy the highest positions in the county, lying near the level of the original constructional plain. The surface is very gently undulating to almost flat, modified in a few places by small sinks or depressions.

The hilly areas of the eroded loess plain are of relatively small extent. They occur chiefly in the southwestern part of the county, on the high divide between Cedar River and Plum Creek. Smaller areas lie about 2 miles west of Petersburg in the northern part and about 3 miles southwest of Albion in the central part of the county. The tops of the ridges are narrow and the slopes are steep. In many places small landslides are a prominent feature, the slopes presenting

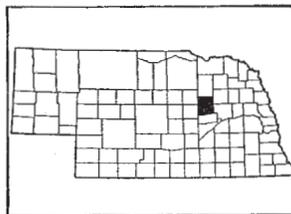


FIG. 39.—Sketch map showing location of the Boone County area, Nebraska

a succession of contourlike shelves known as "catsteps" caused by the sliding action. Here the streams have cut deep, narrow channels and are still actively eroding. The valleys are usually narrow.

The greater part of the eroded loess plain is in a mature stage of development and has a rolling topography. The slopes to the larger streams are long and gradual, except in the southeastern corner of the county on the east side of Beaver Creek and in the southwestern part on the south side of Cedar River, where they are rather abrupt and in places blufflike. The main drainage ways have broad rather deep valleys. The secondary drainage channels are usually narrow and often steep sided, becoming gradually broader in their lower courses.

The second upland division includes the sand-hill area in the northwestern part of the county. Throughout this division the loess has been largely removed by erosion and an underlying sand sheet exposed. Wind has been the controlling factor in the formation of the topographic relief, and the surface varies from gently undulating to hilly, depending upon the degree of wind action to which it has been subjected. Over the greater part of this area the sand has been whipped into dunes varying in height from 30 to 60 feet, giving the surface a decidedly hilly appearance. Around the margins of the hilly area the topography varies from flat to gently undulating and in places hummocky.

The alluvial lands of Boone County comprise about 15 per cent of the total area. They include the terraces and flood plains along the larger streams. The largest developments are along Cedar River and Beaver Creek, where they occur as continuous strips varying in width from one-eighth mile to about  $2\frac{1}{2}$  miles.

The terraces lie well above overflow. They occur at several distinct levels. The highest terraces are east of Albion and north of Primrose, where the surface is from 75 to 85 feet above the stream channels. The most extensive terrace development in the county lies from 35 to 40 feet above the normal flow of the streams and occurs largely on the south side of Beaver Creek between St. Edward and Albion. Smaller terraces of this level lie east of Primrose and north of St. Edward. The lowest terraces, lying from 12 to 15 feet above the stream channels, occur in numerous bodies and narrow strips bordering the flood plains along Cedar River and Beaver, Plum, and Timber Creeks. The slopes between the several terrace levels are usually short and rather abrupt, while those to the uplands are more gradual.

The first bottoms or flood plains in Boone County are well developed along all the major streams. They occupy the lowest positions in the area and are subject to frequent inundations during periods of high water. The main developments occur along Cedar River and Beaver Creek as narrow, continuous strips varying in width from one-eighth to about three-fourths of a mile. The topography is flat, modified in places by old stream channels, cut-offs, and shallow depressions.

Boone County has an average elevation of about 1,850 feet above sea level and a general slope to the southeast. The altitude ranges from approximately 1,675 feet southeast of St. Edward to about 1,950 feet in the north-central part of the county. It is estimated

that the general surface of the upland lies from 100 to 150 feet above the Cedar River and Beaver Creek flood plains. The elevation of St. Edward is 1,653 feet, Boone 1,699 feet, Albion 1,748 feet, Loretto 1,834 feet, Petersburg 1,897 feet, Primrose 1,820 feet, Cedar Rapids 1,782 feet, and Bradish 1,774 feet.<sup>1</sup>

Boone County drains to the southeast, with the exception of a few square miles along the northern boundary, which drain northward into Antelope County. The drainage is effected through Shell Creek, Beaver Creek, Plum Creek, Cedar River, and Timber Creek, with their tributaries. These streams flow in parallel courses in a southeasterly direction.

Beaver Creek, the longest stream within the county, flows diagonally across the county through the northwest and southeast corners. The channel has an average width of about 30 feet and varies in depth from 2 to 4 feet. It is very meandering, although the general course of the valley is straight. The creek, together with its tributaries, drains the northwestern, central, and southeastern parts of the county. The extreme northeastern part is drained by the headwaters of Shell Creek, which empties into the Platte River in Colfax County. The southwestern half of the county is drained by Plum Creek, Cedar River, and Timber Creek. Cedar River has a very meandering channel, which varies in width from 60 to 100 feet and has an average depth of 2½ feet. Timber Creek drains the extreme southwest corner of the county and empties into Cedar River in Nance County. Plum Creek flows between Beaver Creek and Cedar River and empties into the Loup River.

The greater part of Boone County is well though not excessively drained. Nearly all sections are reached by the streams or their branches. In the northwestern corner, however, in the sand-hill area, surface drainage has not been established and the surplus moisture seeps through the loose porous sands and reaches the main streams through subterranean channels.

The most poorly drained areas include parts of the first bottoms, which are subject to frequent overflow, and a few local depressions on the upland, where water accumulates for short periods after heavy rains. In many places the smaller upland drainage ways have partly filled their channels with sediment where they issue onto the broader flood plains, and the water spreads over the surface before it reaches the main stream.

All the streams of Boone County have fairly steep gradients, are swift flowing, and are actively deepening their channels. Water power is developed at St. Edward and Albion on Beaver Creek and at Cedar Rapids on Cedar River.

Well water of excellent quality is readily obtained in all parts of the county. The upland wells throughout the eroded loess plains range in depth from 100 to 190 feet. They usually extend to the sand sheet underlying the loess mantle. In the sand-hill area the wells are much shallower and an adequate water supply is usually obtained within 80 feet of the surface. The wells throughout the bottom lands range in depth from 30 to 100 feet. Artesian water has been obtained in the Beaver Creek Valley in the northwestern corner of the county from wells that average about 30 feet in depth. Nu-

<sup>1</sup> Gannett, Dictionary of Altitudes.

merous springs also occur in this region on both sides of the main stream.

Native timber grows in narrow belts along all the larger drainage ways throughout the county. It consists chiefly of elm, ash, box-elder, willow, and cottonwood, interspersed with some oak and hackberry. The timber is not of merchantable size, but is of value for firewood and post material. Planted groves of cottonwood, ash, and elm are found on many farms.

The first settlement in Boone County was made in 1871, and the county was organized during the same year. Within the next few years most of the land was included in homesteads. The early settlers came largely from the east-central States. They were of many nationalities, although the majority were of American birth.

According to the census, the population of the county was 8,638 in 1890, 11,689 in 1900, 13,145 in 1910, and 14,146 in 1920. The last census gives the density of the population as 20.4 persons per square mile. The entire population is classed as rural. In 1920 over 90 per cent of the inhabitants were native white persons. Those of foreign birth are principally from Germany and the Scandinavian countries. The population is rather evenly distributed, although somewhat denser in the Cedar River and Beaver Creek Valleys. The sandy land in the northwest corner is the most sparsely settled.

Albion, the county seat and largest town, with a population of 1,978, is located in the central part on Beaver Creek and is an important distributing center for farm implements and supplies. St. Edward in the southeast corner ranks second in size with 1,002 inhabitants. Cedar Rapids, in the southwestern part, has a population of 766 and is an important milling center. Petersburg (501 inhabitants), Primrose (155), Loretto, Raeville, and Bradish are markets and distributing centers for the localities in which they lie.

The transportation facilities of Boone County are good. All the railroads are branch lines, but make good connections with outside points. A branch of the Chicago & North Western Railway enters the county from the east and extends up the Beaver Creek Valley for about 15 miles, then turns north. Bradish, Albion, Loretto, Petersburg, and Raeville are on this line. A branch of the Union Pacific Railroad follows the Cedar River Valley across the southwestern corner of the county, passing through Cedar Rapids and Primrose. A spur of this branch follows the Beaver Creek Valley from Genoa, Nance County, to Albion, passing through St. Edward and Boone. These roads furnish good shipping facilities to all except the northwestern and northeastern parts of the county.

The public-road system of Boone County is well developed, except, in the northwestern part, where the sandy land makes the expense of road construction and maintenance excessive. Most of the highways follow section lines. All are dirt roads. The more important ones are kept in excellent repair, and the minor roads are kept in fair repair throughout the year. There are several State and Federal-aid roads in this county, and these receive the most attention, being gravel surfaced where necessary, kept well graded, and dragged after each rain. Increased attention is being given to the construction of concrete culverts and steel bridges. Albion has several miles of concrete pavement.

All parts of the county are supplied with rural mail delivery, telephones are in common use, and the public-school system is highly developed.

## CLIMATE.

The climate of Boone County is typical of northeastern Nebraska and is well suited to grain farming and stock raising. The long, warm summers are especially favorable to corn, while the low temperatures sometimes occurring in winter are not usually destructive to winter-grown crops owing to the protection of snow. The springs are usually cool, with considerable rainy weather, and the autumns are long and pleasant with only occasional periods of rainy weather. There is not sufficient variation in topography to cause any appreciable differences in climate within the county.

The table below, compiled from the records of the Weather Bureau station at Albion, in the central part, gives the normal monthly, seasonal, and annual temperature and precipitation:

*Normal monthly, seasonal, and annual temperature and precipitation at Albion.*

[Elevation, 1,747 feet.]

Month	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1898).	Total amount for the wettest year (1920).
	<sup>°</sup> F.	<sup>°</sup> F.	<sup>°</sup> F.	Inches.	Inches.	Inches.
December.....	23.7	72	-29	0.87	0.20	1.28
January.....	21.3	64	-37	.63	.60	T.
February.....	22.7	75	-32	.82	.67	2.20
Winter.....	22.6	75	-37	2.32	1.47	1.48
March.....	35.2	89	-15	1.02	.20	1.06
April.....	48.5	100	12	2.86	1.37	5.61
May.....	59.4	100	23	3.91	4.03	5.22
Spring.....	47.7	100	-15	7.79	5.60	11.89
June.....	68.4	103	33	3.96	4.62	2.13
July.....	73.6	107	40	3.12	1.11	6.82
August.....	71.6	107	32	3.04	1.47	4.85
Summer.....	71.2	107	32	10.12	7.20	13.80
September.....	62.9	103	20	2.32	1.28	1.94
October.....	51.5	90	3	1.93	.51	4.41
November.....	36.1	84	-15	.95	.61	1.35
Fall.....	50.2	103	-15	5.20	2.40	7.70
Year.....	47.9	107	-37	25.43	16.67	34.87

The mean annual temperature is 47.9° F. January is the coldest month and July is the warmest. There is a range in temperature of 52.3° between the means of the coldest and warmest months. The absolute minimum temperature is -37° F. recorded in January and the highest is 107° F. recorded in both July and August. The average date of the last killing frost in the spring is May 7, and that of

the first in the fall September 29. This gives an average growing season of 145 days, which is ample for the maturing of all farm crops common to the region. The latest recorded killing frost occurred on May 27 and the earliest on September 12. The grazing season begins about June 1 and ends in the latter part of October.

The mean annual precipitation is 25.43 inches, of which about 39 per cent falls during the principal part of the growing season, June, July, and August. The total precipitation in the driest year on record (1898) was 16.67 inches and in the wettest year (1920) 34.87 inches. The driest months are November, December, January, and February, the mean annual precipitation of each being less than an inch.

In the summer the precipitation usually occurs as heavy thunder-showers, though torrential rains are rare. Severe droughts are almost unknown during May and June, but in the latter part of July and all of August the rainfall varies considerably and short dry spells may occur. Crops seldom suffer from lack of moisture, however, when proper cultural methods are followed, as most of the soils have a high water-retaining capacity. The amount of snowfall varies annually from a few inches to several feet. From October 1 to April 1 the prevailing wind is from the northwest and from April 1 to October 1 it is from a southern direction. Strong winds are common, but tornadoes are rare.

#### AGRICULTURE.

Boone County is essentially agricultural. The land was originally covered with a luxuriant growth of prairie grasses, with marginal strips of timber along the larger streams. The first permanent settlement was made in 1871. The early settlers located along the edge of the first bottoms, where fuel and water were easily obtained. Within a few years much of the land had been filed on under the public-land laws. During the first few years vegetables, corn, and spring wheat were grown. These food products were supplemented by milk, game, and pork. As the settlements became more permanently established and conditions more stable, the farmers began to break the land for the more extensive production of corn and wheat, with some oats for stock feed. Very few cattle were raised. Ranching was followed to some extent, but became important only in the more sandy sections. Over most of the county larger returns were obtained from grain crops.

The early development of agriculture was slow, owing to the lack of markets and transportation facilities and to the ravages of insect pests. In 1874 the grasshoppers destroyed the crops over large areas. The construction of the railroads gave the first marked impetus to agricultural progress.

The census reports the average value per farm of all farm property, including land, buildings, implements, and domestic animals, at \$1,392 in 1880, \$3,908 in 1890, \$6,579 in 1900, \$18,187 in 1910, and \$39,150 in 1920. Between 1880 and 1920 the number of farms increased from 794 to 1,859.

The following table, compiled from the census reports, gives the acreage and production of the principal crops of the county in 1889,

1899, 1909, and 1919, and shows the general trend of agriculture during the last 30 years:

*Acreage and production of principal crops in 1889, 1899, 1909, and 1919.*

Crop.	1889		1899		1909		1919	
	Area.	Production.	Area.	Production.	Area.	Production.	Area.	Production.
	<i>Acres.</i>	<i>Bushels.</i>	<i>Acres.</i>	<i>Bushels.</i>	<i>Acres.</i>	<i>Bushels.</i>	<i>Acres.</i>	<i>Bushels.</i>
Corn.....	59,804	1,997,496	114,482	3,496,210	132,378	4,309,733	131,888	3,975,883
Oats.....	18,172	396,863	40,892	1,206,990	60,881	1,122,887	59,547	1,825,364
Wheat.....	10,079	80,037	54,168	715,720	24,368	442,998	17,218	166,445
Rye.....	361	4,084	6,508	92,370	635	7,666	3,815	36,230
Barley.....	749	11,341	658	13,520	713	11,285	3,746	86,587
Emmer and spelt.....					848	14,499	43	529
Flaxseed.....	1,605	10,827	10	200	3	11		
Potatoes.....	815	64,855	893	96,272	1,030	73,341	726	39,779
		<i>Tons.</i>		<i>Tons.</i>		<i>Tons.</i>		<i>Tons.</i>
Wild hay.....	35,442	44,128	27,886	25,122	18,218	18,139	15,348	13,204
Alfalfa.....			626	830	23,314	48,812	33,670	46,167
Timothy and clover (mixed).....					3,887	5,173	1,004	1,090
Millet and other tame grasses.....			5,343	11,044	2,287	3,572	1,369	2,262
Coarse forage.....			292	844	191	449	3,268	8,956
	<i>Trees.</i>	<i>Bushels.</i>	<i>Trees.</i>	<i>Bushels.</i>	<i>Trees.</i>	<i>Bushels.</i>	<i>Trees.</i>	<i>Bushels.</i>
Apples.....	2,066	123	17,205	1,975	30,007	23,215	23,016	5,783
Cherries.....					11,247	1,845	5,796	2,330

As in eastern Nebraska generally, grain growing is the principal occupation now followed in Boone County. Much attention, however, is given to the winter fattening of cattle, hog raising, and the production of purebred cattle, hogs, and horses for breeding purposes. Dairying is practiced in a small way. Corn, oats, wheat, alfalfa, and wild hay are the principal crops.

The type of farming practiced is uniform throughout the county, except that the relative importance of the various crops differs with the sections. The proportion of land used for grazing is larger throughout the bottom lands and the more sandy and rougher parts of the uplands. A larger proportion of the better drained terrace land is used for alfalfa on account of the more favorable moisture supply and usually higher yield.

According to the Federal census the value of all crops produced in Boone County in 1919 was \$8,699,702. Dairy products were produced to the value of \$356,044 and poultry and eggs to the value of \$337,955. The total value of all domestic animals on farms in the county in January, 1920, was \$5,342,594.

Corn is by far the most important crop. In 1921 it occupied about 35 per cent of the area of the county, and yielded an average of 31 bushels per acre.<sup>2</sup> Corn is grown more or less on all the soil types with the exception of Dunesand. It is raised most extensively on the Marshall soils of the upland. The more sandy areas of the Valentine soils and the poorly drained parts of the bottom lands are seldom used for corn. Most of the grain is fed within the county to hogs, beef cattle, work stock, and dairy animals, although some is shipped to outside markets. The chief varieties grown are Reid Yellow Dent, Nebraska White Prize, and Iowa Silvermine. The greater part of the corn is planted in checkrows and the rest is

<sup>2</sup> All 1921 data are taken from Nebraska Crop Reporter, December 31, 1921.

listed in. The former method requires more labor but usually results in higher yields on account of the more thorough seed-bed preparation. It is common practice to husk the corn from the standing stalks in the fall and pasture cattle and horses in the fields during the winter.

A part of the crop is cut for winter roughage. On farms equipped with silos, of which there are many in the county, from 15 to 20 acres of corn are cut each year for ensilage. This corn is usually cut with a corn binder when the ears are in the dough stage, and hauled to the ensilage cutter while the stalks are green. The silos range in capacity from 80 to 200 tons. Many farmers annually fence off a few acres of unhusked corn for a hog range, and during 1921 the low market value of the grain induced many farmers to run fattening cattle in the larger fields in order to save the expense of husking the crop.

Corn is often grown on the same land five or six years in succession. Better yields are obtained, however, where it is grown in rotation with small grains and alfalfa. In recent years more attention has been given to the improvement of the seed corn, but as a rule seed selection is not carefully practiced.

Oats generally occupy an acreage about half as large as that of corn. The average yield in 1921 was 25 bushels per acre, but in exceptional seasons as high as 90 bushels have been obtained under good management. The crop is grown on all the improved soils of the county, but is poorly adapted to the more sandy soils on account of its shallow root system and the danger of injury to the young plants by drifting sand. It is considered less profitable than wheat or rye, but is very important for stock feed and as a step in the rotation. As it is not practicable to follow corn with winter wheat, oats usually follow corn in the rotation. Kherson and Swedish Select are the principal varieties. The oat crop does well on the heavier textured upland and terrace soils, but on the bottom land it grows too rank and often lodges. The Kherson, a very short, stiff-strawed variety, has given excellent results on the bottom land. Oats are seldom sown in succession. Seed selection is not carefully practiced. A few farmers import seed from other sections, although the usual method is to clean a sufficient amount of the previous crop for the next season. Smut often lowers crop yields during prolonged periods of rainy or cloudy weather. The grain is usually cut with a binder and either shocked or stacked for threshing. Most of the crop is fed to horses, a small part to other livestock, and very little is sold. The straw is used for roughage, stock being allowed to feed around the stack.

Wheat was not an important crop in Boone County in 1921, chiefly on account of the high cost of production and the low market value for the grain. Only 5,166 acres were devoted to wheat, with a total yield of 76,035 bushels. Both winter and spring varieties are grown; the latter, however, occupy only a few hundred acres. The average yield of winter wheat is reported as 15 bushels per acre, and that of spring wheat 10 bushels per acre. Under good management the yields are often much larger and yields of 20 to 25 bushels are common. The danger of winterkilling has been considerably reduced since the introduction of Turkey, a very hardy

winter wheat, which yields better than spring wheat, can be sown in the fall at a time when farm work is light, and matures before the dry weather and hot winds occur. Seed selection is not carefully practiced. Some damage is caused by smut to both winter and spring wheat. Rust rarely injures winter wheat, but is very destructive to spring varieties. The ravages of the Hessian fly sometimes reduce the yields.

Wheat is usually cut with a binder, except during very dry seasons, when the stems are too short for binding and the grain is headed. The crop is shocked or stacked in the field for threshing. Most of the grain is sold direct from the threshing machine, although some is stored in local bins and elevators until the market is satisfactory. The straw is left in the field and stock allowed to feed upon the stack.

Rye is grown to a small extent in Boone County. The crop is generally raised for the grain but also to some extent for hay and pasture. It usually yields better than wheat and will thrive on soil that is more impoverished. Its low market value, however, has tended to curtail its production. Much of the crop is raised upon the Valentine soils of the uplands and upon the O'Neill soils of the terraces. The crop is cut with either a binder or header, depending upon the length of the stems. The grain is threshed from the shocks or from stacks, the latter method being invariably used for headed rye. Most of the rye is fed locally to hogs, although some is shipped to outside markets.

Alfalfa ranks third in acreage in Boone County. It is grown on all the heavier textured soils in the county. The highest yields are obtained upon the better drained parts of the bottom land on account of the more favorable moisture conditions. Alfalfa does especially well on the soils of the Knox series because of their high lime content. The crop is also very beneficial to these soils, as it tends to prevent erosion and at the same time increases the naturally low content of organic matter. Soils of the Valentine series are poorly suited to the production of alfalfa on account of their low lime content.

Alfalfa seed is usually sown in August, after the first good rain, at the rate of 12 to 15 pounds per acre. The main consideration in obtaining a stand is thorough seed-bed preparation. Occasionally a nurse crop of wheat, oats, or rye is sown with the alfalfa. It is doubtful, however, if this practice is conducive to best results, as the nurse crop uses up available moisture and weakens the vitality of the young stand, and when the nurse crop is removed the evaporation is often excessive, causing serious injury to the alfalfa. A stand of alfalfa is usually allowed to remain from six to eight years. If allowed to remain longer the yields materially decrease. A field is rarely frozen out. The crop is usually cut three times during the summer season, and occasionally a fourth cutting is obtained. Yields range from  $2\frac{1}{2}$  to  $4\frac{1}{2}$  tons per acre, depending upon the soil and the moisture conditions. The hay is generally stacked in the field and hauled to the feed lots as needed. It is usually fed to cattle and hogs. Alfalfa hay is seldom fed to work horses, as the dust in the hay irritates the breathing organs and has a tendency to produce heaves. Many farmers run hogs in the fields during the summer.

Cattle, however, are seldom allowed to graze on green alfalfa on account of the danger of bloating. Alfalfa not only has high nutritive value and yields well, but is valuable in increasing the productive power of the soil for grain crops, particularly corn and oats. It is equal to red clover in this respect, although less suited to short rotations.

Wild hay ranks next to alfalfa in acreage. The entire county, with the exception of narrow strips of forest along the larger streams, was originally covered with prairie grasses. Most of the virgin sod, however, has been broken for grain production and tame-hay crops, and at present only a small area is used for wild-hay production. The native grasses on 12,030 acres were cut for hay in 1921, yielding an average of 1 ton per acre. Most of the native hay is produced on lands unsuited to cultivation, either because of their sandy nature, rough topography, or poor drainage. The principal hay grasses in the sandy sections of the county are sand grass, stipa, and bunch grass. On the heavier textured upland soils they include grama grass, buffalo grass, big bluestem, little bluestem, and small amounts of western wheat grass. The poorly drained bottom soils are covered for the most part with a luxuriant growth of coarse marsh grasses and sedges. In places, however, volunteer timothy and clover have become well established and spread over considerable areas, the seed having been washed down from Wheeler and Greeley Counties to the west, where these crops were sown extensively by the early ranchers in an effort to improve the range. The highest yields of native hay are obtained on bottom soils. The quality of the upland hay, however, is usually much better, as it grows less rank and has a finer texture and higher feeding value. The hay is stacked in the field and either baled for market or hauled to the feed lots as needed.

Sweet clover was grown on 2,662 acres in 1921. The plant is a biennial and dies at the end of the second year, after producing seed. It is used chiefly for hay and pasture. When hay is desired, the crop is usually cut during the first year before the growth becomes coarse and woody. The second year it is allowed to mature and reseed itself. The permanence of a sweet clover stand depends entirely upon its ability to reseed, and care is usually taken during the second year not to graze so closely as to prevent the maturity of enough of the crop to reseed the land. Seeding during two consecutive years at the start has been recommended to provide for annual reseeding and also for continuous late and early pasture. Sweet clover has an unusually wide adaptation. It thrives on both relatively wet and dry soils and on soils of either light or heavy texture. It is better suited to the soils of the Valentine series than alfalfa on account of its lower lime requirement.

Barley, potatoes, red clover, millet, and sorghum are grown in small patches to meet the farm requirements. They yield well during normal years.

Scarcely any trucking is carried on, except in a small way in the vicinity of the towns. Vegetables are grown on almost every farm, though not always enough to supply even the home demand. Watermelons and cantaloupes are raised heavily on the sandy terrace and bottom soils along Beaver Creek and Cedar River.

A considerable number of farms have small orchards of apples, cherries, pears, and peaches, which with proper care produce excellent fruit. There are no commercial orchards in the county. Of the small fruits, strawberries are the most important. They are grown chiefly on the more sandy and well-drained terrace soils in the vicinity of the larger towns. The Federal census reported 6 acres of strawberries with a total yield of 2,860 quarts in 1919, and 29,974 orchard trees of bearing age yielding 8,159 bushels of fruit. Of the wild fruits, plums, grapes, and chokecherries are the most important. They grow chiefly in the bottoms along Beaver Creek and Cedar River.

The raising of livestock is an important industry, and the county ranks among the foremost in the State in the production of purebred cattle, horses, and hogs for breeding, the winter fattening of cattle, and the fattening of hogs for market. The raising of grass-fed cattle is of minor importance, except in the more sandy sections.

The Federal census reports 32,884 beef cattle, with a total value of \$1,738,301, in the county in January, 1920. The purebred cattle are chiefly of the Shorthorn breed. In the grazing sections grade Herefords and Shorthorns predominate. Many cattle are shipped in for winter feeding and are fattened on corn and alfalfa. During recent years contract feeding has been practiced quite extensively. Under one form of contract the owner delivers the cattle to the feeder and allows him so much per pound for all gain in weight, and at the end of the feeding period the owner ships the animals to market. Another system is to allow the feeder \$5 per head plus the market price per pound for all gain. Under the latter system the feeder assumes the risk of loss on a falling market equally with the owner. Many purebred cattle are purchased by outside buyers for the improvement of their herds.

Dairying is gradually being extended in conjunction with general grain farming. The number of purebred dairy cattle is small but sufficient to serve as a basis for the development of the dairy industry. The abundance of rich nitrogenous feeds to balance the corn crop and the good marketing facilities combine to favor the extension of the dairy industry. From six to eight cows are kept on the average farm and practically every farm has a cream separator. A few farms are devoted to dairying exclusively and there are several purebred dairy herds in the lowlands along Beaver Creek. Many farmers milk grade beef cows. The purebred dairy cattle are chiefly Holsteins. Most of the surplus cream is shipped to Fremont and Omaha. The creamery at Albion furnishes a good local market. According to the census there were 7,491 dairy cattle, with a total value of \$444,997, in Boone County in January, 1920, and the value of dairy products sold in 1919 was reported as \$230,180.

Hog raising is practiced extensively in Boone County. Nearly every farmer fattens 30 to 60 hogs a year, and a few have herds of several hundred. Large numbers are raised in connection with the feeding of beef cattle. All the hogs are of excellent quality. Duroc-Jersey, Spotted Poland-China, and Hampshire are the leading breeds. There are several purebred herds in the county. Practically all of the hogs to be shipped to market are raised and fattened on the farm. Many purebred hogs are shipped to outside buyers for breeding purposes.

Hog raising is at times disastrously affected by the prevalence of hog cholera. During recent years much attention has been given to vaccination and to sanitary measures in combating this disease, and the losses have been greatly reduced. The census reports 83,712 hogs, with a total value of \$1,735,254, in Boone County in January, 1920.

The breeding of draft horses receives attention on nearly all farms. Some mules are also raised, but the local demand for mules is greater than the supply. The horses are of excellent quality and many of them are purebred animals of heavy draft types, chiefly of Percheron breeding. One of the foremost breeders of Percherons in the State is located near Boone, in the southeastern part of the county. Much improvement in the quality of the horses has been made in recent years. The Federal census reports 13,618 horses valued at \$1,222,206, and 1,490 mules valued at \$178,058, in Boone County in January, 1920.

There are only a few flocks of sheep in the county and sheep raising receives little attention. A few carloads are shipped in, fattened on corn and alfalfa, and returned to market when the prices are favorable.

Poultry is raised on all farms, the flocks ranging in size from 50 to about 200 chickens. The principal breeds are Plymouth Rock, Leghorn, Rhode Island Red, and Orpington. Many farmers also raise a few geese, ducks, turkeys, and guinea fowls. The 1920 census reports 164,180 chickens and 2,416 other poultry in the county, and receipts from the sale of chickens and eggs in 1919 as \$152,170.

A few colonies of bees are kept on many farms, and a few small apiaries of from 10 to 60 colonies are in the lowlands along Beaver Creek and scattered throughout the uplands. The county ranks among the foremost in the State in the production of honey, and the abundance of alfalfa and clover seems to warrant the extension of the bee industry. The census reports 1,106 colonies valued at \$5,269 in 1920, and a production of 21,562 pounds of honey and 162 pounds of wax with a total value of \$6,529 in 1919.

The adaptation of certain soils to particular crops is observed to some extent by the farmers. The areas of Dunesand and the more sandy soils of the Valentine series are recognized as being best adapted to grazing and hay production on account of the danger of soil drifting when the native vegetation is destroyed. The Knox soils are known to be well adapted to the production of alfalfa on account of their high lime content. The crop is also considered beneficial to these soils, as it tends to prevent destructive erosion and increases the content of organic matter. The Valentine soils are poorly adapted to alfalfa because of their low lime content, but are suited to the production of sweet clover. Corn thrives better upon the sandy soils than small grain, on account of its deeper rooting system, but the highest yields of corn are obtained upon the heavier textured terrace and flood-plain soils. Small grain does best upon the Marshall and Waukesha silt loams. When raised on the bottom lands it often grows rank and is likely to lodge. The Marshall silt loam is considered the best upland soil for general farming. While the above crop adaptations are recognized, there is not sufficient variation in yields to cause specialized farming in any part of

the county, except in the Dunesand areas, where cattle grazing is practiced almost exclusively.

Increased attention is being given to the careful preparation of the seed beds and the subsequent care of the crops. In the more sandy sections of the county the corn is usually listed in, as the ridged surface tends to check excessive wind erosion and consequent injury to the young plants. On the heavier textured soils check-row planting is usually practiced, as this method requires a more thorough seed-bed preparation and is considered favorable to higher yields. Planted corn is also more easily kept free from weeds, as it is possible to cultivate in several directions.

The preparation of the seed bed for small grain varies somewhat, depending upon the soil. On the more sandy land, where the soil is naturally loose and friable, plowing is resorted to only every second or third year. During the intervening years the seed bed is prepared by double-disking. On the heavier textured soils the land is plowed from 4 to 6 inches deep before planting. All small grain is sown with a press drill. Wheat is often sown between the corn rows in the fall.

Alfalfa is sown usually broadcast on well-prepared stubble ground and harrowed in, although a few farmers prefer to seed with a press drill on account of the more even stand obtained. Barnyard manure is very beneficial to alfalfa.

Potatoes are planted in plow furrows, the cuttings being dropped by hand, about 2 feet apart in every third furrow. Potato beetles are very injurious, and it is often necessary to spray the vines with various poisons to control the insects.

Farm buildings, especially the houses, usually are well painted and kept in good repair. There are many large modern houses and barns in the county. The farms are fenced and cross-fenced, mostly with barbed wire, though many farms are inclosed with hog-tight woven-wire fencing. There are a few hedge fences, mainly of Osage orange, which were established before the introduction of barbed wire. The work stock on all farms consists of heavy draft horses and mules. A few tractors are operated on the more level sections. On most farms the 4-horse hitch is used. The farm equipment consists of the most modern labor-saving machinery, including gang or sulky plows, disk harrows, straight-tooth harrows, drills, listers, corn planters, mowing machines, cultivators, rakes, hay loaders, stackers, binders, and wagons. In addition to these a few farms are equipped with corn binders, hay balers, and manure spreaders. There are enough threshing machines in the county to handle the grain crops. Most of these machines are owned by farmers who thresh the grain for the surrounding community. Only the more expensive farm machinery is sheltered.

The corn crop is usually cultivated three or four times during the summer. A 2-row riding cultivator is commonly used. Many farmers harrow the corn land a number of times before the young plants are large enough to cultivate, in order to keep down the weeds and conserve soil moisture. Potatoes are usually cultivated four or five times with a single-row walking cultivator.

Definite systems of rotation are followed by only a few progressive farmers. Over most of the county, however, the crops are changed with sufficient regularity to prevent the soil from becoming impoverished. The general tendency is to grow corn two or three years, or even longer, followed by one year of oats and one or two years of wheat, rye, or barley. When alfalfa sod is broken the land is usually used for corn two years, oats one year, then wheat or rye, and back to corn. Crops following alfalfa in the rotation are often subject to drought during the first year or two, as the alfalfa plant requires considerable moisture and leaves the soil in a comparatively dry condition. Corn is probably better adapted to recently broken alfalfa ground than small grains, on account of its deeper rooting system. Alfalfa does not adapt itself well to short rotations and most farmers prefer to keep the stand for five or six years.

Considerable barnyard manure is produced, but in most cases little care is taken to preserve it. On most farms the manure is piled out of doors without protection, where much of its fertilizing value is lost by leaching. The manure is hauled in the fall or spring and generally broadcast on land to be used for corn or small grain. It is often applied to the more eroded or more sandy parts of the field in an effort to control wind erosion and increase the organic content. On tenant farms little care is taken in applying the manure where it is most needed, and most of it is spread on the land near the barnyard.

During the past season farm labor has been quite plentiful. Wages range from \$40 to \$60 per month. Day labor commands \$2.50 to \$3 a day, and during the harvest season from \$5 to \$6 was paid in 1921. Wheat is threshed for 7 cents a bushel and oats for 3 to 4 cents, depending upon whether shocked or stacked. Corn shuckers usually receive 3 to 4 cents per bushel. Many farmers hire help by the year in order to insure an adequate supply at critical periods.

The Federal census reports show that 92.4 per cent of the county was in farms in 1920, and that 77.4 per cent of the farm land was improved. The average size of the farms was 220 acres. The size generally ranges between 80 and 320 acres, although there are many small holdings and a few large ranches of over 1,000 acres.

Owners occupied 1,029 and tenants were on 821 farms in 1920. The proportion of tenant farms has been gradually increasing. Both the cash and share systems, or sometimes a combination of the two, are followed in renting farms. Under the share system, which is most popular, the owner receives two-fifths of the grain delivered and \$5 an acre for pasture. All seed, labor, and machinery is furnished by the tenant. When alfalfa land is rented on shares the owner receives half the hay stacked in the field. Under the cash system the tenant pays \$5 to \$8 an acre for the use of the land, including the pasture areas. Farms suited only for pasture are often rented for a lump sum. On a few farms the renter is allowed the use of the pasture land without charge. During the last few years very little of the land suited for grain production has been rented for cash.

The selling price of the farms ranges from about \$35 to \$275 or \$300 an acre, depending upon the topography, drainage, improvements, character of the soil, and location with respect to markets.

The 1920 census reports the average assessed value of farm land in Boone County as \$143.22 an acre. The lowest priced land includes the Dunesand areas, which are valuable only for pasture. The average price of land of the Marshall silt loam, which occupies the greater part of the county, is about \$150 an acre. The highest priced land is in the immediate vicinity of the larger towns. The better parts of the Valentine soils, which are adapted to crop production, sell for \$75 to \$120 an acre, depending upon location and improvements. The heavier textured terrace soils comprise some of the highest priced land in the county and sell for \$150 to \$300 an acre, depending chiefly upon location. Bottom land along Beaver Creek and Cedar River sells for \$40 to \$200 an acre, according to drainage.

#### SOILS.

The soils of Boone County owe their most striking characteristics to the influence of climate. The decrease of rainfall westward in the United States and the corresponding decrease of moisture in the soil results in a less advanced stage of weathering and leaching of the soil material. Boone County lies almost on the boundary between two great natural soil regions; that is to say, between a region in which the leaching of carbonates has extended to a depth of more than 3 feet, and one in which leaching is not taking place to that depth, so that there is actually an accumulation of carbonates and other easily soluble compounds within the 3-foot section.

Climatic conditions and the topographic features of the area, with their resulting soil differences, have combined to prevent the growth of trees and to favor a dense growth of short grasses. The soils of the county have therefore been developed under a grass vegetation and have those characteristics which, under favorable climatic conditions, are impressed upon true prairie soils. The most obvious characteristic of the surface soils, and one common to prairie soils developed in the Temperate Zone under the influence of a moderate supply of moisture, is their color. This color is imparted by finely divided organic matter derived from the decay of grass roots and intimately mixed with the mineral constituents of the soil. All the soils of the county, with the exception of recently exposed loess, wind-laid sands, and recent river deposits, which have not yet had time to develop a mature profile, have very dark colored surface soils varying according to age, locality, and topography from very dark grayish brown to almost black.

The second common characteristic is the arrangement of structures developed in the profile. The surface soils are characterized by a fine granular structure which gives the loose, mellow condition to all the types of the area. The next lower zone of the well-drained upland is heavier in texture and more coarsely granular, but no type in this group has any marked compaction in the subsoil. The color changes gradually from the surface color to a brown, the transition zone usually having a thickness of 4 to 6 inches. The brown horizon usually extends to depths of 18 to 24 inches below the surface. As a rule, neither this horizon nor the surface soil contains enough carbonates to effervesce when treated with acid. The next lower zone is usually lighter in texture and looser than those above and ap-

proaches the parent material in color and structure. It has a large content of carbonates, mainly lime carbonate. As this county is on the border of the region in which carbonates accumulate in the subsoil, it is difficult to determine whether the carbonate present is a constituent of the parent material which has not been removed by leaching or is the result of an accumulation from above or below. It is believed, however, that much or all of it is a part of the parent material.

The profile described above is typical of a series of soils that cover the greater part of the upland. This group includes all soils classed with the Marshall series except the flat phase of the Marshall silt loam. Variations from this profile are the basis for the differentiation of nearly all the dark-colored soils. More thorough leaching in certain soils may have removed the carbonate, or conditions of restricted drainage may have modified the character of the subsoil, as in the case of the flat phase of the Marshall silt loam.

The Waukesha series includes a group of well-drained soils with dark-colored surface soils and brown heavy subsoils, which are not widely different from the two upper zones of the Marshall soils. These soils have been developed on terraces under conditions of good surface and subsoil drainage, and the lime has been largely removed to a depth of more than 3 feet. The O'Neill series may be classed with this well-drained, well-oxidized group, but the lower subsoil is sandy or gravelly.

The light-colored soils classed with the Knox series may be regarded as immature soils. Constant erosion of the surface layer has prevented the accumulation of organic matter in the soil, and the rapid removal of surface water from the slopes has not permitted leaching of the carbonates from the subsoil as fast as the subsoil has been brought near the surface. The surface soil has a brown color slightly darkened by organic matter. This is underlain immediately by the yellowish-brown parent material having no compaction and containing a large percentage of carbonates.

The soils of the Valentine series have been developed over accumulations of wind-blown sand that has ceased to move and has become covered with grass. The carbonate content is too low to cause effervescence in acid. The profile is immature, consisting of a surface soil darkened by a small percentage of organic matter and a subsoil of unweathered parent sand.

Some soils of the county have been developed under imperfect drainage conditions, so that oxidation has been much retarded. The surface soils as a rule are dark colored, but the subsoils are gray or mottled yellow and gray. In this area all such soils are developed on water-laid material. The group includes the Wabash, Cass, and Lamoure series in the first bottoms and the Scott and Gannett series in depressions. The Sarpy series occurs on recently laid alluvium and has a rather light colored surface soil.

The soils of Boone County, with respect to the origin of the parent material, may be divided into three groups—loessial, eolian, and alluvial. In order to understand the derivation of the soil material it is advisable to consider briefly the physiographic structure of the region.

The bedrock materials of the county, underlying the mantle rock, consist of formations of Cretaceous age, overlain in places by isolated bodies of Tertiary material. There are no exposures of Cretaceous beds, but the outcrops along the Missouri River in Knox and Cedar Counties to the north and in counties to the south, together with well records between these points, indicate that the formations pass under Boone County. The only bedrock exposed in the area is the Arikaree sandstone of late Tertiary age, which outcrops southeast of Primrose on the south side of Cedar River. This is sedimentary from material washed down from the more elevated regions to the west and deposited over a large part of the High Plains. It consists of a light-gray soft sandstone loosely cemented with lime. The bedrock of the county has no influence upon the character of the soils and very little upon the topography, although it is quite important as a source of water supply.

The mantle rock, which lies unconformably upon the bedrock, consists of a sand sheet, overlain by a mantle of loess. The exact geological relationship of the sand sheet is not clearly understood. It is thought to represent either glacial sands washed down during one of the later advances of the ice sheet, or débris consisting chiefly of decayed granite carried from regions to the north or west. The material is exposed over a considerable area in the northwestern part of the county, where the protective loess covering has been removed by erosion. In its original condition it consists of a light-brown to yellowish-gray, loose, incoherent sand composed largely of quartz. Subsequent to its exposure, the surface of the sand deposit has been modified, shifted, and reassorted by wind action, and the resultant materials have been classed as eolian or wind blown. Where the wind has been most active the sand has been heaped into dunes varying in height from 30 to 50 feet. Such areas are classed as Dunesand. In the more protected areas, where wind action has been less pronounced, the surface relief is gently rolling to hummocky, and considerable organic matter has been incorporated in the soil through the growth and decay of vegetation. Such areas have been classed with the Valentine series.

In addition to producing Dunesand and the soils of the Valentine series, the materials of the sand sheet have been largely responsible for the physical characteristics of the adjoining loessial areas and the lower lying alluvial lands. The finer particles have been carried by the winds and deposited upon the surrounding uplands, greatly modifying their soil character. The gradual washing down of the sand and its deposition upon the terraces and flood plains has also influenced the texture and structure of the alluvial soils. In a few places within the areas of Dunesand and Valentine soils are small depressional areas having poor drainage which are included with the Gannett series.

The loess mantle rests upon the sand sheet, except where removed by erosion, as in the northwest corner of the county. It occupies the highest position in the area and is a remnant of a gently eastward sloping plain which in comparatively recent geological times covered the eastern part of Nebraska.

In its unweathered condition the loess is an even-textured material composed largely of very fine particles. It is characterized

by a tendency to split into vertical planes, producing perpendicular bluffs along water courses and roads and in other places subject to erosion. The color ranges from light brown to yellowish brown. The nearest approach to the typical loess in its original condition is in the more dissected areas on the high divide between Cedar River and Plum Creek.

Since deposition most of the loess material has undergone decided changes, due to climatic influences. The surface material over large areas has acquired a dark color, owing to the accumulation and decomposition of organic matter. The dark-colored material is deeper on the smooth, level areas which favor the accumulation and decay of plants. The maximum accumulation has taken place in depressions on the smooth table-land, and the minimum in eroded areas of rugged relief, where the run-off is rapid. On the flatter areas the loessial material is characterized by a heavier, more compact layer between the average depths of 1 and 4 feet. This is due to the downward leaching and concentration of the fine particles through the agency of percolating water. Small basinlike depressions in which the subsoils are very heavy and compact are included with the Scott series.

The alluvial materials fall into two divisions—terraces, sometimes called benches or second bottoms, and flood plains or first bottoms.

The original loess plain was eroded by various streams, creating large valleys. Subsequently these valleys were filled with sediment to the level of the highest terraces. Later intrenchment by the streams below the terrace levels and the subsequent deposition of sediment during floods has created the present flood plains. The character of the sediment deposited depended largely upon its origin and upon the depth to which the streams had cut. Cedar River and Beaver Creek flowed through sandy areas and their sediment was naturally of a sandy nature. The smaller upland creeks passing through areas of loess soils carried only fine silty materials. The merging of these streams carrying particles of such different sizes gave rise to soils varying in texture from coarse sand to silt. The soils occurring on the well-drained terraces have been classed with the Waukesha and O'Neill series, and those on the first bottoms and subject to overflow have been included with the Wabash, Cass, Sarpy, and Lamoure series.

In the system of mapping employed in this survey the soils are grouped into series on the basis of similarity in color, structure, and origin or mode of accumulation. The series is divided into soil types on the basis of texture of the surface soil, which depends upon the proportions of mineral particles of different sizes. The type is the unit of mapping.

The Marshall series includes types with dark-brown to black surface soils and a yellowish-brown to yellow subsoil. It is distinguished from the lighter colored Knox series by the large quantity of organic matter in the surface soil. It is developed upon loess. The topography is prevailingly rolling, but ranges to gently undulating, and is flat in small areas. Drainage is good and is excessive in places. The series is represented in Boone County by Marshall loamy sand, fine sandy loam, very fine sandy loam, and silt loam. A flat phase of the Marshall silt loam is also mapped.

The surface soils of the Knox series are light brown to gray and the subsoil is yellow to grayish yellow. Like the Marshall, these soils are derived from loess, but the material has undergone less change in physical characteristics since deposition than that of the Marshall series, the most important change being the slightly darker color of the surface material due to oxidation and a slight accumulation of organic matter. The topography ranges from sharply rolling to hilly, and drainage is usually excessive. The soil is subject to such severe erosion that the surface material now exposed has not had sufficient time to leach and therefore contains more lime than the Marshall soils. The Knox series is represented in this county by the Knox very fine sandy loam and silt loam.

The surface soils of the Scott series are brown to black, and the subsoil is a drab to grayish, heavy, plastic clay. The Scott soils have developed from material which was washed from the higher lying surrounding soils and deposited in temporary lakes or ponds occupying sinklike depressions. The series is represented in Boone County by a single type, the Scott silt loam.

The types of the Valentine series have brown to dark-brown surface soils. The subsoil differs from the surface soil mainly in that it is slightly lighter in color, owing to a lower content of organic matter. Both soil and subsoil have a rather loose, incoherent structure. The materials are derived largely from the sand sheet underlying the loess. The surface varies from almost level flats to low dune-shaped hills. Wind action has played an important part in the final distribution and assortment of the materials. Two types, the Valentine sand and loamy sand, are mapped.

The surface soils of the Gannett series are dark gray to black and contain much organic matter, which in a few places is almost abundant enough to produce a muck. The subsoil is a light-brown to grayish-white, loose, incoherent sandy loam or sand. The series is developed in pockets or swales throughout the more sandy parts of the county. The soils differ from those of the Scott series in the sandier and less coherent nature of both soil and subsoil. They consist of wind-blown materials mixed with fine wash from the higher lying levels and modified by the incorporation of organic matter. Drainage is poor, and the lower areas remain in a marshy condition much of the year. The Gannett fine sandy loam is mapped.

The Waukesha soils are dark brown to black and have a yellowish-brown to brown subsoil. They are derived from water-assorted glacial and loessial materials and occupy the terraces along the larger streams. The topography is flat to very gently undulating, and drainage is good. The soils differ from those of the Marshall series chiefly in position and mode of formation and in having a more compact subsoil. The Waukesha fine sandy loam, very fine sandy loam, and silt loam are mapped in Boone County.

The O'Neill series consists of brown to dark-brown soils underlain by a light-brown to gray, loose, incoherent subsoil. The types occupy terraces along the larger streams. The topography is flat to gently undulating, and drainage is good. The soils differ from those of the Waukesha series in the more sandy and less coherent nature of the subsoils and the lower organic content. The O'Neill loamy fine sand is mapped.

Two types of the Wabash series, the very fine sandy loam and the silt loam, are mapped in Boone County. The surface soils are black and have a high content of organic matter. The subsoil is dark gray to drab. The material has been washed mainly from the loessial uplands and deposited on the flood plains along streams. The topography is flat and the drainage is variable.

The Cass types have dark-brown to black surface soils and a brownish-gray to light-gray sandy subsoil. They occupy flood plains along the larger streams and are subject to overflow. The soils differ from those of the Wabash series in the more sandy and less coherent nature of the subsoil. The Cass loamy fine sand, fine sandy loam, and very fine sandy loam are mapped in Boone County.

The Lamoure soils are similar to those of the Wabash series in topographic position, mode of formation, and structure. They differ in being less perfectly drained and in having a highly calcareous and usually lighter colored subsoil. The series is represented in Boone County by the Lamoure very fine sandy loam.

The soils of the Sarpy series differ from the Cass soils in the light-brown to grayish-brown color of the surface layer. They occupy low positions and are rather poorly drained. The topography is flat, except where modified by slight ridges and depressions. The series is represented by one type, the Sarpy sand.

The following table shows the actual and relative extent of each soil type mapped in Boone County:

*Areas of different soils.*

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Marshall silt loam.....	270,144	62.3	O'Neill loamy fine sand.....	3,776	0.8
Flat phase.....	5,696		Marshall loamy sand.....	3,392	.8
Marshall very fine sandy loam.....	27,456	6.2	Cass loamy fine sand.....	2,880	.6
Dunesand.....	24,512	5.5	Cass fine sandy loam.....	2,368	.5
Waukesha silt loam.....	18,624	4.2	Knox very fine sandy loam.....	1,664	.4
Wabash silt loam.....	17,408	3.9	Wabash very fine sandy loam.....	1,280	.3
Waukesha very fine sandy loam.....	15,872	3.6	Lamoure very fine sandy loam.....	960	.2
Valentine sand.....	15,616	3.5	Sarpy sand.....	512	.1
Knox silt loam.....	14,848	3.4	Waukesha fine sandy loam.....	448	.1
Marshall fine sandy loam.....	6,016	1.4	Scott silt loam.....	320	.1
Valentine loamy sand.....	4,800	1.1	Gannett fine sandy loam.....	320	.1
Cass very fine sandy loam.....	3,968	.9	Total.....	442,880	-----

MARSHALL LOAMY SAND.

The surface soil of the Marshall loamy sand is a brown to dark grayish brown loamy sand 10 to 15 inches deep. The material is rather loose and incoherent and is composed of the medium, fine, and very fine grades of sand, with the fine sand predominating. The surface layer of 6 inches contains considerable organic matter, but not enough to prevent the soil from drifting when the native vegetation is destroyed. The upper subsoil is a brown to light-brown very fine sandy loam to an average depth of 20 inches, where the subsoil changes abruptly to a light-gray or yellowish-brown friable silt containing considerable very fine sand. The type is not usually calcareous within the soil section, but below the 3-foot depth the lime content gradually increases, and the substratum is highly calcareous.

The Marshall loamy sand is confined chiefly to one large area of about 2½ square miles in T. 21 N., R. 8 W. Several small circular patches occur within the Valentine sand type in T. 21 N., R. 7 W. A long narrow strip borders the edge of the Marshall very fine sandy loam type in T. 22 N., R. 7 W. The total area of this soil is a little over 5 square miles. The type has been developed on loess, but the upper part has been modified by wind-blown sand from neighboring soils. Its coarser texture and more sandy nature is due largely to the nearness of the Valentine sand and Dunesand areas, the loessial deposits immediately bordering these areas having received the largest amount of the coarser wind-blown sands.

The greater part of the type has little surface relief. The individual bodies occupy either shallow depressions, low rounded hills, or gentle slopes. In a few places, however, the relief is more pronounced and stream erosion has produced an undulating to gently rolling topography.

Drainage is everywhere good. The surface drainage over most of the type is not well established, but the loose, porous soil and subsoil afford adequate and in places excessive underdrainage.

Owing to its small extent and the danger of soil drifting, the Marshall loamy sand is of little agricultural importance in Boone County. About 40 per cent of it is under cultivation and the remainder is used for pasture. Grazing beef cattle is the chief industry on the greater part of the type. The native grasses will support 150 to 200 head of cattle per square mile during the summer grazing season from June to October. A few hogs are raised on nearly every farm.

Corn, oats, and alfalfa are the leading cultivated crops. Oats do not do so well as on the heavier types of the series, chiefly on account of the loose nature of the seed bed. The soil sometimes blows badly, exposing the shallow root system and causing the young plants to suffer seriously from lack of moisture. Crop yields vary widely from year to year, depending upon the rainfall. The average yield of corn is about 25 bushels per acre, oats 20 to 25 bushels, and alfalfa 2 to 2½ tons from three cuttings.

The soil can be cultivated under almost any moisture conditions without injury. In preparing the land for small grain the soil is plowed every second or third year, and double-disking is practical during the intervening years. Corn is usually listed in, as the ridges tend to check soil drifting. Oats are planted with a press drill, and alfalfa is sown broadcast on well-prepared stubble ground.

Land of the Marshall loamy sand sells for \$50 to \$100 an acre, depending upon improvements and location.

The chief need of this soil is adequate protection against wind erosion. Heavy applications of barnyard manure should prove very beneficial. It is advisable not to disturb the soil until ready to plant the grain, as it should not be left unprotected longer than is absolutely necessary. Alfalfa has proved beneficial in preventing soil drifting.

#### MARSHALL FINE SANDY LOAM.

The surface soil of the Marshall fine sandy loam is a dark grayish brown fine sandy loam 8 to 12 inches deep. The upper subsoil is a lighter brown very fine sandy loam to an average depth of 20 inches.

Below this the subsoil becomes gradually finer in texture and lighter in color, until at 30 inches it consists of a yellowish-brown to light-gray silt containing a large proportion of very fine sand. The surface soil is loose and friable. Although it contains much silt and considerable organic matter the soil drifts slightly when the protective sod is destroyed and the type is brought under intensive cultivation.

On the more level areas, where conditions have especially favored extensive weathering and the accumulation of organic matter, the surface soil in places is 15 to 20 inches deep and of much darker color than usual. In the more exposed situations, such as ridge crests, hilltops, and steeper slopes, water and wind erosion have removed the weathered surface material almost as fast as formed, and the surface soil in these places is often very shallow. In a few places it has been entirely removed, exposing the light-colored subsoil.

The content of organic matter throughout the type gradually decreases with depth. The type is usually not calcareous within the 3-foot section; but below an average depth of 4 feet lime is present in both the powdered form and as scattered angular concretions from one-sixteenth to one-eighth inch in diameter.

The Marshall fine sandy loam is not extensively developed in Boone County. It occupies a few areas in the northwestern part, in close association with the Marshall very fine sandy loam and loamy sand types. One of the largest areas lies northeast of Akron in T. 21 N., R. 8 W. A slightly smaller area lies southeast of Loretto. Other areas occur on the margin of the Marshall very fine sandy loam in the vicinity of the Valentine soils.

The type is derived from loessial material, but the surface soil has been greatly modified by wind-blown sands from the near-by Valentine and Dunesand areas.

The topography ranges from almost flat to sharply rolling, the greater part being gently rolling. The surface is characterized by wide U-shaped valleys and by moderately broad well-rounded divides. The sharply rolling areas are of local occurrence and seldom exceed 100 acres in extent; in these the valleys are narrow and steep sided and separated by sharp crestlike divides.

The type is well drained. Surface drainage is not well established in the more nearly level areas, but the surplus moisture is readily absorbed by the porous soil and subsoil. In the sharply rolling sections the run-off is in places excessive and erosion is becoming a serious factor.

Owing to its small total extent, the Marshall fine sandy loam is of minor agricultural importance in the county. It is retentive of moisture, and where care is taken to prevent soil drifting it is almost as productive as the Marshall silt and very fine sandy loam types. About 85 per cent of it is under cultivation; the remainder is used for pasture and hay land. The native vegetation consists of a great variety of prairie grasses, chief among which are big bluestem, little bluestem, sand grass, and stipa or needle grass. The livestock industry is well developed on this type, and beef cattle are grazed extensively in the sections not used for crop production. Cattle feeding is practiced on many farms, and hogs are raised in large numbers.

Corn, oats, and alfalfa are the principal cultivated crops. Wheat is grown only in a small way, as the soil is too sandy for best results.

Yields on this type vary widely from year to year, depending upon the rainfall. The average yield of corn is about 30 bushels, oats 25 to 30 bushels, and alfalfa 2½ tons per acre from three cuttings. Native hay yields one-half to three-fourths ton per acre. The native grasses will support 50 to 60 head of cattle per quarter section during the summer grazing season.

The land is handled in the same manner as the silt and very fine sandy loams, except that most of the corn is listed in. The soil can be cultivated under almost any moisture conditions without serious injury. Less power and lighter machinery are required than on the heavier soils. Barnyard manure is applied to the land when available, but the supply is seldom sufficient to materially increase crop yields or decrease the danger of soil blowing.

Land of the Marshall fine sandy loam sells for \$75 to \$125 an acre, depending upon improvements and location with respect to markets.

#### MARSHALL VERY FINE SANDY LOAM.

The Marshall very fine sandy loam consists of a dark-brown very fine sandy loam, 8 to 14 inches deep, underlain by a light-gray to yellowish-gray, friable silt to silty clay, which extends below the 3-foot depth. Usually there is an intermediate layer of 6 to 8 inches of brown to light-brown very fine sandy loam between the soil and subsoil. This layer contains a relatively large proportion of silt and constitutes a transition zone both in color and texture. The surface soil is rich in organic matter and has a loose, friable structure. It contains considerable fine and medium sand and in places approaches a loam in texture. The subsoil is usually calcareous below an average depth of 30 inches, the lime existing both in the powdered form and as small angular concretions from one-sixteenth to one-fourth inch in diameter.

In a few places, especially around the outer margins of the type where it borders soils of a more sandy nature, there is a relatively large proportion of very fine sand mixed with the silty material of the subsoil.

The color and depth of the surface soil varies considerably with the topographic position. On the more level areas and gradual slopes, where conditions have favored the accumulation of organic matter, the surface soil is a very dark brown to almost black, in places 18 to 20 inches deep, and the lower part is a silt loam in texture. In the more rolling areas, where erosion is active, the surface soil is very shallow and in a few places has been entirely removed, exposing the light-colored, highly calcareous subsoil. Where these exposures were of sufficient size to warrant mapping, they were included with the Knox silt loam or very fine sandy loam types, depending upon the content of very fine sand in the surface layer. Narrow strips of colluvial and alluvial materials along the intermittent streams were included with this type.

The Marshall very fine sandy loam is extensive in the northwestern part of the county. It occupies an irregular strip, varying in width

from one-fourth mile to 3 miles, around the border of the Marshall silt loam, chiefly in the vicinity of the Valentine and Dunesand soils. The type was originally a silt loam, but the surface material has been greatly modified by wind-blown sand. The largest development is an irregular almost continuous strip extending from the vicinity of Akron to a point south of Albion. This strip is roughly triangular in outline, being widest near the western county boundary. A smaller body lies northwest of Albion on the north side of Beaver Creek. A long narrow strip borders the low terrace on the east side of the creek in T. 21 N., R. 7 W.

The type has been derived from the loessial deposit, but wind-blown materials from the more sandy formations have produced the very fine sandy loam texture of the surface soil.

The topography ranges from gently undulating to sharply rolling. The type as a rule occupies the upper part of the slopes, leading from the Marshall silt loam areas to the lower lying Valentine and terrace soils. A small body near the western county boundary, in the vicinity of Akron, has a level, almost flat topography. The greatest relief occurs a few miles northwest of Albion and several miles west of Petersburg.

Drainage is everywhere good. The more nearly level areas have sufficient slope to carry off the surplus water. In the sharply rolling sections drainage is sometimes excessive and erosion has become a serious factor.

The Marshall very fine sandy loam is an important agricultural soil in Boone County. It is naturally strong and fertile, retentive of moisture, and well adapted to general farming. The soil can be tilled under a somewhat wider range of moisture conditions than the Marshall silt loam. About 90 per cent of it is under cultivation and the remainder, including the more strongly rolling land, is used for pasture and hay. The native vegetation consists of a great variety of prairie grasses, chief among which are big bluestem, little bluestem, grama grass, and buffalo grass.

Corn, oats, alfalfa, and wheat are the most important cultivated crops, ranking in acreage in the order named. A few farmers feed cattle during the winter, although this is not practiced as extensively as on the Marshall silt loam. The grazing of beef cattle is an important industry in the rougher sections. Hogs are raised for market on nearly every farm. All of the livestock is of good breeding, and a few farmers have purebred herds of cattle and hogs.

The average yield of corn is about 35 bushels per acre, oats 30 bushels, wheat 18 bushels, and alfalfa 3 to 3½ tons from 3 cuttings. Wheat is the chief cash crop and is usually hauled to local elevators direct from the threshing machine. The corn, oats, and alfalfa are either fed on the farms where produced or sold to local feeders.

Land of this type is handled in much the same manner as the Marshall silt loam. It is slightly easier to work, however, and can be cultivated with less power and lighter machinery. The methods for maintaining and increasing the soil fertility and preventing erosion that are recommended for the Marshall silt loam will apply admirably to this type.

The selling price of the Marshall very fine sandy loam ranges from \$100 to \$175 an acre, depending upon topography, improvements, and location with respect to markets.

#### MARSHALL SILT LOAM.

The surface soil of the Marshall silt loam consists of a dark grayish brown silt loam 8 to 15 inches deep. The typical soil is high in silt and contains very little material coarser than very fine sand. It is rich in organic matter, has a smooth velvety feel, is finely granular, and breaks down into a loose silty powder when dry. The subsoil is a lighter brown slightly heavier silt loam, changing below 20 inches to a yellow or yellowish-brown, moderately compact silt loam to silty clay loam, which usually continues below the 3-foot depth. Over considerable areas, however, the material gradually becomes heavier with depth until at about 30 inches it consists of a compact yellowish-brown silty clay faintly mottled in places with gray. Locally below an average depth of 36 inches the subsoil grades into a yellowish-gray friable silt containing light-gray mottlings, reddish stains, and scattering concretions of lime. This condition becomes more pronounced in the substratum, as is shown in deep road cuts.

The structure of the soil and upper subsoil is granular, while that of the lower part and the substratum is columnar. The type usually does not contain sufficient lime to react with dilute hydrochloric acid above an average depth of 30 inches, but below this depth the lime content gradually increases and at 4 feet the material is highly calcareous.

The depth and color of the surface soil varies considerably with its topographic position. On the broader divides and upon the more gradual slopes to streams, where conditions have especially favored extensive weathering and the accumulation of organic matter, the soil is very dark in color, frequently 18 to 24 inches deep, and the subsoil is a brown to light-brown, slightly more compact silt loam to below the 3-foot depth. On the sharper divides, steep slopes, and shoulders of hills, where erosion has been severe, the soil is very shallow, and in numerous patches the soil has been entirely removed and the yellowish-brown subsoil is exposed. Where these areas were of sufficient size to warrant mapping, they were included with the Knox silt loam.

Around the outer margins of this type, in the vicinity of Marshall very fine sandy loam and fine sandy loam areas, erosion and wind action have resulted in a rather intricate mixing of the silt and sand particles, giving rise to areas of a loam texture. Owing to their small extent, however, they can not be shown separately on the map. Along intermittent streams, narrow strips of colluvial and alluvial materials are included with this type.

The Marshall silt loam is the most extensive and important soil in Boone County. It covers nearly two-thirds of the total area, and, with the exception of the Marshall silt loam, flat phase, occupies the highest topographic positions. The type has been derived through the weathering of the loess deposit which originally covered the entire county.

The topography ranges from almost flat to sharply rolling, but by far the greater part is gently rolling. The more nearly level areas occur between Petersburg and Raeville, in the north-central part, northeast of Bradish and northeast of Boone. Drainage channels in these localities have not become well established, and broad shallow draws or swales with gently sloping sides are a feature of the topography. The greatest relief occurs northeast of Cedar Rapids upon the high dissected divide between Cedar River and Plum Creek, northwest of Petersburg in the northwestern part of the county and on the north side of Timber Creek in the southwestern part. The topography in these regions is characterized by steep and in places almost precipitous slopes, separated by narrow, crest-like divides. The remainder of the type has a gently rolling to rolling topography and is characterized by broad U-shaped valleys separated by moderately wide, well-rounded divides.

Drainage is good throughout the type, with the exception of a few isolated depressions in the more nearly level areas. In the sharply rolling sections drainage is excessive and erosion has become a serious factor. The acreage of Knox silt loam in these localities is gradually increasing at the expense of the Marshall silt loam.

This type was originally covered with a thick growth of prairie grass, with narrow strips of forest along the margins near the larger streams. The native grasses consisted largely of big and little bluestem, grama grass, and buffalo grass. Most of the prairie sod has been broken and much of the timber has been used for firewood and fence posts. At present about 95 per cent of the type is used for crop production and the remainder, comprising the rougher areas, is included in pasture and hay land.

Of the cultivated crops corn occupies by far the greatest acreage, followed by oats, alfalfa, and wheat. Small fields of barley, rye, and millet are grown for feed on many farms. All garden vegetables and fruits common to the region do well on this soil and are grown for home consumption. The type is recognized as one of the best upland corn soils of the Mississippi Basin. Most of the corn, oats, and alfalfa is fed to livestock on the farms where produced. Wheat is a cash crop and most of it is sold soon after harvest.

The raising of purebred cattle, mostly of the Shorthorn breed, is practiced extensively, and many animals are shipped out of the county for breeding purposes. Many grade animals, chiefly of mixed Hereford and Shorthorn breeding, are shipped in and fattened on corn and alfalfa.

Hog raising is an important industry on this type. A few hogs are raised on nearly every farm and on many farms the herds are large. All of the animals are of good stock and purebred herds are numerous. Duroc-Jersey and Hampshire are the principal breeds. The hogs are fattened on corn and alfalfa. On farms where cattle feeding is practiced the hogs are allowed to follow the cattle in the feed lots.

The raising of draft horses and mules is becoming important. All of the work stock is of heavy draft types and usually of excellent breeding. Percheron and Belgian horses are raised almost exclusively.

Sheep raising is not practiced extensively. Some farmers ship in a carload or two, fatten the animals on corn and alfalfa, and return them to the Omaha market.

Crop yields vary widely from year to year, depending upon the rainfall. Good yields are obtained in normal years, and during dry years the yields are probably higher than the average for eastern Nebraska on account of the high water retaining power of the soil. The average yield of corn is about 35 bushels per acre, although yields of 60 to 65 bushels are common under good management. Oats are grown for feed on nearly every farm and yield from 30 to 40 bushels per acre. Alfalfa yields  $3\frac{1}{2}$  to 4 tons per acre from three cuttings. In exceptionally long seasons a fourth cutting is sometimes obtained. This crop is very beneficial to the land, especially in the rougher areas, as it adds both humus and nitrogen to the soil and prevents destructive erosion. The average yield of wheat is about 18 bushels per acre.

Crop rotation is not systematically practiced. A few farmers use a rotation consisting of corn 1 or 2 years, followed by oats or wheat 1 year and alfalfa 6 or 7 years. No commercial fertilizer is used. Manure is applied when available, and is usually put on the more eroded areas where the surface soil is rather shallow. Many farmers grow the same grain crop continually for several years. The most modern machinery is used. On the steeper slopes the operation of heavy machinery is rather difficult. Four horses are used for most of the farm work. On the more level areas tractors are sometimes used for plowing, but the uneven topography over the greater part of the type prevents their extensive use.

About 80 per cent of the corn is check planted, the remainder being listed in. Wheat is usually planted in the fall, being drilled in on plowed and disked corn or stubble land. Some wheat is sown between the corn rows before the corn is shucked. Land to be used for oats is prepared in the same manner as for wheat, but the seeding is done in the spring. Alfalfa is sown broadcast on well-prepared stubble ground.

Land of the Marshall silt loam sells for \$100 to \$175 an acre, depending upon topography, improvements, and location with respect to markets.

The type is naturally very fertile, and every possible means should be used to maintain its present producing capacity. In the absence of an adequate supply of manure, the productiveness of the type can be maintained by growing a leguminous crop, such as alfalfa or clover, at least once in every four years. Where livestock is not kept in considerable numbers, clover may be plowed under as green manure during the year following the season of seeding. It is good practice to plow the entire crop under when the soil is very deficient in nitrogen. The yields of winter wheat are materially increased by early and deep plowing. Most farmers recognize the superiority of thorough seed-bed preparation for corn over the method of listing.

The control of erosion is important in the more strongly rolling areas of the type. With the gradual depletion of organic matter and the continued washing away of the surface material, the soil is left in a much less productive condition and the land is gullied and rendered

uncultivable. The tendency to wash may be retarded by deep cultivation to facilitate the absorption of water and by having the rows, especially of listed corn, follow contour lines on the steeper slopes. Alfalfa is also very beneficial where erosion is becoming severe.

*Marshall silt loam, flat phase.*—The surface soil of the Marshall silt loam, flat phase, is a very dark brown heavy silt loam 8 to 15 inches deep. It contains a relatively high percentage of clay, which gives it a more granular structure and heavier texture than the average silt loam. The soil is very rich in organic matter and when wet appears jet black in color. The subsoil is a light-brown to light reddish brown slightly compact silty clay to an average depth of 20 inches, below which it grades into a more compact silty clay or clay of light yellowish brown or buff color, often slightly tinged with red. The subsoil is stiff and plastic when wet, but becomes hard and brittle upon drying. At depths ranging from 30 to 40 inches the heavy compact structure disappears and the material changes to the light-gray, loose, floury silt or silty clay of the typical Marshall silt loam. Where exposed in banks and road cuts the first 3 feet usually have a granular structure and below that a vertical flake-like structure. The subsoil is not calcareous within the 3-foot section, but below about 4 feet the substratum usually effervesces with dilute hydrochloric acid.

Around the margins of the phase the subsoil loses its heavy compact structure and the phase grades into the typical Marshall silt loam. Owing to the close association of the two soils and to the imperceptible gradation from one to the other it is often impossible to accurately separate them, and in many places the boundary lines are arbitrarily drawn. The phase differs from the typical Marshall silt loam chiefly in the heavier and more compact nature of its subsoil, in the total absence of calcareous material within the 3-foot section, and in its more even topography. It also usually has a decidedly reddish cast in the subsoil. The phase is subject to less erosion than the typical Marshall silt loam.

The flat phase occupies numerous isolated bodies of irregular outline throughout the upland parts of the county with the exception of the northwestern part. It is usually surrounded by the typical Marshall silt loam and occupies the higher and flatter divides within that type. The areas vary in size from a few acres to about 2 square miles. One of the largest and most typical areas is an irregular strip on the high divide between Plum and Beaver Creeks in T. 19 N., R. 6 W. A smaller area lies about 5 miles north of St. Edward and another 2 miles east of Petersburg. The phase has been derived in the same manner as the typical soil. The topography, however, has especially favored the accumulation of organic matter and the concentration of clay in the subsoil.

Although the surface is prevailingly flat, the drainage is generally good, as the phase occupies the highest positions in the county and there is usually sufficient slope to carry off the surplus water. In a few shallow depressions, seldom exceeding 5 acres in extent, water stands for a considerable period after heavy rains.

The phase has a small total area in Boone County and therefore is not as important agriculturally as many of the other soils. It is well

adapted to general farming because of the high fertility and level topography, and practically all of it is under cultivation. The principal crops are corn, oats, alfalfa, and wheat. Rye, barley, sorghum, and millet are often grown in small patches for feed. Wheat is the leading cash crop. Cattle raising is not practiced extensively, although every farmer keeps a few cows to supply his dairy needs and most farmers have some dairy produce for sale. Hogs are raised on every farm. They are fattened on corn and shipped to the Omaha market. The average yield of corn is about 35 bushels per acre, oats 30 to 35 bushels, wheat 20 bushels, and alfalfa 3 to 3½ tons per acre from three cuttings.

The soil of this phase can be handled under a rather wide range of moisture conditions considering its heavy silty texture. If plowed when wet the land has a tendency to clod, but the lumps are easily reduced. Corn is usually check planted, though sometimes it is listed. Winter wheat is grown more extensively than spring wheat. Alfalfa is usually allowed to remain six to seven years before again planting the land to grain crops. Crop rotation is not systematically practiced, although on most farms the crops are changed with reasonable regularity. Barnyard manure is applied to the land when available.

The selling price of the Marshall silt loam, flat phase, ranges from \$125 to \$200 an acre, depending upon improvements and location.

#### KNOX VERY FINE SANDY LOAM.

The surface soil of the Knox very fine sandy loam is a gray to grayish-brown, friable, very fine sandy loam, 6 to 8 inches deep. The subsoil is a moderately heavy, yellow silt loam to silty clay loam to an average depth of 20 inches, below which it is a slightly lighter textured, friable silt loam of light yellowish brown to buff color. Both soil and subsoil are calcareous, the lime existing in both the powdered form and as small angular concretions. The type is deficient in organic matter, as the light color indicates.

The Knox very fine sandy loam occupies a few scattered bodies, chiefly within or adjacent to areas of Marshall very fine sandy loam. One of the largest and most typical areas, containing about 320 acres, lies 2 miles southwest of Akron in the west-central part of the county. A slightly smaller area lies about 1½ miles east of this town. Two small areas lie north of Beaver Creek a few miles northwest of Albion.

The type has been derived from loessial deposits under conditions unfavorable for the accumulation of organic matter. Wind-blown materials from the adjoining more sandy types have slightly modified the surface soil. The topography is sharply rolling to hilly. Surface drainage is excessive and erosion has become serious.

On account of its small extent and unfavorable topography the type is not used for crop production but is all included in pasture land. The native vegetation includes bluestem, grama grass, and buffalo grass. The individual areas usually occupy only a small proportion of the farms in which they are included.

## KNOX SILT LOAM.

The surface soil of the Knox silt loam is a gray to grayish-brown heavy silt loam 6 to 8 inches deep. The soil material is largely silt and has a very smooth floury feel. It is low in organic matter, as the color indicates. The upper subsoil is a yellow, heavy silt loam to silty clay loam, extending to an average depth of 20 inches. The lower subsoil is a yellow, friable silt loam, somewhat lighter in texture than the upper subsoil. White mottlings and reddish-yellow iron stains are encountered below 30 inches. Both the soil and subsoil are highly calcareous and lime concretions are common on the surface of the type and throughout the soil section. The entire profile has a pronounced open and columnar structure.

The surface soil varies slightly with its topographic position. On sharp divides and steep slopes erosion has prevented even the slight accumulation of organic matter usually present in the typical soil, and the surface material is a yellow silt loam to silty clay loam. On the broader divides and more moderate slopes the organic content is usually large, and the surface soil is brown to dark brown in color, resembling that of the Marshall silt loam. These areas represent a transition stage between the Marshall and Knox soils, which grade almost imperceptibly into each other. In many places it was necessary to draw arbitrary lines separating them. The type differs from the Marshall silt loam chiefly in its lighter colored, shallower surface soil and more uneven topography. When exposed to the air under conditions favorable for the accumulation of organic matter the soil approaches more nearly the Marshall silt loam in physical characteristics.

The Knox silt loam is relatively inextensive in Boone County. It is developed mainly in the southwestern part, where it occurs chiefly as large bodies in the rougher sections of the high divide between Cedar River and Plum Creek. Small circular patches, seldom exceeding 80 acres in size, occur south of Cedar River. A typical area lies  $2\frac{1}{2}$  miles west of Petersburg on the north side of Beaver Creek.

The type is found wherever the surface material of the Marshall silt loam has been largely or entirely removed by erosion. The topography is usually hilly, as the type occupies crests of ridges, hill-tops, and steep slopes. It is thoroughly dissected by short streams, drainage is excessive, and erosion is destructive. The areas of Knox silt loam are gradually increasing through erosion at the expense of the Marshall types.

Owing to its small total extent, unfavorable topography, and low content of organic matter, the type is of little agricultural importance in Boone County. It is productive, and about 40 per cent of it, including the smoother areas, is under cultivation. The virgin areas, which are used for pasture land, support a fairly dense growth of bluestem, grama grass, and buffalo grass.

The common staple crops of the county are grown on the cultivated areas and produce good yields. The soil is particularly well suited to alfalfa on account of its thorough drainage and high lime content. Yields of 3 to  $3\frac{1}{2}$  tons per acre from three cuttings are frequently obtained. Corn yields 30 to 35 bushels per acre, wheat about 16 bushels, and oats about the same as corn. The soil is handled in the same manner as the Marshall silt loam, except that

greater care is usually taken to prevent erosion, and the type receives most of the manure produced on the farm. The supply of manure, however, is seldom sufficient for best results.

This type is usually held in connection with the Marshall silt loam and slightly reduces the value of farms.

The primary need of this soil is the incorporation of organic matter and the prevention of erosion. The type can be protected from washing to a great extent by plowing deeper and by plowing along contour lines. The use of a much larger acreage of leguminous crops, to which the soil is so well adapted, would be beneficial by preventing erosion and by incorporating organic matter. In other counties of Nebraska this type is used extensively in the production of small fruits, vegetables, and orchard products. It is recognized as one of the strongest fruit soils in the United States. In Boone County the climate apparently limits the production of some kinds of fruit. Good yields of potatoes are produced on this type in other counties.

#### VALENTINE SAND.

The surface soil of the Valentine sand consists of a loose, incoherent, brown to grayish-brown sand 10 to 14 inches deep. The upper layer of 4 inches is usually somewhat darker than the lower part owing to a small amount of organic matter, but this is never present in sufficient quantity to prevent the soil from drifting when the protective vegetation is removed. The subsoil is a loose incoherent sand which extends below the 3-foot depth. It is usually grayish brown in color and is practically devoid of organic matter. The soil material has been thoroughly leached and neither soil nor subsoil is calcareous. The sand of which the type is so largely composed includes the medium, fine, and very fine grades, with the medium sand predominating. It consists chiefly of quartz and feldspar. In a few places scattering small pebbles are found on the surface of the type, but very seldom in the subsoil.

The color and depth of the soil vary somewhat with the topographic position. On the more level areas and in shallow depressions, where conditions have been most favorable for the growth and decay of vegetation, the soil is somewhat darker and deeper than usual. On the crests of the low rounded knolls and ridges, however, the organic matter has largely been removed by the wind, leaving the soil shallow and of a prevailing gray color. The type differs from the Dunesand, which it closely resembles, in its smoother surface and the absence of drifting sand. The sand particles are also slightly more rounded and less angular than those of the Dunesand.

The Valentine sand occupies a considerable area in the northwestern part of the county. It usually lies adjacent to areas of Dunesand. The largest area borders the southern edge of the Dunesand region, extending from the western county line to the bottom lands along Beaver Creek, in a strip that varies in width from three-fourths mile to about 4 miles. It is not continuous throughout the area of its occurrence, but contains small patches of other types within its boundaries. Another large area borders the northern edge of the Dunesand on the north side of Beaver Creek. Smaller bodies and narrow strips occur along the edge of the terraces bordering the creek and scattered throughout the sand-hill section. The

type has been derived in part from the underlying sand sheet and in part from blown sands of the sand-hill region.

The topography varies from almost flat to rolling but over the greater part it is gently rolling. The flatter areas are usually modified by low rounded knolls and ridges. Over considerable areas the surface has a choppy or hummocky appearance. Drainage is everywhere good and in many places excessive. There is little run-off, as the porous sands absorb and carry off the moisture as fast as it accumulates.

The Valentine sand is of little agricultural importance on account of its low organic-matter content, low water-retaining capacity, and the danger of drifting when the native sod is destroyed. Not over 30 per cent of it is under cultivation. A few of the more favorably situated areas, especially in the lower depressions where crops can get moisture through seepage, are used in the production of corn and alfalfa. Small grain is seldom grown on account of the loose nature of the seed bed. The average yield of corn is about 25 bushels per acre. Alfalfa does fairly well under the most favorable conditions, yielding 2 to 2½ tons from three cuttings. It is extremely difficult, however, to obtain a stand, and the crop seldom lasts more than three or four years on account of the low lime content of the soil.

Most of the land remains with its original covering of grasses and is used for cattle grazing and hay production. The native vegetation, consisting of sand grass, stipa, big and little bluestem, and some grama grass, will support 150 to 250 head of cattle per square mile during the summer grazing season from June to October, or when cut for hay will yield 350 to 450 tons per section, depending upon the rainfall. Most of the cattle are raised on the ranches and shipped as feeders to Omaha when 2 or 3 years old. A few cattle are shipped in for summer grazing. The native stock is mostly of Hereford breeding. Dairying is not practiced extensively, although every ranch is well supplied with dairy products and many farmers sell butter and cream to local markets.

The Valentine sand is easy to handle and can be cultivated under any moisture conditions without injury. It seems to withstand drought as well as the Valentine loamy sand. It is less stable, however, and blows badly when not protected by a vegetative covering. Coarse manure and straw spread over the land have proved beneficial in preventing excessive drifting. Corn is usually deeply listed.

The selling price of the Valentine sand ranges from \$20 to \$75 an acre. The price depends largely upon the improvements, topography, and location of the land with respect to markets.

While it is possible to grow crops on this type, it is probable that in many cases the practice is detrimental to the soil, as it is very difficult to prevent drifting when the native sod is destroyed.

#### VALENTINE LOAMY SAND.

The surface soil of the Valentine loamy sand is a brown to dark grayish brown, loose, rather incoherent sand, 8 to 12 inches deep, which contains a larger percentage of organic matter than the Valentine sand and therefore has a loamy character. However, it does not contain enough organic material to prevent the soil from drifting unless protected by a vegetative covering. The sand of

which the type is so largely composed consists chiefly of the fine and medium grades, with some very fine sand. The subsoil is a light-brown to yellowish-brown, loose, incoherent sand locally tinged with red. It usually contains barely enough of silt and clay to make it slightly coherent when wet. In a few places small water-worn pebbles are thinly scattered over the surface. Neither the soil nor the subsoil is calcareous.

The type varies slightly with its topographic position. On the flatter areas where conditions have especially favored the growth and decay of plants, the surface layer of 8 inches is a dark-brown to almost black loamy sand. On the low ridges and knolls the surface soil is shallow and much lighter in color.

The Valentine loamy sand occurs in a few irregular-shaped areas adjacent to areas of Valentine sand and Dunesand in the northwestern part of the county. Most of the type occupies an intermediate position between the Valentine sand and the coarser soils of the Marshall series. One of the largest and most uniform bodies, comprising an area of about  $2\frac{1}{2}$  square miles, lies near the Wheeler County line in T. 21 N., R. 8 W. A smaller though typical area lies just north of Akron. Narrow broken strips border the terrace lands on the south side of Beaver Creek.

The parent material of the type is probably derived originally from the sand sheet underlying the plains loess. It has, however, been shifted by wind and water, redeposited, and subsequently weathered, so that it is impossible to determine its origin very definitely.

The topography is flat to gently undulating. The greater part of the type occupies shallow, generally flat depressions in which the surface is modified by low rounded ridges and knolls composed of almost pure sand. The type as a whole lies somewhat below the general level of the Valentine sand and has a slightly more even topography. Surface drainage has not been established, as the rainfall readily sinks into the porous sand, and there is practically no run-off.

The Valentine loamy sand is a better farming soil than the Valentine sand on account of its higher humus content and more stable nature. It requires careful management, however, to prevent drifting, and for this reason is not so well adapted to crop production as some of the heavier soils of the county. About half of it is under cultivation and the rest is used for hay and pasture land. The grazing of beef cattle is the chief industry on the virgin areas. Hereford is the principal breed. Most of the cattle are native stock, although a few farmers ship in cattle for summer grazing. The grasses on this type will support 50 to 60 head of cattle per quarter section during the summer grazing season, or when cut for hay will yield 80 to 100 tons.

Corn is the most important cultivated crop, followed by oats, alfalfa, and rye. The corn is deeply listed to prevent drifting and to conserve soil moisture. Small grain is drilled in on disked corn or stubble ground. The land is plowed only every second or third year. Oats and rye do not do as well as upon the heavier soils on account of the lower fertility of the soil and the difficulty in obtaining a firm seed bed. Alfalfa is grown very little, because the low lime content greatly shortens the life of the plant, and the stand usually dies down or becomes very thin after two or three years.

However, alfalfa is an excellent crop for preventing soil drifting and supplying much needed organic matter.

Crop yields vary greatly from year to year, depending upon the rainfall. The type is retentive of moisture, and during exceptionally dry years the yields compare very favorably with those obtained on the heavier soils. In normal years, however, the hard-land soils give much larger returns. The average yield of corn is about 20 bushels per acre, oats 20 bushels, rye 18 bushels, and alfalfa 2 to 2½ tons from three cuttings. The corn and alfalfa are used mainly as feed for hogs.

The selling price of the Valentine loamy sand ranges from \$25 to \$75 an acre, depending upon location, topographic position, and improvements.

While the soil of this type is slightly more stable than that of the Valentine sand, it drifts badly when the protective covering of grasses is removed, unless great care is taken to protect it at all times. Large quantities of barnyard manure should prove beneficial. It is advisable not to disturb the soil until ready to plant, as it should not be left unprotected longer than is absolutely necessary.

#### SCOTT SILT LOAM.

The surface soil of the Scott silt loam is a very dark brown to black silt loam, 6 to 12 inches deep. It contains a relatively high percentage of clay and in places resembles a silty clay loam in texture. The upper subsoil to an average depth of 18 inches is a black, heavy clay. Below this depth the material gradually becomes lighter in color and at about 24 inches is a dark-gray to slate-colored, stiff, compact clay. Rusty-brown mottlings are numerous below 30 inches. The change in color is very gradual throughout the soil section. The material is not usually calcareous within the 3-foot depth, although in a few places the lower subsoil is a less compact, ashy-gray, silty clay which is highly calcareous.

The type has a total area of 320 acres in Boone County. It occupies a few isolated basinlike depressions, locally known as buffalo wallows, in the areas of Marshall and Waukesha soils. The largest area, containing about 160 acres, borders the Greeley County line in T. 20 N., R. 8 W. A few small circular patches, seldom exceeding 20 acres in size, occur in Ts. 19, 20, and 22 N., R. 5 W.

The type has poor drainage, and in the spring after heavy rains water stands on the surface for periods of a few days to several weeks.

The soil has been formed by wash from the surrounding higher land, deposited over older material which now constitutes the subsoil. The lower subsoil, which is high in organic matter, apparently is a very old soil formed by the deposition of clay and silt in standing water.

Owing to the small extent and poor drainage the type is of little agricultural importance in Boone County. The greater part lies within cultivated fields and is generally used for crop production. In normal years fair yields are obtained. During wet seasons the ground remains too moist for cultivation, and in dry years the soil cracks badly, causing crops to suffer from lack of moisture. A few

farmers do not cultivate across this type but allow it to remain with its native vegetative covering.

The greatest need of this soil is adequate drainage. Where the depressions are deep, however, it is doubtful if the increased production would compensate the expense involved in draining.

#### GANNETT FINE SANDY LOAM.

The surface soil of the Gannett fine sandy loam is a very dark gray to black fine sandy loam, 8 to 12 inches deep. It is especially rich in organic matter, which gives it its dark color and loamy character. In the more poorly drained places the organic content is so great that the soil has a rather spongy structure and light weight. The subsoil is a gray to grayish-brown incoherent fine sand, which is very low in organic matter and does not have the porous compressible nature of the surface soil. In a few places a layer of coarse white sand is encountered below 30 inches. The surface soil of this type is highly calcareous. The subsoil usually contains some lime, although in places there is no lime below an average depth of 24 inches.

The Gannett fine sandy loam is one of the least extensive soils of the county, its total area being one-half square mile. The largest area lies 1 mile northwest of Akron in T. 21 N., R. 8 W. A typical area lies along the Wheeler County line on the west side of Beaver Creek.

The type has been formed of the same material as the Valentine soils, modified by deficient drainage and the decay and incorporation of organic matter. It occupies low basinlike depressions having an almost flat surface. Seepage from the higher levels is largely responsible for the poorly drained, moist condition of the soil, and the water table is seldom more than 3 feet below the surface.

The Gannett fine sandy loam is used for the production of native hay. It supports a luxuriant growth of water-loving grasses which yield three-fourths ton to 1½ tons of hay per acre. The hay is coarser and has a somewhat lower feeding value than that obtained on the better drained soils, but its larger yield tends to offset its inferior quality. The hay is either stacked in the field or stored in barns for winter feeding.

The chief need of this soil is artificial drainage, but the type is of such small extent in the county that it is doubtful if the increased yields would compensate the cost of tiling or ditching the land.

#### WAUKESHA FINE SANDY LOAM.

The surface soil of the Waukesha fine sandy loam is a dark-brown to dark grayish brown fine sandy loam 10 inches deep. It contains a relatively high proportion of sand and in places approaches a loamy fine sand in texture. The upper subsoil to an average depth of about 16 inches is a light-brown fine sandy loam. Below this depth the sand content gradually decreases, and the lower subsoil is a yellowish-brown or light-gray material composed largely of silt and very fine sand, which continues below the 3-foot section. The surface soil contains considerable organic matter which gives it its

dark color and loamy character. The organic content gradually decreases with depth and is scarcely noticeable below 24 inches. Neither the soil nor the subsoil is calcareous, but the substratum below an average depth of 4 feet is rich in lime.

In a few places, especially where the sand content is unusually high in the surface soil, the subsoil consists of compact sandy clay of light-brown to yellowish-brown color, which has a decidedly gritty feel, is rather stiff and plastic when wet, and crumbles easily upon drying.

The Waukesha fine sandy loam has a total area of less than 1 square mile. It occupies two small areas along Beaver Creek in the vicinity of Loretto and a small area about 3 miles southwest of Petersburg. The type has been developed upon terrace material, deposited by the streams when they were flowing at higher levels. Wind-blown materials from the sandier soils have contributed to its formation.

The topography is flat to very gently undulating. The type lies from 8 to 10 feet above the first bottoms and the drainage is everywhere good. Surface channels are not well established, but the porous soil and subsoil absorb all the surplus moisture.

The Waukesha fine sandy loam is a good corn soil and practically all of it is under cultivation. It is not considered so well adapted to small grain as the heavier terrace soils on account of the porous nature of the surface soil which prevents the preparation of a compact seed bed. The average yield of corn is about 35 bushels per acre, oats 30 bushels, wheat 18 bushels, rye 20 bushels, and alfalfa 3 to 3½ tons from three cuttings.

The soil is handled in the same manner as the Marshall silt loam, but it can be cultivated under a wider range of moisture conditions and with lighter machinery and draft animals. Barnyard manure is applied when available. Crop rotation is not systematically practiced, though more alfalfa is being planted each year in an effort to maintain the high producing power of the soil.

Land of the Waukesha fine sandy loam sells for \$100 to \$175 an acre, depending largely upon location and improvements.

#### WAUKESHA VERY FINE SANDY LOAM.

The surface soil of the Waukesha very fine sandy loam is a dark-brown very fine sandy loam 10 to 14 inches deep. It is loose and friable in structure and contains a high percentage of organic matter. The subsoil to an average depth of 30 inches is a rather heavy and compact silt loam to silty clay loam containing a small percentage of very fine sand. It is brown to light brown in color, often slightly mottled with light-gray splotches and scattering iron stains. When wet it is sticky and plastic but upon drying it becomes hard and brittle. Below this layer and extending beyond the 3-foot depth the subsoil is much lighter in texture and color and consists of a light-gray or light yellowish brown, loose, floury silt to silty clay. The type is seldom calcareous within the 3-foot section, although lime is abundant below the 4-foot depth in both the powdered form and as small angular concretions.

Around the outer margins of this type, where it borders the upland, colluvial materials washed from the higher levels have greatly

thickened the surface soil and increased its silt content. In these places the dark-brown soil has an average depth of about 24 inches and over small patches extends to below the 3-foot section with little change in color or texture.

The type has a moderate extent in Boone County. It occupies narrow almost continuous terraces from one-eighth mile to 2 miles wide, bordering the flood plains along Cedar River and Beaver Creek. Albion, St. Edward, and Cedar Rapids are located on this type.

The soil represents weathered terrace alluvial material. The topography is flat, usually with a gentle slope down the valley and toward the stream channel. The type is developed on two distinct levels. The high terrace occurs as a long narrow bench on the south side of Beaver Creek, adjacent to the Marshall very fine sandy loam of the upland. The surface of this bench lies from 35 to 40 feet above the stream channel. The remainder of the type occupies low terrace positions and lies from 12 to 15 feet above the normal flow of the streams. Drainage is everywhere good. Even the flatter areas have sufficient slope to carry off all surplus water.

The Waukesha very fine sandy loam is an important agricultural soil in Boone County. It is considered equal to the Waukesha silt loam for general farming, and all of it is under cultivation. Corn, oats, wheat, and alfalfa are the leading crops. The raising of livestock, chiefly cattle and hogs, is an important industry. There are several herds of purebred cattle and hogs on this type. The cattle are mostly of Shorthorn breeding, and the hogs are mainly Duroc-Jersey and Hampshire. Considerable livestock is shipped to outside buyers for breeding purposes. The winter feeding of cattle is practiced extensively. Most of the cattle are raised in the county, but some feeders, chiefly of Hereford breeding, are shipped in for winter fattening.

The crop yields on this type are about the same as on the Waukesha silt loam and the land is handled in the same manner as the Marshall silt loam of the upland. Barnyard manure is applied when available. Alfalfa is grown extensively on most farms, and the stand is allowed to remain six or seven years before returning the land to grain crops. The soil is in no immediate danger of becoming exhausted, as the surface wash from the adjoining uplands tends to maintain its naturally high fertility.

The selling price of the Waukesha very fine sandy loam ranges from \$175 to \$275 an acre, depending largely upon location and improvements. Those areas lying in and about the larger towns will probably command a much higher price.

#### WAUKESHA SILT LOAM.

The surface soil of the Waukesha silt loam is a dark-brown, friable silt loam, 12 to 15 inches deep, rather loose and mellow in structure, and with a smooth velvety feel. It has a high content of organic matter and when moist appears black in color. The upper subsoil is a brown to light-brown, compact silty clay loam extending to an average depth of 20 inches. It is hard and tough when dry, becomes sticky and plastic when wet, and is mottled in places with gray splotches and rusty iron stains. The lower subsoil becomes gradually

lighter in color and texture with depth, and below 30 inches usually consists of a yellowish-brown, smooth, floury silt loam, resembling the lower subsoil of the Marshall silt loam. Lime concretions occur locally in the lower subsoil, although their presence is not characteristic, and the type as a whole is not calcareous within the 3-foot section. The change from surface soil to subsoil is rather abrupt, both in color and structure.

The type includes a few minor variations, depending upon location. Upon the lower terraces the soil is usually somewhat deeper and darker in color than on the high terraces. The heavy, compact, upper subsoil layer also is usually less pronounced on the lower terraces, and in a few places there is no compact layer in the subsoil. Around the outer margins of the type, where it joins the upland, the surface soil has been greatly thickened by the addition of coluvial wash from the higher slopes. In these places the soil is a dark-brown to almost black, mellow silt loam to an average depth of 24 inches, where it passes into the heavy, compact, brown silty clay of the upper subsoil, and the yellow friable silt of the lower subsoil is not reached within the 3-foot depth.

The soil profile of this type resembles that of the Marshall silt loam. The parent material has a structure similar to that of the loess, but is somewhat heavier, and the subsurface stratum is more compact. In the deeper cuts along slopes the exposed material is similar to that of the loess underlying the upland.

The Waukesha silt loam is the most extensive alluvial soil in Boone County. It occurs along all the larger streams throughout the loessial upland region. The largest areas lie along Beaver Creek in the southeastern part. Extensive areas are also mapped on the north side of Cedar River near Primrose. Numerous small bodies and narrow strips border the flood plains along Cedar River, Plum Creek, and Timber Creek, and isolated areas lie north of Petersburg and in the vicinity of Raeville.

The type has been developed upon alluvial sediments deposited by the streams when they were flowing at higher levels. Surface wash from the adjoining uplands has also contributed to its formation, especially near the foot of the steeper slopes.

The topography is almost level to very gently undulating. The higher terraces are in places somewhat eroded by drainage ways and locally have a strongly undulating relief, but the crests of the low, rounded divides lie at a uniform level.

The terraces occur at three distinct elevations. The highest level is represented by bodies lying north of Primrose and east of Albion, which are 75 to 85 feet above the stream channels. The second terrace level, which includes the greater part of the type, is represented by the large area between St. Edward and Boone, on the west side of Beaver Creek. The lowest areas of Waukesha silt loam occur as numerous small bodies and narrow broken strips bordering the flood plains along all the larger streams throughout the county. They lie from 12 to 15 feet above the normal flow of the streams. The transition between the different terrace levels, as well as to the flood plains, is marked by short steep slopes, while the slope to the upland is usually long and gradual.

The type is well drained. There is usually sufficient slope, even on the flatter areas, to carry off the surplus water. After heavy

rains water sometimes accumulates in isolated shallow depressions, but the total extent of poorly drained land is almost negligible.

The Waukesha silt loam comprises some of the most valuable land in the county. All of it is under cultivation. Originally it supported a dense growth of prairie grasses. Corn, oats, wheat, and alfalfa are the most important crops, corn having the largest acreage. The raising of livestock is an important industry on this type. Most of the cattle are of Shorthorn breeding, all are of excellent quality, and many herds are purebred. Winter feeding of cattle is practiced extensively. Hogs are raised on every farm, and many farms have large herds. The principal breeds are Duroc-Jersey and Hampshire. The raising of heavy draft horses and mules is practiced very extensively. The horses are mostly of Belgian and Percheron breeding.

Crop yields average somewhat higher than upon the Marshall silt loam on account of the more favorable moisture conditions. Corn yields 45 to 50 bushels per acre and yields of 60 bushels are not uncommon. Oats yield 35 to 45 bushels, wheat 20 to 25 bushels, and alfalfa 3 to 4 tons from three cuttings. Wheat is the leading cash crop, and the grain is usually hauled to market directly after threshing or stored in local elevators until the price is favorable. Some corn is also shipped outside the county, although most of the corn, oats, and alfalfa is fed on the farms where produced or is sold to local feeders.

The soil is handled and the crops planted in the same manner as on the Marshall silt loam. Barnyard manure is applied when available. The fertility of the soil is not being impaired to any appreciable extent by cropping, as the type receives considerable organic matter through surface wash from the higher levels.

The selling price of the Waukesha silt loam ranges from \$175 to \$275 an acre, depending largely upon improvements and location.

#### O'NEILL LOAMY FINE SAND.

The surface soil of the O'Neill loamy fine sand is a loose, rather incoherent, brown to dark-brown loamy fine sand 8 to 12 inches deep. The sand is chiefly of the fine and very fine grades, with the fine sand predominating. The surface layer of six inches contains considerable organic material, which gives it a slightly darker color than the lower part, but the content is not sufficient to prevent the soil from blowing when the native sod is destroyed. The subsoil is usually coarser than the soil, being composed of the fine and medium grades of sand, with some very fine sand and silt. It is grayish brown in color and contains very little organic matter. Scattering pebbles occur upon the surface and are numerous in places in the subsoil. The change in color between the soil and subsoil is usually rather abrupt. The type is not calcareous in the 3-foot section.

In small areas a layer of coarse sand and fine gravel is encountered below 30 inches. Included with this type are a few patches of O'Neill fine sandy loam, which differs from the loamy fine sand only in the higher organic content of the surface soil. The total extent of these areas is insufficient to warrant separate mapping. The largest area, containing about 100 acres, is in section 12 of T.

18 N., R. 5 W. In a few spots the surface soil has been entirely removed by wind, exposing the gray, incoherent sand of the subsoil.

The O'Neill loamy fine sand occupies small areas and narrow strips, usually adjacent to the flood plains along Beaver Creek. The type is largely confined to the northwestern part of the county. The largest area is a long narrow strip, from one-eighth to three-fourths mile wide, on the south side of the stream in T. 22 N., R. 8 W. A small but typical area lies west of Loretto on the west side of the creek.

The type represents alluvial sediments deposited by the stream when flowing at a higher level. Surface wash from the adjoining uplands and wind-blown materials from the surrounding types have also largely contributed to its formation.

The greater part of the type is flat to slightly undulating. In some areas the surface has been modified by wind action and is somewhat hummocky. Drainage is good to excessive. Surface channels are not well established, but the surface moisture is readily absorbed by the loose, porous subsoil, and most of the drainage is subterranean. The soil has a low water-retaining power, and in dry years crops sometimes suffer from lack of moisture.

The O'Neill loamy fine sand is of little agricultural importance in Boone County because of its small extent, droughty nature, and the danger of blowing when the native sod is destroyed. Its even topography, however, is favorable for cultivation, and about half of it is used for crop production. The virgin areas are included in pasture and hay land. The native vegetation consists of a fairly dense growth of good pasture and hay grasses, chief among which are big and little bluestem, grama grass, sand grass, and stipa or needle grass. The grasses will support 50 to 60 head of cattle on each quarter section during the grazing season, or when cut for hay will yield about one-half ton per acre.

Corn is the chief crop on the cultivated areas. Corn is usually deeply listed, as it is thought the crop withstands drought better and that the young plants are less subject to injury by the wind. Alfalfa makes a good growth, but the stand is rarely as thick as on the Waukesha silt loam, probably because of the low lime content of this type.

The cattle are mainly native stock and largely Hereford breeding. They are usually sold as feeders when 2 or 3 years old. Very few cattle are winter fattened on this type. Hogs are raised on those farms where corn is produced.

The selling price of the O'Neill loamy fine sand ranges from \$75 to \$100 an acre, depending largely upon improvements.

The chief need of this soil is organic matter to increase its stability. Heavy applications of barnyard manure and straw should prove very beneficial. The land should not be stirred more than is absolutely necessary to destroy the weeds. Alfalfa and sweet clover should be grown extensively in order to increase the naturally low content of organic matter.

#### WABASH VERY FINE SANDY LOAM.

The surface soil of the Wabash very fine sandy loam is a dark-gray to black very fine sandy loam 8 to 12 inches deep. The ma-

terial contains much organic matter and has a loose, friable structure. The subsoil is slightly lighter in color than the surface soil, is more compact, and ranges in texture from a very fine sandy loam to silt loam, which usually continues below the 3-foot depth. Faint gray and brown mottlings are encountered below 24 inches. Neither the soil nor subsoil is calcareous, but below an average depth of 4 feet the substratum in places changes rather abruptly to a light-gray, smooth, floury silt to silty clay, with a high lime content. The type includes small patches having a typical silt loam surface soil, but owing to their small size and irregular occurrence they were not separated on the soil map.

The Wabash very fine sandy loam occupies a few scattering areas within the flood plains of Cedar River and Beaver Creek. One of the largest areas occurs on both sides of Beaver Creek northwest of St. Edward. A much smaller area lies south of Loretto, and several patches occur along Cedar River between Cedar Rapids and the southern county line.

The type has been derived in the same manner and largely from the same materials as the Wabash silt loam. The more sandy nature of its surface soil is due in part to the coarser nature of the latest sedimentary deposits and in part to wind-blown materials from the more sandy bottom-land soils.

The topography is prevailingly flat, modified in a few places by old stream channels, cut-offs, and shallow depressions. Drainage over most of the type is poor. The surface lies only a few feet above the normal flow of the streams and is subject to frequent inundation.

Owing to its small extent and poor drainage, very little of the type is used for crop production. It is as strong and fertile as the Wabash silt loam, however, and in areas where it occurs extensively it is one of the leading agricultural types. Practically all of it in Boone County is used for pasture and hay land. The native vegetation consists of a luxuriant growth of water-loving and prairie grasses with marginal strips of timber along the stream channels. The grasses will support one cow or horse per acre during the summer grazing season, or when cut for hay will yield from three-fourths to 1¼ tons per acre, depending upon the rainfall. Most of the hay is stacked in the field for winter feeding.

The greatest need of this soil is artificial drainage. The areas are of such small extent, however, that it is doubtful if the increased yield would compensate the expense incurred in draining the individual areas. Many of the smaller bodies occur within or adjacent to other poorly drained types, and it is possible to drain these in connection with other areas. A system of tiling or deep drainage ditches would reclaim the land for grain production.

#### WABASH SILT LOAM.

The surface soil of the Wabash silt loam is a very dark gray to black silt loam 10 to 15 inches deep. It contains very much organic matter and little or no material coarser than very fine sand, and has a mellow structure and smooth velvety feel. The subsoil is a black silty clay loam, which contains a small proportion of very fine sand. It is of more compact structure than the surface soil, is rather plastic and sticky when wet, and becomes hard and brittle upon

drying. Faint brown mottlings are encountered below 30 inches. The soil usually is not calcareous within the 3-foot depth.

The type has a number of variations which are of irregular occurrence and not sufficiently conspicuous or extensive to warrant separate mapping. In the narrower stream valleys and in a few places on the wider bottoms the soil section shows little or no change in color or texture within the 3-foot depth, but becomes slightly more compact below 24 inches. The soil in these localities consists of a smooth dark-brown silt loam underlain by a dark-brown, more compact silt loam.

In the higher lying parts of the type a gray compact silt or silty clay occurs locally in the lower subsoil. Where this light-colored material is encountered above the 24-inch depth the soil is included with the Waukesha silt loam.

In a few scattered small areas the surface soil is a dark-gray or ashy-gray, heavy silt loam, underlain at shallow depths by an almost black to drab plastic clay loam or clay. The immediate surface is a hard white crust when dry. Such areas, locally known as alkali spots, occupy the more poorly drained situations and usually vary in size from one-tenth of an acre to one acre.

Over local areas, usually at the foot of the upland slopes, there is a peaty covering of 2 to 3 inches over the silt loam. These areas are very small and occur only where there is considerable seepage from the upland.

The Wabash silt loam occurs as narrow continuous strips within the flood plains of all the larger streams of the county with the exception of Cedar River and Beaver Creek. The strips vary in width from one-eighth to almost three-fourths of a mile. The widest areas are along Shell and North Shell Creeks, in the northeastern part, and the longest are along Plum Creek in the south-central part. A narrow strip borders Timber Creek throughout its course across the southwestern corner of the county. The flood plains of some of the smaller streams are narrow, and in places a slight exaggeration is necessary to show them on the soil map.

The material composing the soil is of alluvial origin, having been washed from the adjoining loessial upland and deposited within the present flood plains. Rank growth and subsequent decay of vegetation under moist conditions account for the dark color and high organic content of the type.

The surface is generally flat, except where relieved by old stream channels. The greater part of the type has adequate surface drainage. It lies from 4 to 8 feet above the normal flow of streams, and during seasons of excessive rainfall most of the type is subject to overflow, but the water seldom remains on the land longer than a few hours. In the lower lying situations, however, the water accumulates on the surface and percolates slowly into the heavy plastic subsoil. Frequently small intermittent drainage ways from the upland carry the surface water to the edge of this type, where, owing to the decreased velocity of the current, the channel becomes filled with sediment and the water spreads over the surface. Some of the more poorly drained areas have been improved by tiling.

Although the areas of Wabash silt loam are rather numerous, their total extent is not large, and therefore the type is of relatively little

importance in Boone County. It is one of the most productive soils of the State in regions where adequate surface drainage is assured. About 80 per cent of the type in this county is in cultivation and the remainder constitutes valuable pasture and hay land. The native vegetation consists of a luxuriant growth of a great variety of water-loving and prairie grasses. Of the cultivated crops, corn, wheat, oats, and alfalfa are the most important, ranking in acreage in the order named. The type is regarded as the strongest corn soil of the county and withstands continuous cropping better than any other type. Short-strawed varieties of oats are grown chiefly, as the crop has a tendency to lodge. Winter wheat is planted more extensively than the spring varieties. Alfalfa is grown on the better drained areas. Potatoes and other garden vegetables are grown for home use. Corn yields 45 to 60 bushels per acre, oats 40 to 50 bushels, wheat 20 to 25 bushels, and alfalfa 2 to 4 tons per acre. The grasses on this type will support a cow or horse per acre during the summer grazing season.

Crop rotation is given little attention. The soil is fairly easy to handle and can be cultivated under a rather wide range of moisture conditions. It forms clods if plowed when wet, but the lumps are easily reduced. Manure is seldom applied to the land, as with proper management it is not needed. The addition of silt washed down from the adjoining uplands tends to maintain the productiveness.

The selling price of the land ranges from \$100 to \$250 an acre, depending upon its drainage and location.

#### CASS LOAMY FINE SAND.

The surface soil of the Cass loamy fine sand is a dark-gray, loose, rather incoherent fine sand 10 to 15 inches deep. It owes its dark color and loamy character to a relatively large content of organic matter, which, however, is not sufficient to prevent the soil from blowing when not protected by a vegetative covering. The subsoil is a gray, loose, incoherent fine to medium sand which continues below the 3-foot depth. Scattering iron stains are often encountered below 28 inches. The entire soil section is usually not highly calcareous.

A few minor variations are included with the type. Locally the subsoil below 30 inches is composed of coarse sand and fine gravel. In some places the lower subsoil is calcareous. The most important variation in the surface texture is toward a fine sandy loam, and it is possible that small areas of Cass fine sandy loam are included. In a few places adjacent to stream channels the surface soil is almost pure sand of such recent deposition that sufficient organic matter has not accumulated to give it a loamy character.

The type occupies flood-plain positions along Cedar River and Beaver Creek. The areas are narrow broken strips, usually bordering the stream channels. Most of the type lies along Beaver Creek in the northwestern part of the county. Two of the largest bodies are in the extreme northwestern corner in T. 22 N., R. 8 W. A smaller area borders both sides of the stream west of Loretto. The areas along Cedar River are small and seldom exceed 90 acres in size. The type has been derived from sediments carried down from the adjoining uplands and from regions to the west.

The topography is flat, modified in places by numerous depressions, dry channels, and slight elevations. Drainage is variable. The surface lies from 2 to 5 feet above the streams and is subject to overflow. Large areas remain in a marshy condition most of the year. The better drained areas are along Cedar River, as this stream does not overflow as frequently as Beaver Creek. During exceptionally dry years the type has excessive underdrainage and crops sometimes suffer from lack of moisture.

Owing to its small extent and uncertain drainage, the Cass loamy fine sand is not an important agricultural soil in Boone County. About 20 per cent of it is under cultivation, the greater part being used for pasture and hay land. The native vegetation consists of a great variety of prairie and marsh grasses together with considerable volunteer timothy and clover. Rushes and reeds occur in the more poorly drained areas and narrow strips of timber usually border the stream channels. The cultivated areas are devoted mainly to forage crops, including alsike clover, redtop, and timothy. Alfalfa is raised to a minor extent on the higher lying, better drained land. Small-grain crops are of little importance on account of the difficulty in obtaining a firm seed bed.

The forage crops will support a cow or horse per acre during the summer grazing season, or when cut for hay will yield 1 to 1½ tons. Alfalfa yields 2 to 2½ tons and native hay three-quarters to 1 ton per acre. The alfalfa is usually cut three times. The native grasses will support about 100 head of cattle on each quarter section. Beef cattle are raised chiefly, Shorthorn and Hereford being the leading breeds.

The soil on the better drained areas is easily handled and can be cultivated under almost any moisture conditions without injury. It can be worked with less power and lighter machinery than is required on the heavier soils of the county. Because of its lower organic content, however, it is less productive and less stable than the heavier soils. Heavy applications of barnyard manure and increased acreage of leguminous crops, such as alfalfa and clover, should increase the productive power of the land. A system of tiling or deep drainage ditches would reclaim most of the land for crop production.

The selling price of the Cass loamy fine sand ranges from \$50 to \$70 an acre, depending upon drainage, improvements, and location.

#### CASS FINE SANDY LOAM.

The Cass fine sandy loam has a surface soil of dark-brown, loose fine sandy loam 10 to 12 inches deep. The subsoil is a light-brown to grayish-brown fine sandy loam to an average depth of 20 inches, where it grades into a loose incoherent sand or fine sand of gray color. The lower subsoil often contains scattering iron stains. Both soil and subsoil are faintly calcareous in places but over large areas no calcareous reaction is obtained with dilute hydrochloric acid.

Fine gravel is encountered here and there within the 3-foot section. In a few places the lower subsoil consists of alternating strata of silt loam and very fine sandy loam. On patches where the organic content of the surface soil is unusually low the soil is light gray when dry. Locally the subsoil is a gray to almost white fine sand.

The principal variation in surface texture is toward a loamy fine sand, and it is possible that small patches of Cass loamy fine sand are included with this type.

The Cass fine sandy loam is confined to the flood plains along Cedar River and Beaver Creek, where it occupies numerous small areas and narrow broken strips, usually adjacent to the stream channels. The largest and most typical development is along Beaver Creek southwest of Petersburg. Two small areas lie north of Albion. Small bodies are mapped southeast of Primrose and below Cedar Rapids on Cedar River.

The type has developed on flood-plain material, which was carried down and deposited by the streams during comparatively recent times. The topography is generally flat, modified in places by old cut-offs, stream channels, and slight elevations. The surface lies only a few feet above the normal flow of the streams and is subject to overflow.

About 70 per cent of the type has adequate drainage. Over the remainder the water table lies so near the surface as to make crop yields uncertain, and the land is used for hay and pasture. Several of the better drained areas occur along Cedar River.

Owing to its small extent in the county, the type is not an important agricultural soil. Corn is the chief crop on the cultivated areas. Some alfalfa is grown on the better drained situations. Much of the poorly drained land supports a good growth of volunteer timothy and clover mixed with the native marsh grasses and is used largely for grazing beef cattle. The dairy industry is not important, although most farmers have a surplus of dairy products for sale. Hogs are raised on all farms where corn is produced.

The average yield of corn is about 35 bushels per acre. Alfalfa yields 3 to 3½ tons from three cuttings. The native grasses will support a cow or horse per acre during the grazing season, or when cut for hay will yield three-fourths to 1 ton per acre, depending on the rainfall.

The soil is easily handled and can be cultivated under almost any moisture conditions without serious injury. Most of the corn is listed in, as the soil has a slight tendency to blow during dry years and the ridges tend to prevent excessive drifting. No fertilizer is used and crop rotation is not practiced. The soil is in little danger of becoming exhausted, as surface wash from the higher levels, together with sediments deposited by the streams during flood stages, help to maintain its fertility.

Land of this type usually occupies only a small part of the farms on which it occurs. It is probably worth from \$50 to \$75 an acre, depending upon location, drainage, and improvements.

#### CASS VERY FINE SANDY LOAM.

The surface soil of the Cass very fine sandy loam is a dark grayish brown very fine sandy loam 8 to 10 inches deep. It contains a relatively large proportion of silt and very little material coarser than very fine sand. The soil is rich in organic matter and is loose and friable in structure. The subsoil is a brownish-gray fine to very

fine sand grading at about 24 inches into a gray or grayish-brown, loose, incoherent fine sand. A layer of coarse sand and fine gravel is encountered locally below 30 inches. The lower subsoil is usually mottled with faint rusty-brown streaks. Both soil and subsoil are slightly calcareous, but over large areas no calcareous reaction is obtained with dilute hydrochloric acid.

The type includes a few variations of irregular occurrence which are not extensive enough to warrant separate mapping. In many places the subsoil is made up of alternating layers of silt, very fine sand, and clay, the sand predominating. Locally the subsoil below 8 inches consists of a gray to almost white, fine to medium sand, which may continue to the bottom of the 3-foot section or may be underlain at about 30 inches by a stratum of silt loam or very fine sandy loam.

The Cass very fine sandy loam is confined to the flood plains along Cedar River and Beaver Creek, where it occupies numerous small bodies and narrow broken strips. The most continuous development is a narrow strip, varying in width from about one-eighth to almost one-half mile, along Beaver Creek between St. Edward and Albion. A rather large and fairly uniform area borders both sides of the stream in T. 22 N., R. 8 W. Other areas lie south of Primrose and north of Cedar Rapids along Cedar River. Local patches of Cass fine sand and loamy fine sand are included with this type.

The topography is prevalently flat, except where relieved by old stream channels, sloughs, and low ridges. The type as a whole is poorly drained. The surface lies only a few feet above the normal flow of the streams and is subject to frequent overflow from the main channels. The water table is seldom more than 6 feet below the surface and during wet seasons rises considerably, causing serious injury to grain crops. In many places intermittent streams from the uplands spread out over parts of the type, creating extensive areas of poorly drained soil. Most of the better drained areas are along Cedar River.

The Cass very fine sandy loam is unimportant chiefly on account of its poor drainage. About 70 per cent of it is included in pasture and hay lands, and the remainder, comprising the better drained areas, is used largely in the production of corn and alfalfa. The native vegetation consists of a luxuriant growth of prairie and swamp grasses, with marginal strips of timber where the type borders the stream channels. The grazing of beef cattle is the chief industry. Most of the animals are native stock, chiefly of Shorthorn breeding. They are usually sold when 2 or 3 years old as feeders to local buyers. A few hogs are raised on farms where corn is produced.

The average yield of corn is about 35 bushels per acre. Alfalfa yields 3 to 3½ tons from three cuttings. The native grasses will support a cow or horse per acre during the summer grazing season, or when cut for hay will yield 1 to 1¼ tons. The hay is somewhat coarser than that obtained on the better drained upland soils.

Crop rotation is not systematically practiced and no fertilizer is used on the cultivated areas. The soil is in no immediate danger of becoming exhausted, however, as the sediments deposited during

inundations help to maintain its fertility. The soil can be cultivated soon after heavy rains without serious injury, and is one of the first soils to warm up in the spring. It is well adapted to fruits and vegetables.

The selling price of the Cass very fine sandy loam ranges from \$50 to \$150 an acre, depending largely upon improvements and drainage.

The chief need of this soil is adequate drainage. It is naturally fertile, and where drainage is established it produces almost as well as the Wabash silt loam. The type is not as strong, however, on account of the low organic content of its subsoil. A system of tiling or deep ditching would reclaim much of the land for grain crops.

#### LAMOURE VERY FINE SANDY LOAM.

The surface soil of the Lamoure very fine sandy loam is a friable very fine sandy loam, 10 to 14 inches deep. It contains an unusually large proportion of silt and very little material coarser than fine sand. It has an abundance of organic matter which gives it a very dark gray to black color. The upper subsoil to an average depth of 20 inches is a slightly more compact brown silty clay containing a small percentage of very fine sand. This gives way rather abruptly to a gray or mottled gray and white silty clay, which is sticky and plastic when wet but becomes hard and brittle upon drying. The entire soil section is highly calcareous and small angular lime concretions from one-sixteenth to one-eighth inch in diameter are very abundant in the lower subsoil. The type differs from the Wabash very fine sandy loam chiefly in the calcareous nature and lighter color of its subsoil.

Included with this type are a few small areas in which the surface soil contains so much silt and organic matter that in the moist field conditions it resembles a silt loam. The sand content, however, is usually very noticeable when the soil is dry. In a few places a thin layer of partly decayed organic matter from 1 to 2 inches thick covers the surface of the type. Such a condition prevails only in the more poorly drained areas where seepage water from the higher levels retards adequate soil aeration and the decay of plant remains.

The Lamoure very fine sandy loam is confined to a few small bodies within the flood plains of Cedar River and Beaver Creek. A typical area lies on the east side of Cedar River in section 23, T. 18 N., R. 7 W. Small areas lie south of Primrose on the south side of the stream. Two rather variable bodies lie west of Petersburg on the north side of Beaver Creek; in these the surface soil contains somewhat more silt than usual, but the texture varies and will probably average a very fine sandy loam.

The topography is flat, modified in a few places by shallow depressions, old cut-offs, and stream channels. Drainage is poor, as the surface lies only a few feet above the normal flow of the streams and is subject to frequent inundations. In many places small upland streams spread out over the surface of the type, creating extensive areas of marshy soil.

Owing to its small extent and poor drainage the type is of little importance. It is all included in pasture and hay land. The native

vegetation consists of a luxuriant growth of water-loving grasses and sedges. In many places volunteer clover and timothy is mixed with the native grasses, greatly improving the quality of the hay and pasture. Cattle raising is the only industry practiced on the type. The principal breeds are grade Hereford and Shorthorn. The grasses will support a cow or steer per acre during the summer grazing season, or when cut for hay will yield from 1 to 1¼ tons per acre.

Land of this type usually occupies only a small percentage of the farms in which it occurs. It has a tendency to lower the general value of the land.

The soil is naturally strong and fertile, and where adequate drainage is assured it is as productive as the Wabash soils. A system of tiling or deep drainage ditches would reclaim all the land for grain production.

#### SARPY SAND.

The surface soil of the Sarpy sand consists of a gray to light-brown, loose, incoherent fine to medium sand grading into a subsoil of the same texture and structure. The surface soil is usually slightly darker than the remainder of the soil section owing to a small amount of organic matter. The subsoil below 30 inches is locally mottled with rusty iron stains. In a few places the lower subsoil is almost white, and below 24 inches is composed of a loose mixture of coarse sand and fine gravel. The type differs from the Cass loamy fine sand chiefly in the lower content of organic matter and the lighter color of its surface soil.

Included with this type are small patches of Riverwash lying adjacent to the stream channels. The material differs from the Sarpy sand in the almost total absence of organic matter and in its less stable nature. It occupies sand bars and sand flats a few feet above the streams. The material is not permanent and undergoes changes with each slight rise of the streams. Even during normal flow small areas are shifted about, added to, or destroyed by the varying current. The material represents the first stages of alluvial soil formation, and with the accumulation of organic matter under undisturbed conditions of weathering will gradually develop into Sarpy sand.

The Sarpy sand is confined largely to a few small bodies within the flood plains of Cedar River. Two small areas occur along Beaver Creek in the extreme northwestern corner of the county. Typical areas lie south of Primrose and in the vicinity of Cedar Rapids on Cedar River.

The type represents recent alluvium deposited on the flood plains during periods of high water. It has not yet developed a dark-colored surface soil, as sufficient time has not elapsed for the growth and decay of much organic matter.

The topography is flat, modified in places by old cut-offs, depressions, and slight elevations, the latter being caused by wind, which in the more exposed places whips the incoherent sand into low, rounded knolls and ridges. The surface of the type lies from 3 to 5 feet above the normal flow of the streams, but is subject to overflow during seasons of heavy precipitation. The water table lies a

few feet below the surface of the type and in wet years rises to the surface in the lower situations. In dry years underdrainage is excessive and vegetation sometimes suffers from lack of moisture.

Owing to its small extent, low organic content, and incoherent structure, the type is not used for crop production. In dry years the soil blows badly where the native grasses are destroyed. All of it is used for pasture land, but as the vegetation is rather scanty, the type does not have a high value even for pasture. Narrow strips of timber, including a dense growth of cottonwood and willow, occur along the streams. In a few places the subsoil material is used for building purposes.

It is doubtful if any of the type should be used for crop production, as it blows badly when disturbed and is rather droughty during dry years. The seeding of alsike clover and timothy in the poorly drained areas and sand grasses on the more exposed parts would greatly increase the value of the land for pasture.

#### DUNESAND.

The surface soil of the Dunesand is a grayish-brown or brown, loose, fine to medium sand. It contains some organic matter, but not enough to prevent drifting when the covering of grasses is removed. There is very little change in color or texture to great depths, and the subsoil differs little from the surface soil except in its lower content of organic matter. Neither the soil nor the subsoil is calcareous. The type is rather retentive of moisture, considering its loose structure.

Dunesand is extensively developed in Boone County. It occurs as a large, roughly triangular area, extending from the northwestern corner in a southeasterly direction almost to Loretto. The area is separated into two unequal parts by the alluvial lands along Beaver Creek, the greater part being south of the stream.

The soil is a surface modification of the vast sand sheet underlying the plains loess. The general absence of fine material is probably due to its removal by wind during the continual shifting of the dunes. The monotonous topography of the Dunesand is due to wind action. The surface is sharply rolling, ridged, and heaped into dunes, varying in height from 30 to 60 feet. Steep slopes abound, and small hummocks of wind-lodged sand, hollows, and "blow-outs" are of common occurrence and vary the otherwise billowy appearance of the landscape. Blow-outs are most common on the northwest face of the dunes, but some are on the southwest side. At present a negligible part of the type is subject to active wind erosion.

The type is practically without surface drainage, but owing to the loose porous nature of the substratum all the rainfall is absorbed and subsurface drainage prevails.

Dunesand has no value for farming. Isolated patches of the sod have been broken, but the soil is so subject to wind erosion that the removal of the native vegetation ruins the land. It is used principally for pasture, although rather extensive areas are cut for hay. The native vegetation includes a great number of grasses, of which blue-stem, reed grass, redfieldia, and stipa are the most common. The type is capable of maintaining 100 to 150 head of stock on each

section during the grazing season. Native hay yields one-third to three-fourths ton per acre, depending upon the rainfall.

The grazing of beef cattle is the principal industry. Most of the animals are of native stock and largely of Hereford and Shorthorn breeding. A few ranchers ship in cattle for summer grazing. The animals are usually sold in the fall to local feeders.

The selling price of the Dunesand ranges from \$10 to \$50 an acre, depending upon improvements.

The preservation of the native grasses is the foundation of the only agricultural industry apparently possible on this soil. Drifting sand along old roads and around watering tanks plainly shows the disastrous effects of disturbing the soil-binding roots. Care should be taken to prevent and control fires which burn off the protective covering of grasses.

#### SUMMARY.

Boone County lies in the northeastern part of Nebraska. It comprises an area of 692 square miles, or 442,880 acres. The greater part of the county lies within the loess hills region of the State, but also includes a small part of the sand-hill area. The surface ranges from almost flat to hilly. The greater part, however, has a rolling relief.

Most of the county drains to the southeast. A small part along the northern boundary drains northward into Antelope County. The greater part is well, though not excessively, drained. The larger streams, together with their tributaries, reach nearly all sections. The most poorly drained areas include parts of the first bottoms or flood plains.

The first settlement in Boone County was made in 1871, and within the next few years most of the land was included in homesteads. The early settlers were chiefly of American birth.

According to the 1920 census the county has 14,146 inhabitants. The population is all classed as rural and is rather evenly distributed. Albion, the county seat and largest town, is located near the central part on the south side of Beaver Creek.

The transportation facilities are good. Several railroads cross the county and furnish good connections with outside points. The public road system is well developed except in the more sandy regions.

The climate of Boone County is well suited to grain farming and stock raising. The mean annual temperature is 47.9° F., and the mean annual precipitation is 25.43 inches. Winter-grown crops usually do not suffer materially from low temperatures, and serious droughts are practically unknown.

The county is essentially agricultural and is devoted largely to a combined system of stock raising and grain farming. It ranks among the foremost in the State in the production of purebred cattle, horses, and hogs.

Corn, oats, alfalfa, wild hay, wheat, sweet clover, rye, and barley are the principal crops. They yield well in all but the most unfavorable seasons.

The Federal census reports 409,037 acres, or 92.4 per cent of the county, in farms in 1920. The average size of the farms is reported as 220 acres.

The greater part of the farm land is occupied by the owners, although the number of tenant farmers is gradually increasing.

The selling price of the farm land ranges from about \$35 to \$300 an acre, depending upon the type of soil, topography, drainage, improvements, and location with respect to markets.

Twenty-one soil types, one phase, and a miscellaneous material, Dunesand, representing 11 soil series, are mapped in Boone County. The upland soils comprise the Marshall, Knox, Gannett, Scott, and Valentine series, together with Dunesand. The soils occupying terraces or second bottoms are included with the Waukesha and O'Neill series. The first-bottom or flood-plain soils comprise the Wabash, Cass, Lamoure, and Sarpy series.

The Marshall silt loam is the most extensive and important soil in Boone County. It covers over 60 per cent of the total area and is well adapted to the production of all crops common to the region. The lighter textured Marshall soils are less productive and more subject to drifting.

The Knox silt loam is of small extent and occurs where the surface soil of the Marshall silt loam has been removed by erosion. The type has an exceptionally high lime content and is well suited to the production of alfalfa.

The Scott silt loam is of little agricultural importance on account of its small extent and heavy intractable nature.

The Valentine soils are usually of a loose rather incoherent nature and subject to more or less drifting when the native sod is destroyed and the soil brought under cultivation.

The Gannett fine sandy loam occupies sinklike depressions, mainly in the Valentine soils and the Dunesand areas. It is used for grazing and hay land.

The Waukesha silt loam is one of the most important and extensive terrace soils in the county. The largest areas are along Beaver Creek. The type is very strong and fertile and well adapted to all crops common to the region, and is an exceptionally good corn soil. It comprises some of the highest priced land in the county. The Waukesha very fine sandy loam is a little lighter in texture but has practically the same value for farming as the silt loam.

The soils of the O'Neill series, although rather sandy, are well adapted to general farming when carefully managed to prevent soil drifting. They occupy terrace positions and are well drained.

The soils of the Wabash series occur in the first bottoms along the larger streams and are subject to overflow during periods of excessive rainfall. They include some of the strongest and most fertile soils in the county and produce high yields of all crops where adequate drainage is assured. The subsoil is usually heavier than the soil.

The Cass soils differ from those of the Wabash series in the lighter texture and more sandy nature of the subsoil. They occupy first-bottom positions, are for the most part poorly drained, and are used largely for cattle grazing and hay production. The better drained areas are productive and well suited to general farming.

The Lamoure very fine sandy loam is very similar to the Wabash very fine sandy loam in topographic position, drainage, and struc-

ture, but differs from that type in the decidedly calcareous nature and unusually lighter color of its subsoil. The type is used largely for hay production.

The Sarpy sand is very similar to the more sandy members of the Cass series, except that the surface soil is low in organic matter and much lighter in color. The type is used largely for pasture land.

The areas mapped as Dunesand occur in the northwestern corner of the county. The material has been derived from the sand sheet underlying the plains loess. Wind action has played an important part in the transportation and assortment of the sandy material. The soil is loose and incoherent, low in organic content, and is not suited to cultivation. It is all included in pasture land.

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