

SOIL SURVEY OF BROWN COUNTY, KANSAS.

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LOCATION AND BOUNDARIES OF THE AREA.

Brown County is situated in the northeastern part of Kansas, near the Missouri River. It is bounded on the north by Nebraska, on the east by Doniphan County, on the south by Atchison and Jackson counties, and on the west by Nemaha County. Parallel $39^{\circ} 50'$ north

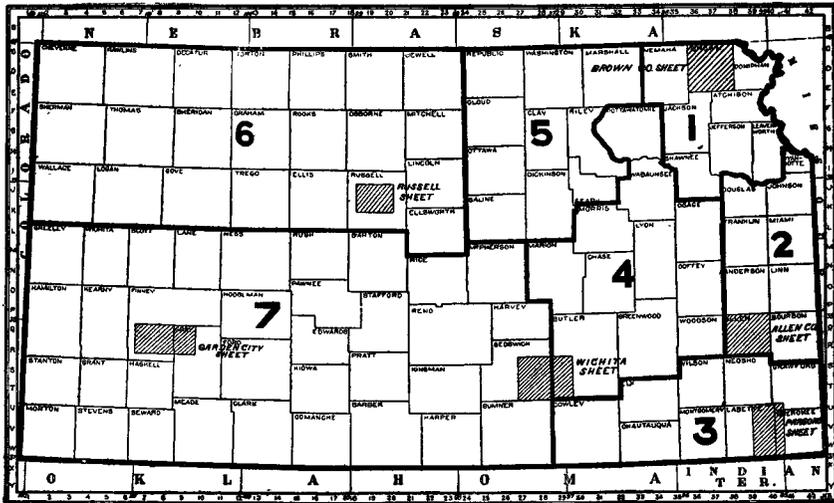


Fig. 39.—Sketch map showing location of the Brown County area, Kansas.

latitude and meridian $95^{\circ} 35'$ west longitude intersect near the center of the county. The county, which is approximately 24 miles square, contains 366,720 acres, or 573 square miles.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

The first legislature of the Territory of Kansas, held in 1855, passed an act dividing a portion of the Territory into counties. Under this act the boundaries of Brown County were established and the county attached to that of Doniphan for civil and military purposes.

Prior to 1855 settlement in this section was very slow, only a few pioneers having the courage to face the perils of settling on Indian lands. In 1855, however, quite a number took up land in the new

county, and in the early part of that year the settlers on Walnut Creek formed a protective association and passed laws that were rigidly enforced, especially those prohibiting the sale of liquor to the Indians.

In 1854 the nearest trading post was St. Joseph, from which both mail and supplies had to be procured. A trading post was established at Iowa Point in 1856, and from this place supplies were distributed to the whole county for two or three years. The first claims were located near the wooded stream bottoms, where logs for building purposes could be easily obtained.

In 1857 the Iowa Indian trust lands lying in Brown County were sold to the highest bidder by the Federal Government. These lands brought extravagantly high prices and were purchased principally by wealthy speculators, the actual home-seeker being content with the rich prairie lands that were his for the asking. In the year following the public lands were sold and many of the preemptors were forced to mortgage their claims and borrow money at a high rate of interest to prevent their property from going into the hands of speculators. Their embarrassed condition at that time was caused by the two successive unfavorable seasons and the lack of markets for even the inferior crops secured.

In the summer of 1859 the excitement created by the discovery of the Pikes Peak gold fields brought many pioneers, who, with their teams, passed through the county on their way to the West. This travel through the county created a demand for corn, butter, and eggs, and those farmers who lived near the "trail" profited by the sales they made.

In the spring of 1860 there was a demand for corn in the new gold fields and many wagon trains were loaded in the county, every farmer selling all the corn he could spare at 25 cents a bushel. The following summer was exceedingly dry and crops failed entirely. Thus many of the settlers were without the necessaries of life and would have suffered but for donations from the East. In the spring of 1861 thousands of bushels of corn and wheat were shipped in from the East to be used as seed, and that year's crops fortunately resulted in abundant harvests.

From 1861 to 1865 prices were high, but the producers were few, the county as yet being only sparsely populated. At the close of the civil war many immigrants made their homes in this county. At this time the Missouri Pacific Railroad Company obtained control of 127,832 acres of the Kickapoo Indian Reservation, the most of which was located in Brown County, and by liberal advertising induced many seekers of homes to locate on their lands. The years 1866, 1868, and 1874 were memorable on account of the grasshopper pest—the grasshoppers being exceptionally destructive in 1874.

The first railroad in Brown County, the St. Joseph and Grand Island, was constructed in 1870. Since that time the Rock Island and the Missouri Pacific have built lines through the county.

The population of Brown County is cosmopolitan in character, consisting in large part of people from many of the older States, with a less proportion of foreigners of various nationalities. Most of the immigrants came from agricultural communities and had previously acquired some practical knowledge of farming, which fact accounts, in a great measure, for the thrift and industry everywhere noticeable among the agricultural class. As early as 1864 an agricultural society was organized in the county, and in the same year the first county fair was held at Hiawatha. In 1874 the Brown County Agricultural, Horticultural, and Mechanical Association was chartered, and in 1882 the Brown County Improved Horse Association was organized.

The most important organization in which the farmers of this county are interested is the farmers' institute. The institute, begun in 1882, has done valuable work from the start, but its efficiency has been greatly increased within recent years.

CLIMATE.

Brown County has a distinctly humid climate. The precipitation is relatively light during the period from October to March, inclusive, thus affording favorable weather for plowing and for harvesting the corn crop. The weather is not so favorable during the season for harvesting small grain, since at that time heavy rains are liable to occur. From the accompanying table it is seen that more than 70 per cent of the annual rainfall occurs during the period from April to September, inclusive—an important factor in the production of corn.

An important feature in the climate of Brown County, and of this part of the Mississippi Valley generally, is the occasional marked deficiency in the quantity of annual rainfall. Several times since 1850 the annual precipitation has fallen below 30 inches, and in this prairie country, where hot winds in the summer are not unusual, even a small decrease in the rainfall during the summer months is likely greatly to reduce crop yields; hence the necessity of such management of the soils each year as best to conserve moisture.

The following tables, compiled from the records of the Weather Bureau stations at Horton and Atchison, show the normal monthly and annual temperature and precipitation and the dates of the first and last killing frosts:

Normal monthly and annual temperature and precipitation.

| Month. | Horton. | | Atchison. | | Month. | Horton. | | Atchison. | |
|---------------|-------------------|---------------------|-------------------|---------------------|--------------|-------------------|---------------------|-------------------|---------------------|
| | Temper- ature. | Precipi- tation. | Temper- ature. | Precipi- tation. | | Temper- ature. | Precipi- tation. | Temper- ature. | Precipi- tation. |
| | °F. | Inches. | °F. | Inches. | | °F. | Inches. | °F. | Inches. |
| January..... | 27.5 | 1.10 | 27.5 | 1.17 | August..... | 75.7 | 4.13 | 76.5 | 4.30 |
| February..... | 26.9 | 1.12 | 27.2 | 1.25 | September.. | 68.1 | 3.29 | 69.1 | 3.56 |
| March..... | 39.4 | 1.98 | 40.0 | 2.28 | October..... | 57.2 | 1.99 | 58.2 | 2.66 |
| April..... | 54.7 | 2.85 | 54.9 | 3.72 | November.. | 40.9 | 1.04 | 41.6 | 1.30 |
| May..... | 63.8 | 4.67 | 64.4 | 5.14 | December.. | 30.7 | 1.12 | 31.2 | 1.65 |
| June..... | 73.2 | 4.55 | 73.3 | 4.75 | Year.. | 52.9 | 32.08 | 53.4 | 36.92 |
| July..... | 77.1 | 4.24 | 77.3 | 5.14 | | | | | |

Dates of first and last killing frosts.

| Year. | Horton. | | Atchison. | |
|--------------|--------------------|-------------------|--------------------|-------------------|
| | Last in spring. | First in fall. | Last in spring. | First in fall. |
| 1897..... | Apr. 19 | Nov. 2 | Mar. 29 | Oct. 29 |
| 1898..... | Apr. 7 | Oct. 20 | Apr. 2 | Oct. 17 |
| 1899..... | Apr. 9 | | Apr. 9 | Sept. 29 |
| 1900..... | Apr. 13 | Oct. 8 | Apr. 13 | Nov. 8 |
| 1901..... | Apr. 18 | Sept. 17 | Apr. 18 | Sept. 18 |
| 1902..... | Apr. 23 | Oct. 14 | Apr. 2 | Oct. 14 |
| 1903..... | May 1 | Oct. 18 | May 3 | Nov. 6 |
| Average..... | Apr. 17 | Oct. 13 | Apr. 11 | Oct. 18 |

From the above table it appears that the growing season for tender crops is about six months.

PHYSIOGRAPHY AND GEOLOGY.

Brown County is situated in the central physiographic division of the United States, and has a general elevation of about 800 feet above sea level. The main divide between the Kansas and Missouri rivers enters the county on the west, about 8 miles south of the Nebraska State line, and runs in a southeasterly direction, leaving the county near Everest. South of this divide the drainage flows into the Kansas, while to the north it flows into the Missouri River. The drainage of the northern part of the county is effected by Pony, Walnut, Lause, and Roys creeks, the eastern part by Wolf Creek and its tributaries, and the southern part by Muddy, Cedar, and some other smaller creeks. Walnut, Wolf, and Cedar creeks are the largest streams in the county.

The surface of the county is gently to heavily rolling and rough. The area may be divided into two main physiographic divisions, namely, the uplands and the lowlands along the streams. Again, the uplands may be subdivided into the gently and heavily rolling areas and the rough, hilly areas.

The gently to heavily rolling areas are found on the broader divides, generally away from the larger streams. This part of the uplands is not too rough for cultivation and generally permits the use of improved machinery. The more level areas are found around Everest, Willis, Baker, and Powhattan, and along a line running from Morrill to Reserve. The heavily rolling areas are found in the vicinity of all the streams, where erosion has been more active. The rough, hilly areas are seen along the creeks and are best developed around the headwaters of Pony, Walnut, and Cedar creeks. Along these, and also along Wolf Creek, are hundreds of acres of land too rough for cultivation and devoted to meadow and pasture. Along Wolf and Roys creeks the rough lands do not extend very far from the stream channels, but, as is the case along most of the other streams, form high, precipitous bluffs against which the streams are now flowing. These hilly areas are usually marked by outcrops of limestone, calcareous sandstone, and shales, out of which flow perennial springs. These rough portions are generally of little agricultural value.

Fingering out from all the streams are numerous ravines and draws, some of which are quite deep and rapidly becoming deeper, threatening serious damage to many good farms unless steps are promptly taken to check their extension. The soil on the uplands is easily eroded, and the uneven topography makes erosion very active.

The bottom lands vary in width from one-fourth to three-fourths of a mile and are generally level and fairly well drained, though occasional flat areas occur where tiling is necessary. Along most of the streams various kinds of hardwood trees, such as ash, walnut, hickory, linden or basswood, locust, hackberry, and others, are found growing. At various places along the bluffs and in some of the draws a good grade of limestone is quarried for building purposes.

The soils of Brown County are influenced by strata that belong to two distinct geological ages. In the deep ravines and in heavily eroded areas in various parts of the county, notably in the western half, are found outcrops of sandstone and limestone of considerable thickness. The sandstones are usually calcareous and frequently are found interbedded with carbonaceous shales and limestones. The limestones are fossiliferous and belong to the Upper Coal Measures.

Above these beds of limestone, sandstone, and shale, and lying conformably to them, are fragmental remains of what seems to have been a continuous mantle of glacial material. Patches of sand,

gravel, and pebble, small areas of boulder clay, and huge boulders of the Sioux quartzite, weighing many tons, together with smaller rounded fragments of granite, schists, and other rocks of complex composition are found scattered over parts of the southern and western portions of the county.

This glacial material is a part of the Kansan drift. It is exposed only where erosion has removed the overlying mantle of buff-colored silty material known as loess, which was deposited during later Quaternary time. In the northeastern part the loess is quite thick, but the depth becomes gradually less as the extreme western part of the county is approached, until in the vicinity of some of the streams it disappears, except in small, irregular patches.

SOILS.

Five distinct types of soils were recognized in Brown County. All of these, except the Yazoo silt loam, are upland soils. The name and extent of each are given in the following table:

Areas of different soils.

| Soil. | Acres. | Percent. |
|-----------------------------|---------|----------|
| Marshall silt loam..... | 307,264 | 83.9 |
| Yazoo silt loam..... | 29,952 | 8.2 |
| Rough stony land..... | 17,088 | 4.6 |
| Marshall gravelly loam..... | 10,176 | 2.6 |
| Marshall sandy loam..... | 2,240 | .7 |
| Total..... | 366,720 | |

MARSHALL SILT LOAM.

The soil of the Marshall silt loam is a dark-brown silt loam, containing from 20 to 30 per cent of clay. The clay content tends to make it rather plastic and heavy when the usual amount of humus is lacking. Where the topography is reasonably level, there is generally sufficient organic matter to produce a mellow, friable, silty loam, easily cultivated and very retentive of moisture.

The subsoil is a heavy silty loam of a somewhat lighter color and heavier texture than the soil. It contains from 25 to 35 per cent of clay and but for the very high silt content would be called a clay loam, and in some instances it is a clay loam. It frequently contains iron concretions, carries an appreciable amount of lime carbonate, and only a small percentage of humus. Where deep exposures are found, the subsoil assumes an ashy-gray to buff color and is composed of very fine sand and silt, with only a comparatively small clay content. The amount of clay seems to decrease below a depth of 3 or 4 feet. The depth of the soil is quite variable, ranging from

a few inches to 15 inches on the knolls and ridges and becoming deeper and deeper as the lower levels are approached. In many of the depressions it is very deep, while toward the crests of the ridges it frequently thins out, and the subsoil is exposed. This thin top soil is of frequent occurrence in the west half of the county, where it is sometimes called "sheepskin soil."

The Marshall silt loam is quite uniform in its mechanical composition. In some places, however, there is some very fine sand present, owing to the incorporation of underlying material. Where the type is derived from the weathering in place of limestone, it usually contains broken fragments of the underlying rock. However, the soil is generally without stone, gravel, or sand in any appreciable quantity.

The Marshall silt loam is the most extensive type in the survey. It covers hill and dale alike, except where it has been removed from the higher elevations by erosion. Its typical development is in the eastern half of the county, where large areas with gently rolling surface are found around Everest, Willis, and Baker. In the central and western parts it is frequently cut through by erosion and is most typically developed on the divides. Here it thins out toward the streams and gives rise to the other types found in the county.

The surface of the type is very irregular and in the main heavily rolling. The hills are not usually too steep for the use of machinery, and the intervening depressions have a gentle and easy gradient. In the immediate vicinity of the streams there is sometimes developed a sharp bluff line, exposing a series of rock outcrops, which quickly disappear under the covering of silt.

In many places the Marshall silt loam is deeply eroded, and places are frequently found where recently-developed gulches expose vertical walls from 20 to 30 feet deep. These walls nearly always show the columnar structure characteristic of the loess. Some of these gulches have cut into the fields, undermining hedges, destroying roads, and rapidly reducing the value of many farms.

The drainage features of the type as a whole are excellent, though the surface drainage is better than the subdrainage. The subsoil is rather heavy, and while capillary water moves rapidly enough, the downward and lateral percolation of water is relatively slow. Many places occur in the western and some in the eastern part of the county, where the water from the higher levels, after soaking through the thin layer of soil and coming in contact with the heavy subsoil, moves laterally along the line of contact between soil and subsoil until the lower levels are reached, where the land is thus made too wet for the growing of crops. Only in these and a few other cases, however, is the drainage

of the type deficient, and this can usually be remedied with a little expenditure of time and money.

The Marshall silt loam is derived largely from the loessial deposits found generally over the Mississippi Valley. These deposits are composed of the more finely divided materials derived from the breaking down of rocks of almost every description and of many different geological formations. In the western part of the county this soil is in part derived from the weathering in place of limestone and shale, which belong to the Upper Coal Measures. In the process of formation the decay of plants has added to the weathered loess large quantities of organic matter, which imparts to the soil its mellow, friable texture and in no little degree its moisture-holding power. The deeper loess is not essentially different from the surface soil, except in point of organic matter and a slightly lower clay content, and it is due to this fact more than to any other that the Marshall silt loam, when deteriorated by erosion and continuous cultivation, can easily be restored to a high state of productiveness by simply incorporating with the soil liberal quantities of humus and bringing it into proper tilth.

All the staple crops grown in the county—such as corn, wheat, oats, clover, etc.—give the largest yields on the Marshall silt loam. It is especially well adapted to corn and clover. The average yields per acre of the different crops are corn 30 bushels, wheat 20 bushels, oats 20 bushels, and emmer 30 bushels. The usual yield of clover and timothy is from 1½ to 2 tons per acre.

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

Mechanical analyses of Marshall silt loam.

| Number. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|--------------------------|--------------|----------------|----------------|----------------|----------------|-----------------|----------------|----------------|
| | | <i>Per ct.</i> | <i>Per ct.</i> | <i>Per ct.</i> |
| 11893, 13733, 13735..... | Soil..... | 0.1 | 0.4 | 0.3 | 0.9 | 3.8 | 65.0 | 29.5 |
| 11894, 13734, 13736..... | Subsoil..... | .1 | .3 | .2 | .7 | 2.3 | 64.8 | 31.7 |

YAZOO SILT LOAM.

The soil of the Yazoo silt loam is a dark heavy silt loam, containing from 20 to 30 per cent of clay. It carries a large proportion of organic matter and retains its dark color to a depth of nearly 2 feet, where it grades gently into a subsoil consisting of a dark-brown heavy silt loam of nearly the same mechanical composition as the soil. The subsoil, which is very deep, contains iron concretions in the lower depths and a smaller proportion of organic matter, which gives it an apparently heavier texture than that of the soil.

The Yazoo silt loam is an alluvial soil. It is most typically developed along Wolf, Roys, Walnut, Pony, and Cedar creeks, where the width of the areas varies from one-fourth to three-fourths of a mile. It also occurs to a limited extent in the northeast part of the survey, where the Nemaha River swings south of the Nebraska State line into Brown County. Other small, narrow strips occur along the larger tributaries of the stream mentioned.

The surface of the larger areas of this type is generally level, but the smaller areas are usually cut by the winding of the streams, and the surface is somewhat irregular. In wet seasons the larger areas are sometimes water-logged by the drainage from the higher land. A large area near Reserve is rendered uncultivable in this way. Here, as in several other places, tile drainage is recommended. It is quite practicable to underdrain this soil, since the streams everywhere flow several feet below the surface.

The Yazoo silt loam is derived from material washed from the hill-sides and usually represents reworked loess. It is, however, modified in many places by the admixture of clay and sand from the Rough stony land and the Marshall gravelly loam. The admixture of these materials causes it to vary somewhat in texture, being lighter or heavier as the type approaches or recedes from the sandy or clayey slopes. By reason of its topographic position much organic matter has collected in the first 2 feet of the surface in addition to the annual decay of the native plant growth, which alone adds large amounts of humus. This soil is gradually becoming deeper through the addition of sediments from occasional overflows.

There is no better corn soil in the county than the well-drained areas of the Yazoo silt loam. It is a very strong soil. Some places were pointed out where corn had followed corn for forty years in succession with large yields each year that weather conditions were favorable. From 45 to 60 bushels of corn and from 20 to 25 bushels of wheat are counted a good yield on this type when the soil is well drained and the season is not too wet. At present a large proportion of the type, where the drainage is poor, is devoted to pasture. White clover, bluegrass, and other native grasses thrive on this rich alluvial soil.

The following table shows the average results of mechanical analyses of typical samples of soil and subsoil of this type:

Mechanical analyses of Yazoo silt loam.

| Number. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|-------------------|--------------|----------------|----------------|----------------|----------------|-----------------|----------------|----------------|
| | | <i>Per ct.</i> | <i>Per ct.</i> | <i>Per ct.</i> |
| 11887, 13725..... | Soil..... | Tr. | 0.5 | 0.4 | 1.1 | 2.6 | 70.9 | 24.2 |
| 11888, 13726..... | Subsoil..... | 0.2 | .6 | .3 | .7 | 2.3 | 72.9 | 22.8 |

ROUGH STONY LAND.

The Rough stony land includes the precipitous bluffs and the rough, rocky land along the stream channels, where the covering of loess has been removed by erosion.

The soil varies from a reddish-brown to a bluish-gray silt loam to clay loam, from 0 to 18 inches deep. The subsoil is a silty clay of a gray to brownish color. Its depth varies considerably, being underlain at various depths by limestones and shales. It contains a larger percentage of clay than is found in the soil and generally grades into undecomposed shales and limestones. The type is also characterized by numerous outcrops of shale and limestone. There is considerable lime found in both soil and subsoil.

The Rough stony land in this area is developed by erosion and is always found in the vicinity of the larger streams. Its greatest extent is found in the western part of the county, along Pony and Cedar creeks and around the headwaters of Walnut Creek. Its most typical development is in the northwest part of the survey and embraces the rough, uncultivable lands along the headwaters of Pony Creek. The boundary between this type and the Yazoo silt loam is nearly always marked by a sharp bluff several feet high. On many of the steeper slopes the rocks come to the surface, and here the soil contains a large percentage of limestone and chert fragments. Deep gulches finger out from the streams into the uplands and so thoroughly dissect the type as to render the greater proportion of it uncultivable. The surface is usually very stony, the rock outcrops lying horizontally where erosion has removed the overlying soil.

With the exception of the Yazoo silt loam and a few small areas of the Marshall silt loam, the Rough stony land lies at a lower level than any of the other types. While this type, as a whole, is well drained topographically, still when there is an unusually large rainfall the water soaks down through the more pervious soils of the surrounding types and, encountering the residual substratum of impervious clay, flows out horizontally along the line of contact, causing boggy places in the upland and a water-logged condition on many of the slopes.

The Rough stony land is a residual soil and is derived from the weathering in place of carboniferous limestones and shales. The steep slopes and the impervious nature of the weathered material causes rapid erosion, and the soil is thin on the hillsides and in many instances is removed as fast as formed.

This soil when sufficiently deep is especially adapted to clover and other lime-loving plants. Although not generally cultivated, corn does fairly well upon it, yielding from 30 to 40 bushels per acre. Much of the rougher areas of the type should be seeded with grasses

and white clover and used as permanent pasture. The more level areas may be used for red clover or alfalfa. Apples would doubtless do well on this soil.

MARSHALL GRAVELLY LOAM.

The Marshall gravelly loam is quite variable in texture. It grades from a bowlder clay, containing much small gravel, to a light sandy loam with little gravel present. The changes are quite frequent and abrupt, being due in great measure to the assorting action of water, which tends to localize the different grades of material. The soil is about 11 inches deep and of a dark-brown to gray color, depending on the amount of organic matter present. The subsoil is usually quite gravelly and of a reddish-brown to yellow color. The subsoil contains sufficient clay to make it sticky when wet.

This type, like the Rough stony land, is developed by erosion and is always found in the vicinity of streams. It occurs mostly in the eastern half of the county, along the headwaters of Walnut, Wolf, and Roys creeks. It occurs in narrow strips and patches and is ordinarily found between the Marshall silt loam and the Rough stony land. Areas are also frequently found skirting the upper edge of the Rough stony land and capping knolls of this type, and sometimes in spots of an acre or two in a field where erosion has been very active. These spots of gravelly bowlder clay give trouble in the cultivation of the fields. The type is being gradually extended as the loess covering is removed by erosion.

The surface of the Marshall gravelly loam is rolling to hilly. In most cases it slopes toward the streams and is badly dissected by small draws. It is sometimes sufficiently level to cultivate, but its occurrence near and along the bluff lines makes it rather undesirable and unprofitable for general agricultural purposes.

The Marshall gravelly loam has excellent surface drainage, but the subdrainage is sometimes poor. In many shallow draws, where the water seeps out along the line of contact between this type and the Marshall silt loam, the soil is boggy. In the lighter phases of the type the water passes through the soil too readily, while on the heavier phases the capillary movement is retarded so that plants suffer, except in seasons of ample rainfall.

The Marshall gravelly loam is derived from the glacial till found beneath the loess over the greater part of the county. Huge quartzite bowlders are of frequent occurrence, while granitic and other feldspathic rocks are scattered through both soil and subsoil.

The Marshall gravelly loam is generally used for pasture and meadow. Clover and corn do fairly well when the soil is put in proper tith and manured. From 25 to 30 bushels of corn and from 15 to 20 bushels of wheat per acre are good yields on this type.

Excepting areas occurring in the fields of Marshall silt loam little of the Marshall gravelly loam is cultivated.

The following table shows the average results of mechanical analyses of the fine earth of this soil type:

Mechanical analyses of Marshall gravelly loam.

| Number. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|-------------------|--------------|----------------|----------------|----------------|----------------|-----------------|----------------|----------------|
| | | <i>Per ct.</i> | <i>Per ct.</i> | <i>Per ct.</i> |
| 11891, 13727..... | Soil..... | 7.5 | 8.2 | 4.2 | 7.8 | 12.9 | 34.9 | 24.5 |
| 11892, 13728..... | Subsoil..... | 8.5 | 10.6 | 4.1 | 8.4 | 16.2 | 25.6 | 26.5 |

MARSHALL SANDY LOAM.

The soil of the Marshall sandy loam is a dark-colored light sandy loam from 6 to 36 inches deep. Some small gravel are present in the soil, but not in sufficient quantity to influence the type as a whole. The subsoil grades from a buff-colored sandy loam to a sandy clay or silt, sometimes becoming an almost pure sand at from 20 to 36 inches below the surface.

The Marshall sandy loam occurs in the eastern part of the survey along the headwaters of Roys Creek and along the lower part of Wolf Creek. Small spots are found elsewhere in the area.

The surface of the type is much like that of the Marshall gravelly loam; in fact, the two types are intimately associated, both having a common origin—namely, the Kansas drift. Like the Marshall gravelly loam, it is developed by erosion and is most pronounced in places where the silt has been entirely removed from the surface. The two types grade gradually into each other and the boundaries are sometimes difficult to determine.

The Marshall sandy loam produces fair yields of corn and wheat in moist seasons, but in dry seasons it does not do so well, as its open texture tends to make it droughty. This may be remedied in some degree by plowing under clover or cowpeas. From 25 to 35 bushels of corn and from 15 to 18 bushels of wheat per acre are considered good yields for this soil.

The following table gives the results of mechanical analyses of the fine earth of samples of this type:

Mechanical analyses of Marshall sandy loam.

| Number. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|------------|--------------|----------------|----------------|----------------|----------------|-----------------|----------------|----------------|
| | | <i>Per ct.</i> | <i>Per ct.</i> | <i>Per ct.</i> |
| 13731..... | Soil..... | 0.5 | 4.9 | 12.4 | 27.5 | 9.6 | 23.2 | 21.9 |
| 13732..... | Subsoil..... | 1.1 | 2.7 | 4.3 | 11.5 | 9.0 | 35.7 | 35.7 |

HARDPAN.

There are several spots and patches in the county where the clayey subsoil comes within an inch or two of the surface and forms a hardpan. The most important occurrence of this hardpan is north of Powhattan in sections 17 and 18, Powhattan Township. Here the soil is from 10 to 12 inches deep, underlain by a stratum of heavy black clay loam from 18 to 20 inches thick, beneath which is the ordinary silty material that generally forms the subsoil of the Marshall silt loam.

These hardpan areas may be easily distinguished by the light growth of corn on them in wet seasons. The areas are comparatively level and the hardpan holds the water near the surface, causing the soil to become waterlogged. Deep plowing and underdrainage are recommended as a remedy for this condition. Deep surface drains would also be effective in areas where damage from erosion would not be likely to result.

AGRICULTURAL METHODS.

It is the general opinion of the farmers of Brown County that the average yields of corn, oats, and wheat are growing appreciably less from year to year. They say that it requires probably a third more work to make a fair crop of corn now than it did ten years ago; that the oat crop would not be worth attention if it were not to rest the land and prepare it for wheat.

In view of these facts the farmers are beginning to diversify their crops, and stock raising and dairying are receiving considerable attention. This necessitates the sowing of more clover and timothy. The farmers are experimenting with various new grains and grasses, and as a result emmer, fescue, and alfalfa are coming more into favor. The breeding of seed corn is becoming important in the county, and the results obtained in this direction bid fair greatly to increase the average yield of this crop.

The following table shows the time of seeding and harvesting of the principal crops grown in the area:

| Crops. | Seeding. | Harvesting. |
|----------------------------|----------------------------|---------------------|
| Wheat, hard | Sept. 20 to Oct. 3 | June 28 to July 10. |
| Wheat, soft | Sept. 10 to Sept. 25 | June 17 to June 28. |
| Rye | Aug. 28 to Sept. 25 | June 15 to June 30. |
| Oats | Mar. 20 to Apr. 10 | July 4 to July 15. |
| Barley | Apr. 1 to Apr. 10 | June 15 to June 25. |
| Emmer | Mar. 10 to Mar. 25 | July 10 to July 25. |
| Corn | Apr. 28 to May 25 | Oct. 20 to Nov. 30. |
| Timothy ^a | Aug. 25 to Sept. 10 | |
| Fescue ^b | Aug. 25 to Sept. 10 | |
| Red clover | Mar. 1 to Apr. 20 | |
| Bluegrass | Sept. to Apr. | |
| Alfalfa ^c | Aug. 15 to Sept. 15 | |

^a Introduced five years ago.^b Introduced six years ago.^c Introduced ten years ago.

As seen from the foregoing table, corn is seeded from April 28 to May 25, when heavy rains are of frequent occurrence. The oat crop is seeded in March and usually on land planted the preceding year to corn. The lister is in general use and most of the corn is planted with it. Comparatively little plowing is done in the preparation of the seed bed of any crop.

Many of the farmers practice a systematic crop rotation which varies with the requirements of each farm. Where land is fairly level and the raising of hogs and cattle is the principal farm industry a seven-year rotation is recommended—clover two years, corn two years, wheat one year, emmer one year, and oats two years.

For hog production probably the best rotation is one in which clover follows corn in short succession. The following six-year rotation is recommended by some farmers: Clover in the spring on fall-sown timothy, mowing the first year and pasturing the second, plowing in the fall; corn the third and the fourth years, followed with oats the fifth year, and wheat the sixth year.

Alfalfa is not used in these short rotations, but is very valuable for permanent meadow, and will become more and more important as the dairying interest increases.

There is much complaint among the farmers of failure in recent years to secure satisfactory yields of oats, as both the blight and rust are very prevalent. It is said that the early growth of the plants is all that could be desired; that the growth of straw is, if anything, too rank. This suggests that it might be better to change the rotations above given and allow wheat, which is not so strong a feeder as oats, to follow corn. The removal of a part of the nitrogen by the wheat crop can be expected to reduce somewhat the rankness of growth in the succeeding oat crop, and, it is believed, make it less likely to suffer from the diseases mentioned.

In preparing the soil for corn the general practice is to use the lister. While in more arid regions this method is to be recommended, there are several serious objections to its use here. The heavy rainfall induces severe erosion in the silty soils at best, and the practice of listing, with the consequent deep furrows and ridges, tends greatly to increase the damage from this cause. In listing, also, the intervals between the rows are broken only to a depth of 3 or 4 inches or as deep as the ordinary cultivator tooth will run. This, of course, increases the surface run off, with consequent increase in erosion. Moreover, the shallow breaking of the soil between the rows tends to interfere with the growth of lateral roots of the corn plants, and this undoubtedly decreases the yield. Deep plowing is one of the most effective means of checking erosion, even on steeply rolling lands, and the fact that it is more expensive to plow the land thoroughly than simply to list the crop in is met by the equally accepted fact

that the protection of the land from erosion and the increased yield of corn and of subsequent crops will more than repay the additional expense for preparation of the seed bed.

AGRICULTURAL CONDITIONS.

On most of the farms in the county are seen good dwellings, barns, and cattle sheds. The price of land has increased to some extent within recent years, but this seems to be due to the demand for homes by the younger residents of the county and not to the desire for profitable investment on the part of capital. The prevalent idea among the farmers is that they are not so prosperous now as they were some years ago. During the last few years the low price for cattle and the ravages of the Hessian fly have no doubt lessened the profits on many of the farms.

Of the 368,640 acres of land in the county 93 per cent is in farms and about 88 per cent of these farms are improved. According to the census of 1900 the average size of farms is 148 acres.

Less than 50 per cent of the farms are operated by the owners, and the tenant system is becoming more general, owing in part to the fact that many of the older residents are moving to the towns. As is to be expected, tenants do not show the same interest in keeping up the farms as do those farmers who cultivate their own land. Consequently in many cases the hedges go uncut, the gullies in the fields deepen, the fences get out of repair, and the land depreciates in crop value. The tenant system as at present conducted is very unsatisfactory to the land owners.

The use of improved farm machinery is general throughout the county, and many of the farmers are able with their own families to do nearly or quite all the work of the farm. Hired labor is scarce, since the demand is not sufficiently large to induce laborers to seek employment in this section of the State. Some of the more wealthy farmers keep a few hired men, but the average farmer either does all his work or exchanges work occasionally with his neighbor.

The principal products are corn, wheat, and hay. The hay crop generally consists of timothy and clover. Several hundred acres of land are devoted to wild grass meadow. Alfalfa is coming into general favor and will soon form an important part of the hay crop. The creamery business is attracting considerable attention among the farmers, thus necessitating the raising of more grass and increasing the acreage devoted to pasture.

The raising of cattle and hogs is the most important item in the economy of the present farm practice of this area. Most of the cattle are either good grades or throughbreds, and the hogs are mainly of the Duroc Jersey strain.

The farmers generally recognize that the soil type known as the Marshall silt loam is especially well suited to corn, wheat, clover and timothy, alfalfa, and the grasses. Comparatively little study has been made of the other types of soil on account of their topographic position. It is probable, however, that oats will do better on the Marshall gravelly loam than elsewhere and that some varieties of fruit, as apples, would do well on the Rough stony land. The Yazoo silt loam produces good crops of corn, clover, and timothy. Wheat also does well on the well-drained portions of this soil.

The transportation facilities of the county are very good. The St. Joseph and Grand Island, the Missouri Pacific, and the Rock Island railroads put the farmers in direct communication with Kansas City, St. Joseph, Omaha, Chicago, and St. Louis. These cities furnish ready markets for the farmer's produce, the most of which, however, goes to Kansas City. Rural free delivery routes reach all parts of the county, schoolhouses are conveniently located, and the county, as a whole, possesses advantages favorable to a higher development of its agricultural interests.

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