

# SOIL SURVEY OF BANNER COUNTY, NEBRASKA.

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## DESCRIPTION OF THE AREA.

Banner County, Nebraska, lies in the extreme western part of the State. It is bounded on the north by Scotts Bluff County, on the west by the State of Wyoming, on the south by Kimball County, and on the east by Morrill and Cheyenne Counties. The county is rectangular in outline, its dimensions being  $35\frac{1}{2}$  miles east and west and 21 miles north and south. It has an area of 742 square miles, or 474,880 acres.

Banner County lies in physiographic province known as the Great Plains, lying in the western part of this province and in the division known as the High Plains, and comprising a remnant of the ancient table-land sloping away from the Rocky Mountains. Originally this table extended over the entire area included in the county, but through erosion, effected principally by Pumpkin Creek, most of the surface now lies several hundred feet below its original level and on formations below the surface formations of the High Plains.

The topography of the county may be separated into four broad divisions: (1) a smooth and level to deeply dissected table, representing a remnant of the original high plains and occupying the southern one-third of the area; (2) a broad lowland strip, extending in a southeast-northwest direction, known as the Pumpkin Creek Valley, occupying all the remainder of the county except a small area in the northeastern part; (3) a high ridge known in the Nebraska surveys as Wild Cat Ridge, extending across the northeastern corner of the county; and (4) a small lowland area lying on the north side of Wild Cat Ridge and representing a part of the North Platte River Valley, which is so extensively developed in Scotts Bluff and Morrill Counties.

The topography of the table-land in the southern part of the county varies greatly. In the southwestern part it is almost flat to slightly rolling, with a gentle slope toward the southeast. Stream channels are not well developed and occur mainly as shallow swales, which tend to give the surface its gently rolling character. In the

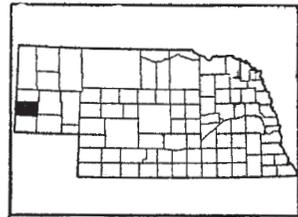


FIG. 37.—Sketch map showing location of the Banner County area, Nebraska.

south-central part the topography gradually becomes more rolling, and in the southeastern part the table is so dissected and broken that only the sharp, narrow divides and small, flat hilltops remain as its original surface level. The northern edge of the table is bordered by a steep escarpment, ranging in width from one-eighth mile to about 2 miles. It has an average drop of about 300 feet and is steepest near the edge of the table, where it often forms cliffs and vertical walls, and becomes less pronounced near its base, where it flattens out gradually into the Pumpkin Creek Valley.

The Pumpkin Creek Valley comprises about 40 per cent of the area of Banner County. It is widest in the northwestern part, where it extends across the north county line into Scotts Bluff County from the base of the escarpment on the south. In the eastern part it has an average width of about 6 miles. The valley is bounded on the north by the southern escarpment of Wild Cat Ridge, which extends diagonally across the northeastern part of the county.

Pumpkin Creek flows near the northern edge of its valley. Its flood plain, which lies from 1 to 3 feet above the stream channel, varies in width from a few rods to about one-fourth mile. The surface is generally flat, though modified in places by slight depressions. Bordering this flood plain and extending for short distances up the larger laterals is a strip of terrace or bench material having an average width of about one-half mile. The surface of this bench lies from 8 to 10 feet above the stream channel and about 5 feet above the flood plain. It has a flat to gently undulating topography, with a gentle slope down the valley and toward the stream channel. The break between the edge of the terrace and the flood plain is marked by a rather short, steep slope.

The land slopes from both sides of the terrace to the edge of the escarpments bordering the valley. The valley slopes on the south side of Pumpkin Creek and those in the northwestern part of the county, where the land slopes eastward, are long and gradual. On the north side of the stream they are relatively short and steep. The topography of the slope land presents a variety of features. It ranges from almost flat to rolling. The drainageways have narrow, shallow valleys, and the areas between them are relatively smooth. In a few places occur low, rounded gravel covered hills and ridges representing remnants of old colluvial and alluvial fans, which, in times past, have been built of materials washed down from the adjoining uplands, deposited on the valley slopes, and subsequently eroded until only small areas remain to indicate their former presence. More recent colluvial fan material which has been subjected to considerable erosion since its deposition and now has a gently rolling to rolling topography occurs extensively on the lower valley

slopes. In a few places erosion has isolated parts of the upland and left them standing as butte forms on the valley slopes. Gabe Rock, Castle Rock, and Bighorn Mountain are notable examples.

As previously mentioned, Wild Cat Ridge borders the Pumpkin Creek Valley on the north. This ridge occurs as a high, narrow divide between the North Platte River and Pumpkin Creek and represents a narrow strip of the original table-land which has escaped the rapid erosion that lowered the surrounding country. It is bordered on both sides by steep, precipitous escarpments. A reference to the map will show that the northern escarpment lies inside the county for only a short distance in the extreme northeastern part. The topography of this land form is extremely rough and broken and has a great range in relief. There is a 600-foot rise in a distance of  $2\frac{1}{2}$  miles from the base of the escarpment to the crest of the ridge which lies at the original level of the table.

The escarpment on the north side of Wild Cat Ridge drops abruptly into the Platte River Valley, a small section of which occurs in the extreme northeastern part of the county. The topography of this section is flat to rolling, the surface sloping gently toward the north. The more level part occurs on the west side, while that along the east county line has been considerably modified by colluvial fan and wind-blown materials in an advanced stage of erosion.

The lowest elevation in the county is at the point where Pumpkin Creek crosses the eastern boundary, approximately 3,940 feet above sea level. The highest elevation recorded by the United States Geological Survey is 5,240 feet in sec. 23, T. 18 N., R. 58 W. The most abrupt relief occurs between Hogback Mountain, a prominent land form, and Pumpkin Creek. The summit of the former is 5,082 feet above sea level and the latter, 2 miles south, is 4,300 feet above sea level. An elevation of 4,500 feet is attained on the Harrisburg-Scottsbluff highway near where it crosses the north county line. The elevations of other prominent landmarks are: Wildcat Mountain, 5,038 feet; Funnel Rock, 4,502 feet; Castle Rock, 4,472 feet; Gabe Rock, 5,006 feet; Bighorn Mountain, 4,713 feet; Sheep Mountain, 4,507 feet; and Smokestack Rock, 4,326 feet. The general slope of the county is to the southeast.

Pumpkin Creek, the largest stream in the county, drains the northern two-thirds of the area, with the exception of a few square miles in the northeastern part, from which the run-off is north into the North Platte River. The table-land in the southern part of the county is drained by Lawrence Fork and its tributaries. Pumpkin Creek has a fall of about 460 feet in its course of about 27 miles in this county, averaging 17 feet to the mile. It flows in a shallow channel from 2 to 4 feet deep and has an average width of about 20

feet. Near its head the stream is swift and cutting its channel, but it becomes more sluggish toward the eastern county boundary. In its course through the county the creek receives no water from constant natural tributaries; it is fed entirely by intermittent drainageways, springs, and underground seepage. The principal drainageways emptying into Pumpkin Creek are Bull Canyon, Willow Creek, Indian Springs Canyon, Bighorn Gulch, Hackberry Creek, and Chalk Creek. These drainageways are all on the south side of the stream. Many of them have springs near their heads, in the rough, broken escarpment bordering the table-land, but the water becomes lost in the loose, porous sands of the valley slope before reaching the main stream.

Lawrence Fork is a dry drainageway in the southeastern part of the county. Its principal tributary is Rocky Hollow. Except for a short distance along Pumpkin Creek, in the eastern part of the county, all the drainageways have a very steep gradient and are swift flowing. By far the greater part of the county is well drained. Streamways reach all sections except the sandier parts in the Pumpkin Creek Valley, where the water finds its way to Pumpkin Creek through subterranean channels, and a few areas in the upland where shallow depressions occur. The first bottom of Pumpkin Creek is poorly drained, owing to the flat topography and to the nearness of the water table to the surface.

Banner County was formed from a part of old Cheyenne County in the fall of 1888 and was organized as a county in January, 1889. Settlement on the lowlands along Pumpkin Creek began as early as 1885. The first settlement was made by people from Illinois, but these were followed by others from eastern Nebraska and from Iowa. The settlers were of mixed parentage, a large percentage being American born. The population of Banner County is reported in the 1910 census as 1,444, and is all classed as rural. The population averages 1.9 persons per square mile. Settlement is densest on the table-land in the southeastern part of the county and along Pumpkin Creek in the northern part. The region surrounding Harrisburg is also comparatively thickly populated. The rough broken areas in the southeastern part of the county and Wild Cat Ridge in the northeastern part are the most sparsely populated sections.

Harrisburg, the county seat and principal town, has an estimated population of 100. It lies in the central part of the county and serves as a distributing point for the most necessary farm supplies. Flowerfield is a small village in the southwestern part of the county.<sup>1</sup>

<sup>1</sup> Since this report was written the preliminary announcement of the population of Banner County and its civil divisions in 1920 has been issued by the Bureau of the Census, as follows: Banner County, 1,435; rural, 1,435; Epworth precinct, 199; Flowerfield precinct, 123; Gabe Rock precinct, 127; Lone Pine precinct, 148; Long Springs, precinct, 310; Loraine precinct, 181; Wrights precinct, 247.

The transportation facilities in Banner County are inadequate, and this condition is largely the cause of its slow development. There are no railroads in the county. One passes through Kimball, about 11 miles south, and another through Gering, 8 miles north of the county. A stage line from Kimball to Scottsbluff crosses the central part of the area from north to south, passing through Harrisburg. The wagon roads in the south-central, southwestern, and northwestern parts of the county are good and follow for the most part section lines. In the Pumpkin Creek Valley the roads are not so well established, and in the areas of Rough broken land in the southeastern and northern parts of the county they are few and poor. All are earth roads. The county is not supplied with rural mail delivery routes, though rural telephone lines are fairly well distributed.

There are no markets in Banner County for any of the farm produce, the nearest ones being along the railroads in Kimball and Scotts Bluff Counties. Most of the grain is hauled to the elevators located at Kimball and Bushnell, in Kimball County. Live stock is generally driven to Gering or Scottsbluff for shipment. The heavy hauling required to get grain over the steep escarpments bordering both sides of the Pumpkin Creek Valley, together with the long distances to market, has had a tendency to discourage commercial grain growing in the valley.

#### CLIMATE.

The climate of Banner County is typical of the High Plains country. It is characterized by cold winters and short summers, with great extremes in temperature. The rainfall, which is always low, generally comes in the form of local showers, which occasionally are torrential. Hail sometimes does considerable damage over local areas.

The following table, compiled from records from the Weather Bureau station at Kimball, covering a period of 25 years, gives the normal monthly, seasonal, and annual temperature and precipitation, and the precipitation for the wettest and driest years.

*Normal monthly, seasonal, and annual temperature and precipitation at  
Kimball, Kimball County.*

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maxi- mum.	Absolute mini- mum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.
	°F.	°F.	°F.	Inches.	Inches.	Inches.
December.....	28.8	69	-24	0.62	0.45	0.00
January.....	26.5	73	-33	.45	.91	.65
February.....	27.1	74	-30	.69	.48	1.20
Winter.....	27.5	74	-33	1.76	1.84	1.85
March.....	34.9	82	-17	1.00	.20	1.87
April.....	45.6	95	6	2.01	.88	5.57
May.....	54.6	97	8	2.67	.49	4.04
Spring.....	45.0	97	-17	5.68	1.57	11.48
June.....	65.1	102	29	2.14	1.49	4.10
July.....	70.7	106	38	2.44	1.18	3.48
August.....	69.7	104	26	1.54	.80	2.38
Summer.....	68.5	106	26	6.12	3.47	9.96
September.....	60.7	97	19	1.14	1.42	1.57
October.....	48.1	92	0	.73	.91	.73
November.....	36.7	87	-22	.34	.25	T.
Fall.....	48.5	97	-22	2.21	2.58	2.30
Year.....	47.4	106	-33	15.77	9.46	25.59

The mean annual rainfall is about 16 inches, but the precipitation varies greatly from year to year. Precipitation in the wettest year on record amounted to 25.59 inches and in the driest year to 9.46 inches. About 76 per cent of the annual rainfall occurs during the growing season, from April to September, inclusive. About 46 per cent occurs in May, June, and July, with the maximum in May. From October to March, inclusive, the precipitation commonly averages less than 1 inch per month. The rainfall in May and June is usually well distributed. In July, August, and September the distribution is not so favorable and occasional long droughts occur during these months. The average annual snowfall is less than 2 feet. The greater part falls during December, January, and February.

The mean annual temperature is 47.4° F. January is the coldest month, with a mean annual temperature of 26.5° F., and July the warmest with a mean of 70.7° F. The mean annual temperature for August is only 1° lower. The lowest temperature recorded is -33° F. in January and the highest 106° in July.

The average date of the latest killing frost in the spring is May 15, and that of the first in the fall September 22. This gives an average growing season of only 129 days, and it is necessary to grow quick maturing varieties of crops to realize the largest returns. The earliest recorded killing frost in the fall occurred August 25, and the latest in the spring June 5. The summer grazing season begins about the middle of May and lasts until the 1st of November. Most of the grasses cure into hay under natural conditions and furnish considerable sustenance for stock throughout the winter.

The prevailing winds in the winter are from the northwest, and during the summer months from the south and southwest. Strong though not destructive winds are common.

The climate of the region is the controlling natural factor in agricultural development. While the rainfall is not always sufficient for as high yields of grain as can be reasonably expected in the eastern part of the State, the farmers have adopted methods whereby fairly good returns are assured in all but the driest years. Careful conservation of soil moisture and the selection of only the most hardy and early maturing varieties of grain have resulted in making the tillable parts of the county fairly dependable in crop production. The growing season, however, is short, and corn and oats sometimes fail to mature.

#### AGRICULTURE.

The first settlers to enter Banner County confined themselves to cattle ranging on the open range, where a great variety of nutritious grasses afforded good pasturage. During 1885 and 1886 the land was rapidly taken up by homesteaders. With the passing of the herd law in 1887 most of the cattlemen were forced out of the country. As in other parts of the Great Plains, the waves of settlement have advanced and receded. During the eighties the settlers had a few years of good crops, and immigration was greatly stimulated, so that by 1890 there was a farmer on nearly every quarter section in the county. These good years were followed by the most disastrous drought the region has ever experienced, ending in the extremely dry years of 1893 and 1894. Total failures of all crops resulted, and the new settlers were so impoverished that they left the county in large numbers. In 1890 there were 565 farms in the county. This number had decreased to 226 in 1900. The early population was larger than that enumerated as late as 1910.

The droughts experienced in these early years would not have checked the development so seriously if the present dry-farming methods had been practiced. The settlers were not supplied with sufficient capital to maintain themselves during the years of failure;

they had no knowledge of the crops best adapted to the soils and climate; the means of conserving soil moisture by proper cultivation was not understood; the system of combined stock ranching and grain farming had not been introduced; and the general financial depression then prevailing over the entire country caused low prices for all agricultural products. All these factors contributed to the failure of this period.

The vacated land was taken up by ranchers, who combined stock raising and farming. Since then many of the large tracts have gradually been broken up as the population has increased, but the greater part of the county is still used for the production of hay and as pasture land. Most of the public land in the county passed into private ownership many years ago. The resettlement of the remainder was hastened by the passage in 1905 of the Kincaid Act, which increased the size of homestead claims to 640 acres, and made it possible to take up land valuable chiefly for pasture. Within a short time after the passage of this act the remaining public land passed into private ownership.

The following table, compiled from the census, gives the acreage and production of the principal crops of the county in 1889, 1899, and 1909, and shows the general trend of agriculture during the last 20 years:

*Acreage and production of the principal crops of Banner County, 1889, 1899, and 1909.*

Crop.	1889		1899		1909	
	Area.	Yield.	Area.	Yield.	Area.	Yield.
	<i>Acres.</i>	<i>Bushels.</i>	<i>Acres.</i>	<i>Bushels.</i>	<i>Acres.</i>	<i>Bushels.</i>
Corn.....	9,006	56,122	1,581	10,160	5,882	89,884
Oats.....	656	11,074	475	4,070	8,280	208,184
Wheat.....	788	6,477	1,535	8,770	6,297	85,306
Rye.....	41	398	72	340	222	2,710
Barley.....	90	1,395	35	300	141	3,600
Emmer.....					599	12,825
Beans.....		285	2	10	17	77
Flax.....	349	1,351			272	1,520
Potatoes.....	677	24,401	147	7,414	333	24,697
Other vegetables.....					88	
Wild, salt, and prairie grasses.....	8,196	<i>Tons.</i> 4,964	8,138	<i>Tons.</i> 4,250	17,874	<i>Tons.</i> 10,487
Grains cut green.....			1,961	1,679	560	549
Coarse forage.....			836	666	194	263
Tame and cultivated grasses.....			1,467	1,283	3,193	3,377
Alfalfa.....			374	358	1,063	1,520

The table indicates that the early settlers depended largely upon cultivated crops. From 1889 to 1899 corn was the leading cultivated

crop. The early settlers came from corn-producing regions and endeavored to raise the crop with which they were most familiar. The shortness of the growing season, however, makes the crop very uncertain, and by 1909, oats and wheat occupied acreages larger than corn. The table shows a decided decrease in the acreage of most crops between 1889 and 1899 and a gradual increase during the following decade.

The agriculture at the present time consists of a combined system of grain growing and cattle ranching. The level table-land in the southern part of the county is used mostly for grain production. The rest of the land, including the Pumpkin Creek Valley and the areas of Rough broken land, is used for the grazing of beef cattle and horses and the production of hay and grain for feed. Most of the farms and ranches grow a few garden vegetables for home needs.

Wheat is now the most important grain crop, ranking first in acreage in the county. The report of the Nebraska State Board of Agriculture shows there were 29,427 acres devoted to wheat in 1918, about three-fourths of this acreage being planted to spring varieties. Turkey is the chief winter wheat and durum wheats the principal kinds used for spring sowing. Most of the wheat is grown on the heavier soils, as there is considerable danger of drifting by the heavy winds of the fall and spring on the sandy soils. The average yield of spring wheat is less than that of winter wheat, but the spring varieties seem better adapted to the sandy lands, and the durum varieties are especially popular on account of their drought-resisting qualities. The average yield of winter wheat is 22 bushels per acre and that of spring wheat 19 bushels per acre. Wheat is the chief cash crop of the county and is nearly all shipped to outside markets. The quality is generally good.

Corn ranks second in importance among the grain crops. The Nebraska State Board of Agriculture reports 8,224 acres in corn in 1918, with a total production of 172,704 bushels. Warm, dry winds and droughts in some years cause considerable damage to this crop. Owing to the high altitude and the shortness of the growing season only the earliest maturing varieties are planted, principally Blue and White Squaw corn, Small Yellow Dent, and Small Calico Dent. These produce smaller stalks and ears than the varieties grown in the eastern part of the State. The yields show wide variations through a period of years, ranging from complete failure to 25 or 30 bushels per acre. The grain is used for feeding work stock and cattle. A few farmers grow more corn than they need and sell the surplus in the community, but the demand is greater than the supply, and some corn is annually shipped in from the corn belt.

Oats were grown on 8,071 acres in 1918 and gave an average yield of 30 bushels per acre. Most farmers do not consider oats a very

profitable crop, but it is needed to feed the stock, especially horses. The crop is grown on practically all the farms and ranks as one of the most important in the county. It does not withstand droughts, however, as well as the other small grains, and is frequently damaged by warm, dry winds or droughts at heading time. The crop gives the best results on the heavier soils. Swedish Select and Kherson are the principal varieties. Yields are very uncertain, but in the best years 40 to 50 bushels per acre are obtained. In the drier years the heads often fail to fill well and the crop is cut for forage. Oats are generally fed to work stock on the farms and ranches where produced. A few farmers, however, grow a surplus, which is sold locally.

Flax ranks next to oats in acreage. There were 786 acres devoted to flax in 1918. Only the seed of this crop is utilized. All the flax is sold outside the county. The crop is generally grown on newly broken land. The average yield is about 6 bushels per acre.

Rye was grown on 524 acres in 1918. The crop is planted chiefly on the heavier soils, and generally for the grain, but it is also grown to some extent for hay and pasture. The yield of grain ranges from 10 to 30 bushels per acre, depending upon the rainfall. The crop is quite drought resistant and yields better upon the sandy soils than wheat, but its lower market value tends to prevent any decided increase in acreage.

Potatoes rank next to rye in acreage, 311 acres being devoted to potatoes in 1918. The crop is grown chiefly for home consumption and very few farmers have a surplus for sale. The principal varieties are Early Ohio, Bliss Triumph, and White Eureka. Yields range from 50 to 200 bushels per acre, with an average of about 112 bushels per acre.

Of the hay crops, alfalfa occupies the largest acreage. It has steadily increased in importance since it was introduced. There were 8,870 acres in alfalfa in 1918, as compared with 1,063 acres in 1909. The crop is of local importance for hay and pasture. It is grown to a minor extent on nearly all the upland soils of the county, but does best on the terraces and well-drained parts of the flood plains. In a few places along Pumpkin Creek the terraces are irrigated, and in these localities alfalfa is the principal crop. Under irrigation the crop generally gives three cuttings and yields 2 to 4 tons per acre per season. On unirrigated land the yield is about 2 tons per acre under favorable conditions, the crop usually being cut but twice.

Wild hay was cut from 4,726 acres in 1918. The crop consists of stipa or needle grass, sand grass, bunch grass, grama grass, buffalo grass, blackroot (a sedge), western wheat grass, and some marsh grasses. The first two named grow on the sandier soils in the Pumpkin Creek Valley; the following five species grow on the heavier soils

in all parts of the county. Marsh grasses are found only in the poorly drained flood plains of Pumpkin Creek. The yield of hay varies greatly in the different sections of the county and from year to year. On the flood plains it ranges from 1 to  $1\frac{1}{2}$  tons per acre. In the upland the yields range from one-fourth to three-fourths ton per acre, depending upon the rainfall. The upland hay is finer in texture and is considered better in quality than that produced on the flood plains. The greater part of the hay is fed during the winter months to work stock and cattle. The average yield of wild hay in 1918 is reported as 0.8 ton per acre.

Sorghum, emmer, millet, and barley constitute the less important grain and forage crops. They are grown in small patches on many farms. Millet gives fair promise of becoming a good hay crop, as it withstands drought well and good yields are generally obtained.

Garden vegetables can not be successfully grown unless artificially watered. A very small quantity of fruit is grown. The severe climate and the late spring frosts generally injure the trees, and fruits in general are not suited to local conditions. Plums and apples are the most dependable of the tree fruits and gooseberries and currants of the small fruits. Wild plums, wild grapes, and buffalo berries are the principal native fruits.

By far the greater part of Banner County is used as grazing land and live-stock raising is the most important industry. The value of live-stock products in 1909 exceeded that of all crops combined by about \$2,000. The Nebraska State Board of Agriculture reports a total of 714 milch cows in the county in 1918, with a value of \$64,260, and 16,793 other cattle, with a value of \$1,175,510. The number of horses in the same year was 5,084 valued at \$457,560, and the number of mules 175, valued at \$17,300. The number of hogs was 1,610, with a value of \$48,300, and there were 1,429 sheep, valued at \$17,124.

Stock raising is highly profitable, as the animals generally are free from disease. Cattle and horses are the chief sources of income. A small herd of horses is raised on nearly every farm and most farmers have a surplus for sale. The stock has been improved from the western broncho to medium draft horses weighing 1,000 to 1,200 pounds. The Percheron is recognized as the best breed under existing conditions. The horses are seldom fed grain during the winter, but are allowed to run on the range, except in the severest weather, when they are driven into shelter and fed hay. Many of the horses are sold to buyers who come into the county. The most popular breeds of cattle are the Hereford and the Shorthorn. Very few of the animals are purebred, but the herds are almost invariably headed by a purebred male. The ordinary farmer keeps 20 to 30 head of cattle, but many ranchers have several hundred. The stock is usually sold in the fall when 2 or 3 years old, going to

eastern markets as feeders. Many of the cattle are run on the range throughout the year, hay being fed during severe weather. Only a few hogs are raised, chiefly in an experimental way. The high altitude, healthful climate, and isolation from cholera and other malignant diseases gives fair promise for the development of the hog-raising industry. The animals are generally fattened on corn, but alfalfa is often added to the ration.

A few sheep are annually shipped in for summer grazing, and some ranchers carry the stock through the winter. The diligent herding and care required in this industry have tended to make it unpopular.

A small flock of poultry is raised on nearly every farm, but few farmers have a surplus of poultry products for sale. The Nebraska State Board of Agriculture report shows that there were 1,083 dozen poultry of all grades in Banner County in 1918.

Little or no attention is given to dairying in this county, although a few farmers have a surplus of dairy products, which is sold outside the area.

Topographic and soil conditions have influenced the extent and distribution of the farmed areas more closely than they have affected the distribution of the various crops. The rough topography and the tendency toward excessive drainage in certain parts of the county have hindered the development of farming on some soils. In general, the heavier and deeper soils are recognized as most drought resistant and best adapted to the production of small grains. They include the very fine sandy loams, silt loams, and loams of the table-land in the southern part of the county. The areas of Rough broken land, the sand dunes, and the large areas where the underlying rock lies close to the surface are best adapted to grazing. The poorly drained flood plain soils along Pumpkin Creek are used exclusively for the production of hay and for pasture, and the better drained areas of the first bottoms are well adapted to alfalfa. Corn is grown in all parts of the county, but seems to do best on the lighter textured soils of the table-land.

The agricultural methods followed by the best farmers are based on experience. They understand that the essential features of dry farming are thorough preparation of the land and the conservation of soil moisture. The sandy lands are not cultivated so intensively to form a mulch as the heavier soils. The surface of the light-textured soils is kept as rough as possible in order to prevent drifting. Moisture conditions are the chief factor controlling cropping and rotations; fertilization and tillage methods are of secondary importance.

As a rule, the farm buildings are moderately good and the machinery and equipment on nearly every farm is adequate for all needs. Horse-drawn gang plows and cultivators are common, and there are

many tractors in the county. Mowers, hay sweeps, and stackers are used extensively in handling the hay crop. Binders and headers are used on most farms in harvesting the grains. Local thrashing machines handle the grain after it has been harvested. A few farmers own "combines," which cut and thrash the grain in one operation. The fences are all of barbed wire and usually kept in good repair. Runways for automobiles have been built in many fences where roads cross property lines.

Corn land is disked or double disked early in the spring and the crop listed in on old corn or stubble ground. Occasionally the heavy soils are plowed before disking. Some corn is planted on newly broken sod. The crop usually is cultivated twice with a two-row cultivator.

Winter wheat is seeded early in the fall and spring wheat is planted as soon after the frost is out of the ground as possible. The crop is usually drilled in on well-disked corn or stubble ground. It is the opinion of most farmers that wheat planted on newly broken sod, which has been well disked, gives larger returns than when planted on old land. The oats crop is always drilled in, usually on corn land. Rye is planted in the same manner as winter wheat.

No definite and systematic crop rotation is practiced, as the land is new and in no immediate danger of becoming exhausted. On many farms wheat and corn have been grown on the same land for four or five consecutive years.

No commercial fertilizer is used and barnyard manure is seldom applied to the land.

Farm labor is rather difficult to obtain. Ordinary wages during the busy season range from \$4 to \$5 a day, and during harvesting \$7 a day is sometimes demanded. When employed by the year laborers receive \$60 to \$80 a month, with board. Most of the farmers endeavor to do their own work, except during the harvest season.

The size of farms in Banner County ranges from a few acres to several square miles. In 1910 there were 368 farms in the county, with an average size of 863.5 acres and comprising 66.9 per cent of the total area. The prevailing size of farms ranges from 160 to 640 acres. Of the land in farms, 33.4 per cent, or 288.8 acres per farm, is classed as improved land. In the strictly grazing and hay-producing sections the ranches vary from 640 to 23,040 acres, with an average of 1,280 acres.

Nearly all the farmers and ranchers own their land and only a few farms are operated by tenants. The leases are about equally divided between the cash and share rental systems. Cash rent ranges from \$150 a square mile for strictly grazing land to \$3 or \$4 an acre for farming land on the high table. Share rent ranges from

one-fifth to one-fourth of the crops, the use of the pasture land generally being given the renter without charge.

It is difficult accurately to determine land values in this county on account of the newness of the country. The valuations given are based on the estimates of reliable farmers. The best grade of farm land in the southern and south-central parts of the area ranges in price from \$40 to \$75 an acre, depending chiefly upon the location and improvements. The heavier land on the slopes of Pumpkin Creek Valley sells for \$20 to \$35 an acre, and the light-textured sandy land for \$15 to \$20 an acre. The Rough broken land sells for \$12 to \$18 an acre. The land areas in which the bedrock lies close to the surface and which are shown on the map as Rosebud very fine sandy loam, shallow phase, are valued at \$12 to \$15 an acre for pasture. The alluvial soils along Pumpkin Creek range in value from \$20 to \$40 an acre, depending upon drainage and improvements.

#### SOILS.<sup>2</sup>

The typical soil profile in Banner County, the one that prevails over as much as three-fourths of the area in more or less perfect development, consists, in the virgin soil, of a surface horizon varying from 1 to 3 inches. It is loose in structure, not flocculated, contains a relatively small amount of grass roots, is light brown in color, and usually lighter in texture and more thoroughly leached than any of the other horizons. It varies considerably in the perfection of its development, being somewhat less perfectly developed in most of the smooth upland areas. When the second or underlying horizon is best developed the uppermost may be absent altogether, and in general, the less perfectly developed this horizon is, the better is horizon 2 developed. The latter is dark brown in color, rather compact, breaks up in clods when first broken from the virgin condition, has a more or less pronounced columnar structure on exposure, and may be a little heavier in texture than the surface horizon. It ranges in thickness from about 5 inches to 12 or 14 inches, the columnar

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<sup>2</sup> Banner County adjoins Scotts Bluff County on the north, Morrill and Cheyenne Counties on the east, and Kimball County on the south. In certain cases the mapping in the counties does not agree along the boundaries. This in most places is due partly to the extension into this county, of very small soil areas and partly to changes in correlation resulting from a fuller knowledge of the soils of the state.

The soils mapped as Rosebud loamy fine sand in Scotts Bluff County is called in this area the Rosebud fine sandy loam, and the area mapped as Marsh is in this area called Laurel fine sandy loam.

The type mapped in Morrill County as Bridgeport loamy fine sand has been combined in this area with the Bridgeport very fine sandy loam on account of its small area and its similarity to the latter type. In like manner the Tripp loamy very fine sand is combined with the Tripp very fine sandy loam and Riverwash has been called Cheyenne gravelly sandy loam.

The soil called Canyon gravelly sandy loam in Cheyenne County has in this area been combined with the Rosebud very fine sandy loam, shallow phase.

structure and compaction being developed usually in inverse ratio to the thickness. Although it is usually rather compact in the virgin condition, it breaks up readily into fine particles. The compaction is most pronounced in its upper part, and decreases gradually downward, but the transition from horizon 1 to horizon 2 is usually abrupt. Beneath horizon 2 there may occur a thin brown horizon free from compaction, with low organic matter, and differing from the fourth horizon mainly in the absence of lime carbonate. The fourth horizon is light gray or yellowish in color, deflocculated and therefore powdery in structure, except in the sandy members, and carries a high percentage of lime carbonate, the content ranging from 1 per cent to almost any amount, though in most samples it does not exceed 2 per cent. This horizon is usually a foot or more in thickness and changes gradually downward into the parent rock. This may vary greatly in its characteristics.

The profile just described is universally present on the smooth parts of the county, where the soil has lain in its present position for a considerable period of time without being subjected to any serious effect from erosion, burial by wash from higher areas, or creep and slide down slopes. It does not characterize the soils that are made of material recently accumulated and is less well developed on the slopes than on the smooth upland or terrace areas. This occurrence points to the conclusion that the profile here described is the mature one for the region or at least the most advanced in stage of development of any in the area, and since soil-survey studies in the northern Great Plains as a whole have found this profile of universal occurrence in situations such as those in which it is found in this region, the inference seems to be justified that it is the mature profile of the northern Great Plains region. If it be allowable to apply to the soil profile a term used in recent investigations in Ecology<sup>3</sup> it may be designated as the *climax profile* of the northern Great Plains, or, more accurately, the central-northern Great Plains.

The mature profile as described above is not developed over the whole area. The soils characterized by it are included in the various members of the Rosebud, Tripp, and Cheyenne series. The Rosebud soils are the prevailing upland soils and cover somewhat more than 55 per cent of the total area of the county. The Tripp soils occur on river terraces and for all practical purposes are the equivalents of corresponding types of the Rosebud series. Their profiles are exactly alike and they occur on smooth surfaces. The Cheyenne soils occur on terraces also, but on account of their open gravel or sand subsoils are differentiated from the soils of the Tripp series.

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<sup>3</sup> F. E. Clements, Plant Indicators.

The Epping, Mitchell, and Bridgeport soils have profiles less maturely developed than those of the series named above. As a rule the horizons have been developed far enough for identification, but fall much short of perfection. In the Mitchell soils the stage of development is somewhat more advanced than in the Epping or Bridgeport, though in a few areas the profile of the Epping is well developed, approaching in character that of the Rosebud. Owing to the fact that the definition of the Epping soils is a geological one, the variation in character of the soil profile is greater in the various members of this series and even in the same type in different places than is the case in the soils of the Bridgeport or Mitchell. The Epping soils are defined on the basis of their derivation from Brule clay material, one of the geological formations of the area, and the mapping has been done on that basis rather than on the basis of the soil profile. In those rather rare areas where the profile of the Epping soils is approximately mature they do not seem to differ essentially from corresponding members of the Rosebud series and in the future will probably be mapped in that series. Since such areas are very small in Banner County no serious error has been committed in not doing this here.

We are not yet in possession of a sufficient amount of chemical data to show whether a maturely developed soil from the Brule clay will differ from a corresponding type in the Rosebud series. Since the mineral elements, including those usually recognized as the necessary constituents of a productive soil, are very abundant in all these soils, it is perfectly legitimate to question the advisability, or even the justification of a differentiation of the soils on the basis of differences in their content of mineral constituents, except where the amounts of the different constituents are very great. Such data as are available show that these soils (in the two surface horizons) have about 2 per cent of lime, 2 per cent of potash, and 0.2 to 0.5 per cent of phosphoric acid. These data, which can not be presented here, show a rather uniform percentage of these constituents in all the soils of the region. This being the case, it would seem that there is no justification for differentiating a maturely developed soil derived from the Brule clay from the Rosebud series. When both soils are developed to the same mature stage their colors are essentially identical, and since they have developed under the same climatic and drainage conditions their organic matter must be assumed to be in the same stage of decay. Since, also, the color is due to their content of organic matter, it is legitimate to conclude that the content of both is approximately the same. Typically, the profile of the Epping series should show no differentiation into horizons, except the darkening of the surface soil.

The Mitchell soils are derived from terrace material and do not differ in profile in any essential respect from the Bridgeport soils. They are differentiated from the latter on the assumed basis of derivation from terraces whose material came chiefly from the Brule clay. The Bridgeport material is to a considerable extent colluvial in its process of accumulation, while the Mitchell material was accumulated by larger streams. Since the material, however, in both cases came from the same ultimate source, the various crystalline and sedimentary rocks of the Rocky Mountains, there would seem to be very slight reason for maintaining them as separate series of soils. This is done, however, pending the accumulation of more specific data. For all practical purposes the soils of the two series seem to be essentially identical.

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

The Scott silt loam, the only member of the series mapped in Banner County, has developed under imperfect drainage conditions. As would be expected, it occurs in small areas only in depressions in which water accumulates during periods of high rainfall. In wet seasons some of the areas fill with water and become temporary lakes. The surface soils are dark brown in color, while the subsoils are usually grayish in color and rather heavy.

The Dunlap soils have a profile differing from that of the Rosebud in one important respect. The lower part of horizon 2 consists of a heavy clay that as fully developed becomes very intractable, and does not permit the ready passage of capillary water. It seems to be the only soil in the area whose course of development has been influenced by the presence of soluble salts. It occurs on flat surfaces, where surface drainage has not been rapid, and where such salts as were developed by weathering processes would tend to accumulate. It is well known that the presence of certain salts, even in quantities too small to influence the growth of plants by their presence, may influence the character of the soil by the deflocculation of the surface horizons, thus allowing percolating water to carry the finer particles into the subsoil, where they accumulate, forming a heavy clay horizon. It is apparent that this process has been at work in this area to produce the soils mapped as Dunlap.

The Laurel soils have a profile marked by the absence of well-developed horizons, except a darkish surface horizon. They consist of recently accumulated alluvial material.

## THE SOIL MATERIAL.

The soil materials of Banner County have been derived from the country rocks within the county and from the Rocky Mountains around the head of the Platte River. The country rocks occurring in the region are all sedimentary in origin and of late geological age. They consist of a series of mechanical sediments, all of them more or less calcareous, with thin, discontinuous beds of limestone. The lowest rocks, those exposed only in the lower slopes of the larger streams, consist of fine-grain sediments known as the Brule clay, made up of alternating beds of silt, clay, and very fine sand. The Brule clay beds are overlain by beds of gray sandstone, varying from imperfectly cemented to well-defined sandstone with interbedded layers of impure limestone. Like the Brule beds, these outcrop only on the slopes of the valleys, and have contributed but a relatively small amount of material to the formation of the soils of the county. They are described by geologists as the Gering and Arikaree beds. Overlying these are the beds described under the term Ogallala by the Nebraska geologists, consisting of sand, gravel, and silt with a rather high percentage of lime carbonate. The upland soils of the area, those covering by far the greater part of the total area of the county, have been derived from the Ogallala and Arikaree beds and from finer grained material collected from sources farther west, but from rocks differing in no essential respect from these, all coming from the same ultimate source, the crystalline and sedimentary beds of the Rocky Mountains. The upland soils derived from these materials include the various types of the Rosebud series and those of the Valentine, Scott, Dunlap, and Bridgeport series.

The Bridgeport soils have been derived from material washed from these beds and accumulated on long, gently sloping fans in the broader valleys. They are, in fact, terrace materials, but derived from local rocks rather than from distant rocks like those materials from which the true river-terrace soils have been developed.

The soil materials from which the true terrace soils along the Platte River have been developed consist of material derived from all the rocks mentioned above and also from the rocks of the Rocky Mountains within the basin of the river. These materials vary widely in character and include portions from crystalline, sedimentary, and metamorphic rocks. The soils developed from these beds are the members of the Tripp and Cheyenne series, and with them may be included the soils of the Laurel series occurring on the modern valley floors.

The Epping soils have been derived from the residual decay of the Brule clay beds, while the several members of the Mitchell series have developed from terraces whose materials are supposed to have come largely from the same beds.

The several soil series identified and mapped in the county are described as follows:

The surface soils of the types in the Rosebud series are dark gray to brown; the subsoils are light colored and highly calcareous. A characteristic feature is the light-gray to almost white color of the deeper subsoil. The Rosebud soils are derived from the light-colored, calcareous, unconsolidated Tertiary deposits of the High Plains, mainly of the Arikaree and Ogallala formations. Their topography varies from almost flat to steeply rolling. In places the surface is excessively eroded or dissected. The more hilly areas in many places are dotted with white exposures of the underlying formations.

The types in the Dunlap series are distinguished by a brown surface soil, 6 to 12 inches deep, underlain by a brown, compact silt loam. This passes gradually through a light-brown heavy silt loam into a light-gray calcareous silt. The Dunlap series occupies the flat tops of the high tables representing remnants of the original High Plains. Drainage channels are not established over the entire surface. The material has been derived through weathering from the fine-grained, calcareous sandstones of Tertiary age, under conditions of restricted drainage. The Dunlap series differs from the Rosebud series in its heavy, compact subsoil and more nearly level topography.

The surface soils of the types included in Epping series are brown to gray, and the subsoils light buff and normally somewhat heavier than the surface layer. The soil material is of residual origin, being derived from the weathered Brule formation. The subsoil is usually composed of the unweathered compact silt or silty clay loam of the Brule formation. The Epping series occupies undulating or dissected plains and sloping or comparatively level flats. Drainage is generally thorough, and in many places excessive.

The Valentine soils consist of a dark-brown to grayish-brown sand, differing little throughout the 3-foot section. A characteristic feature is the absence of calcareous material. The Valentine soils are probably composed of partly weathered wind-blown material derived originally from the underlying Tertiary sandstone. The material has been so shifted by wind and water and subsequently weathered that it has lost most of its residual characteristics. The soils occupy level to sharply rolling upland plains. They differ from the members of the Rosebud series in the absence of a light-colored subsoil and in their lower lime content.

The types of the Bridgeport series are grayish-brown or brown. The material below 6 to 12 inches is in places slightly lighter in color than that above, but in most areas there is practically no change in the 3-foot section. The Bridgeport soils consist of recent alluvial and colluvial material carried down from the adjoining uplands by

intermittent streams and surface wash and deposited upon the valley slopes of the larger streams. Wind has also played an important part in their formation. The topography varies from gently undulating to rolling. Drainage is everywhere good. The Bridgeport soils differ from those of the Valentine series, which they often resemble, in the calcareous nature of their lower subsoils and of gravel, which is generally scattered in small quantities over the surface.

The Mitchell series includes light-brown or buff-colored silty soils, which in this county cover terrace-like benches and evenly graded slopes. They are composed mainly of colluvial and wind-blown materials, derived principally from the Brule clay and to a lesser extent from the Arikaree and Gering formations. These soils have been transported only short distances and differ but slightly from the soils of the Epping series. The Brule clay formation underlies them at depths ranging from 3 to 40 feet. The topography varies from level to gently rolling, but the drainage is usually good.

The surface soils of the types comprised in the Tripp series are grayish-brown to brown. The subsoils are light brown to gray and highly calcareous; in places the lower subsoil is almost white. The Tripp soils are alluvial, being developed on both high and low terraces along Pumpkin Creek and its tributaries. They consist of sediments brought down from exposures of the White River and Loup Forks Beds, with which sediments there has subsequently been mixed a large proportion of wind-blown material in places. The surface drainage over most of the series is not well established, but the porous subsoil carries off all the surplus water. The topography is almost flat to very gently undulating.

The types of the Cheyenne series have brown surface soils and grayish-brown, porous, gravelly subsoils, generally calcareous. The Cheyenne soils are derived from alluvial terrace materials and from colluvial wash which has partly filled the higher valleys and draws. They differ from the Bridgeport series in the large amount of gravel in the subsoil. The soils lie high above overflow and are well drained, often being droughty.

The types of the Laurel series have light-brown to gray soils underlain by light-gray subsoils. Both soil and subsoil are highly calcareous. Iron stains are common below 15 inches. There is often a porous stratum of sand and gravel in the lower subsoil. The Laurel soils occupy first bottoms, and are composed of sediments derived from the White River and Loup Fork beds, recently deposited along the stream channels. The surface is flat and drainage is generally poor. The soils are subject to overflow at varying intervals.

The types in the Scott series are dark brown to almost black in the surface soil, which is underlain at about 10 inches by a heavy com-

pact, drab clay loam or clay, extending as a rule throughout the 3-foot section. The material is of lacustrine origin, having been deposited in shallow basins or depressions. The series is developed in small areas throughout the uplands and is associated with the residual types. Drainage is usually restricted, and in many areas water stands on the surface part of the year. Both the soil and subsoil are calcareous and soluble salts often accumulate in injurious amounts.

Dunesand includes areas of almost pure sand having a dunelike topography and being subject to drifting.

Rough broken land constitutes areas with a topography unsuited to farming.

The following table gives the actual and relative extent of the several types of soil developed in Banner County. The distribution of these soils is shown on the map accompanying this report.

*Areas of different soils.*

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Epping very fine sandy loam . . . . .	87,488	} 20.2	Laurel fine sandy loam . . . . .	3,136	0.7
Basin phase . . . . .	8,512		Valentine loamy fine sand . . . . .	3,136	.7
Rough broken land . . . . .	76,544	16.1	Bridgeport very fine sandy loam . . . . .	3,072	.6
Rosebud loam . . . . .	67,712	14.2	Epping silt loam . . . . .	2,816	} .6
Rosebud silt loam . . . . .	46,912	9.9	Basin phase . . . . .	256	
Rosebud very fine sandy loam . . . . .	20,224	} 9.9	Tripp very fine sandy loam . . . . .	2,816	.6
Shallow phase . . . . .	26,432		Dunesand . . . . .	2,624	.6
Bridgeport loamy fine sand . . . . .	40,704	8.6	Mitchell silt loam . . . . .	2,496	.5
Bridgeport fine sandy loam . . . . .	21,696	4.6	Rosebud fine sandy loam . . . . .	1,728	.4
Epping fine sandy loam . . . . .	15,232	3.2	Bridgeport sandy loam . . . . .	1,600	.3
Tripp fine sandy loam . . . . .	9,088	1.9	Dunlap silt loam . . . . .	1,152	.2
Cheyenne gravelly sandy loam . . . . .	7,360	1.5	Valentine very fine sandy loam . . . . .	448	.1
Rosebud gravelly sandy loam . . . . .	5,120	1.0	Scott silt loam . . . . .	256	.1
Cheyenne sandy loam . . . . .	4,928	1.0	Laurel very fine sandy loam . . . . .	256	.1
Bridgeport gravelly sandy loam . . . . .	4,032	.9			
Cheyenne loam . . . . .	3,840	.8			
Mitchell very fine sandy loam . . . . .	3,264	.7	Total . . . . .	474,880	-----

DUNLAP SILT LOAM.

The surface soil of the Dunlap silt loam is a dark-brown to brown heavy silt loam. The silt content is unusually high and there is very little sand of any grade. The soil is rich in organic matter and in places where the topography has especially favored the accumulation of this material the surface 6 inches is almost black. The soil is slightly more compact than that of the Rosebud silt loam.

The upper subsoil is a dark grayish brown, heavy, compact silt loam. At about 20 inches it passes into a gray or grayish-brown heavy silt loam to silty clay which typically continues throughout the 3-foot section. In places the material changes rather abruptly at

about 30 inches into a light-gray or white floury silt loam, similar to that of the Rosebud silt loam. The change in color between the soil and subsoil is in most places gradual. The surface soil and upper subsoil are only slightly calcareous, but the lower stratum contains a high percentage of lime.

The type occurs as small isolated bodies in the southern part of the county. It occupies shallow depressions in an otherwise flat country. The soil has been derived from the sandstones and clays of the underlying formations, weathered under conditions of poor drainage. This process has resulted in the concentration of clay in the subsoil and in the removal of much of the lime from the soil and upper subsoil. The topography is flat to very gently undulating. Local drainage has not been established, but owing to the light rainfall water seldom accumulates on the surface.

The type is of such small extent that it is not important in Banner County. It is all used for pasture and hay land. The native vegetation consists of western wheat grass, grama grass, buffalo grass, and a sedge, blackroot. These yield from one-fourth to three-fourths ton of hay per acre, depending upon the season, and supply grazing for 40 to 50 head of cattle per section throughout the year.

The land is valued at \$60 to \$75 an acre, the price depending upon improvements and location.

The Dunlap silt loam, when occurring in areas of large extent, as in Box Butte, Dawes, and Cheyenne Counties, is one of the most valuable dry-land farming soils of the High Plains region.

#### ROSEBUD GRAVELLY SANDY LOAM.

The Rosebud gravelly sandy loam is a brown to light-brown loose sandy loam, generally containing relatively large proportions of coarse sand and gravel. The gravel consists of both angular and waterworn fragments of many different crystalline rocks found in the underlying sandstone formations. The gravel particles are of various sizes, ranging from small pebbles to pieces 2 or 3 inches in diameter. The surface 6 inches is often slightly darker in color than the rest of the soil, owing to an accumulation of organic matter. There is very little textural difference between the soil and subsoil. The brownish color of the surface soil extends to a depth of 12 to 15 inches, where the material becomes grayish or light brownish and is notably more calcareous than at the surface.

Along the south county line a few bodies of the type depart considerably from the typical description, as the fragments of crystalline rocks become less numerous and light-colored calcareous rock fragments predominate. Where these are especially numerous the type approaches the Rosebud very fine sandy loam, shallow phase. There is generally a sufficient amount of coarse sand and gravel, how-

ever, to give the type its gravelly sandy loam texture. The soil is derived by weathering from the beds of coarse sand and gravel of Tertiary age.

The type is relatively inextensive in Banner County. It occurs chiefly in the southern part, as scattering areas around the escarpment bordering the Rough broken land and as small areas along the south county line. The areas vary in size from a few acres to 1 or 2 square miles. The largest and most typical area lies about 5 miles southeast of Harrisburg. A small though very uniform body is mapped about 3 miles southeast of Flowerfield.

The topography is rolling and in places hilly. The type often occupies hilltops and the steep slopes along drainage ways. Drainage is in most places excessive. The soil is porous, is not retentive of moisture, and is poorly adapted to farming in a region of light rainfall. The character of the topography also is unfavorable for farming, and the land is all included in pasture. It supports a fairly thick growth of grama grass, buffalo grass bunch grasses, and black-root, which affords good grazing. Stock raising is the principal industry. The cattle are generally shipped in the fall after coming off summer pasture. A small herd of horses is carried on most farms. The topography affords protection to stock during severe weather.

The selling price of the Rosebud gravelly sandy loam is difficult to determine; as the bodies of this soil are generally small, and most farms include areas of other types. It has a tendency, however, to lower the value of farms on which it occurs, as it can be used for pasture only.

#### ROSEBUD FINE SANDY LOAM.

The Rosebud fine sandy loam is a light-brown or grayish-brown, loose, friable soil 10 to 14 inches deep. The upper 6 inches of the surface contains considerable organic matter, and has a slightly darker color than the lower part. Below 6 inches there is a deficiency of this material. A relatively large percentage of silt and very fine sand is generally present. In places the surface soil is quite coarse, approaching a sandy loam in texture, but areas of this kind are not of sufficient size to show on the map. The subsoil usually differs but little in texture from the surface material, but is lighter in color, ranging from pale yellow to light gray. In many places it changes to a silt loam or very fine sandy loam at a depth of about 24 inches. The lower subsoil has a high lime content, and fragments of white limestone or calcareous sandstone are often encountered at about 36 inches. The Rosebud fine sandy loam is derived by weathering in place from the more sandy strata of Tertiary age.

The type is of very limited extent in Banner County, and only a few areas are mapped. These occur chiefly along the Banner-Scotts

Bluff County line. The largest area lies in the extreme northwestern corner of Banner County. A smaller body occurs about  $3\frac{1}{2}$  miles southwest of Flowerfield.

The topography is gently undulating to rolling, by far the greater part of the type being gently rolling. Drainage is everywhere thorough and in a few places excessive, owing to the loose, porous nature of the soil and subsoil. Stream channels are indefinite and it is often difficult to trace them across the type.

On account of its small extent the Rosebud fine sandy loam is of no agricultural importance in the county. It is used entirely for pasture and hay land. The native vegetation consists largely of sand grass and stipa; some yucca and sage brush are encountered on the more sandy areas. Yields of one-fourth to one-half ton of hay per acre are obtained in average years. The type will support 80 head of cattle per section, when used only for summer or winter range, and about 40 head when grazed the year round.

The selling price of the Rosebud fine sandy loam ranges from \$10 to \$25 an acre, depending upon the improvements.

By growing crops requiring the minimum of cultivation it is possible that fair yields could be obtained. On the more nearly level areas where the organic matter content is relatively high crops should withstand drought better than on the heavier Rosebud types. In cultivating great care should be taken not to stir the soil more than is necessary, as it blows badly when not protected if finely pulverized.

#### ROSEBUD VERY FINE SANDY LOAM.

The typical Rosebud very fine sandy loam is very similar in color and other characteristics to the silt loam type. It differs chiefly in having a slightly higher content of very fine sand in the surface soil, which tends to make it less coherent in structure. The soil is a brown to dark grayish brown, loose, friable very fine sandy loam, 3 to 12 inches deep. It is composed of the finest grades of sand and there is usually present a considerable quantity of silt. The depth and color of the surface soil depends largely upon its topographic position; it is deeper and darker on the more level areas, where undisturbed weathering has taken place and the accumulation of organic matter has been favored.

The subsoil is a light-brown to ashy-gray silt loam, or silty clay which gradually becomes lighter in color with depth, grading at about 30 inches into a loose, floury white silt. In a few places the upper stratum of the subsoil is slightly compact. Over small, patchy areas the subsoil below 30 inches differs from the typical in having a much larger percentage of very fine sand, sometimes approaching a loamy very fine sand in texture. The surface soil is high in organic

matter. The subsoil is calcareous throughout, and the lower part is largely composed of lime.

The type has been derived chiefly from the underlying sandy strata of Tertiary age, chiefly from the Ogallala formation. Bed-rock frequently outcrops, giving the land a spotted appearance. It is mapped in places among exposures of the Brule clay formation.

The Rosebud very fine sandy loam is of relatively small extent in Banner County. The principal developments are in the southwestern part, though scattering bodies occur throughout the southern part. One of the largest bodies lies in the vicinity of the Epworth Church. Another large area occurs about 1 mile west of Flowerfield. A smaller, though very typical body is mapped 1 mile southwest of Gary.

The topography is flat to gently rolling, with the greatest relief along the stream channels. Many of the smaller bodies of the type occur as long gradual slopes, on valley sides. Drainage is good and in a few places excessive. Much of the rainfall percolates through the porous soil and subsoil. In some of the larger bodies of the type the stream channels are so poorly defined that it is difficult to trace them.

The type is of little importance in this county on account of its small extent. It is a very good dry-land farming soil, however, and about 40 per cent of it is under cultivation. The uncultivated parts are used for pasture and hay land. The native vegetation differs little from that of the Rosebud silt loam. In addition to the common grasses found on the latter type there are a few that thrive on more sandy soil, including needle grass and sand grasses. Wheat, rye, oats, and corn are the principal crops. Wheat and rye are mostly sold outside the county. Oats and corn are fed on the farms where produced. A few potatoes are grown to supply home needs. Live stock constitutes the chief source of farm income. Cattle are kept on the range throughout the year, but most of the stock is shipped in the fall after coming off the summer pasture. Dairying is not carried on very extensively although nearly every farmer has some dairy products to sell. There is a small herd of horses on most farms. The type supports about 100 head of cattle per section where used for summer range and from 30 to 40 head where grazed throughout the year.

In average years wheat yields about 15 bushels; rye, 15 bushels; oats, 30 bushels; corn, 15 bushels; and potatoes, 75 bushels per acre. Native hay yields one-fourth to three-fourths ton per acre, depending upon the rainfall.

The general farming methods are the same on this type as on the Rosebud silt loam. The soil can be cultivated under a wider range of

moisture conditions, however, on account of its sandier texture. Little attention is given to crop rotation and practically no fertilizer is used.

Land of the Rosebud very fine sandy loam type sells for \$60 to \$75 an acre, depending upon its topography, improvements, and location.

As with the Rosebud silt loam the dominating factor governing crop yields on this type is the moisture supply. Thorough tillage, especially during dry weather, is very necessary.

*Rosebud very fine sandy loam, shallow phase.*—The shallow phase of the Rosebud very fine sandy loam consists of a brown to dark-brown very fine sandy loam. In the more nearly level areas, where erosion has not been active, the soil changes at a depth of 8 to 12 inches to a light brown or light gray, which becomes gradually lighter until the parent rock is reached. The texture of the subsoil on these more level lying areas corresponds largely to the texture of the overlying surface material. Where the surface soil approaches a silt loam the subsoil is usually fine in texture, and where a coarser material predominates in the surface the subsoil is often a very fine sandy loam. The underlying calcareous sandstone from which the phase is derived is nowhere more than 3 feet below the surface and over most of the phase it is exposed in patches giving a characteristic white spotted appearance. The soil is deficient in organic matter.

The phase is extensively developed on the table-land in the southern part of the county. It occurs chiefly as narrow sinuous strips along the breaks into stream valleys, and as large, irregular shaped bodies around the heads of drainage ways, where erosion has removed the soil as fast as weathering has broken down the parent rock. One of the largest bodies lies around the head of Lawrence Fork, in the southeastern part of the area. Several smaller though typical areas may be seen along the Harrisburg-Kimball wagon road in the south-central part of the county.

The topography is rolling to hilly and in places broken, though not quite so rough and dissected as the areas of Rough broken land. The phase occupies the sharply cut stream valleys where erosion has left large areas of the rock exposed. Drainage as a rule is excessive.

The phase is unsuited to crop production, the nearness of the bed rock to the surface preventing the use of farm implements even where the topography is favorable. It is used chiefly as pasture land, although some hay is cut on the more level areas. The yields are usually low, seldom exceeding one-half ton per acre. The grasses consist of grama, western wheat grass, wire grass, stipa, and sand grasses. The nutritious sedge, blackroot, occurs also quite

extensively on this phase, and some yucca is encountered on the more exposed points. In the rougher sections scrub pine occasionally occurs, though areas supporting tree growth are generally sufficiently dissected to be classed with Rough broken land. The grazing of beef cattle is the chief industry. From 8 to 12 acres is sufficient to pasture one cow or steer throughout the year, provided hay is fed during severe weather.

The land is valued at \$12 to \$15 an acre, depending upon improvements and distance from markets.

#### ROSEBUD LOAM.

The soil of the Rosebud loam consists of 8 to 10 inches of dark grayish brown to brown mellow loam. It is fine in texture, containing a relatively high percentage of silt and only a small proportion of coarser materials, except in local spots where gravel has rolled down from more elevated types or been brought to the surface by burrowing animals. The surface soil is high in organic matter and the upper 6 inches is usually darker in color than the subsurface layer, owing to a concentration of this material. The color gradually becomes lighter with depth and apparently there is little organic matter below 24 inches, at which depth there is a rather abrupt change to the light-gray or almost white, loose, floury subsoil so characteristic of the heavier Rosebud types. In a few places the upper subsoil contains a higher percentage of coarse particles than the surface material, and numerous white gravelly fragments of calcareous rock and considerable coarse sand is encountered in the lower subsoil. The type has been derived from the disintegration and decomposition of the underlying rock formations.

The Rosebud loam is a very extensive soil on the table-land in the southern part of the county. The largest development is in the southwestern part, where it is the principal soil. In the south-central and southeastern parts the type occurs as scattered irregular shaped bodies, varying in size from a few acres to several square miles. The type is not uniform over large areas and includes many bodies of other soils within its boundaries.

The topography is gently rolling to undulating, with occasional small almost flat areas. Some of the smaller areas occur as shallow depressions around the heads of draws.

All the areas have good though not excessive surface drainage and underdrainage. They are not subject to erosion.

The Rosebud loam is the most important agricultural soil in Banner County. It is friable and well suited to farming under semiarid conditions. About 50 per cent of it is under cultivation and the remainder is used for pasture and hay land. The native vegetation includes, grama, buffalo, wire grass, western wheat grass, and black-

**root.** Of the cultivated crops, wheat ranks first in acreage and is the chief cash crop. Spring wheat is planted most extensively and the durum wheats are the leading varieties. Turkey is the principal winter wheat. It has come into prominence within the last few years, as it gives a higher yield and usually sells for more on the market than the spring varieties. Rye, oats, corn, and potatoes rank in acreage in the order named. Most of the rye is sold outside the county, though some is used for feeding purposes. Corn and oats are fed to work stock and cattle. Only the earliest maturing crops are grown, on account of the shortness of the growing season. Potatoes are generally consumed on the farms where produced, though a few farmers grow them on a commercial scale. The quality of the crop is as good as that obtained on any other soil in the High Plains region. Early Ohio and Triumph are the principal varieties. A small amount of alfalfa is grown, but the crop does not seem to thrive on this soil, probably on account of insufficient soil moisture, 3 cuttings are obtained only in the most favorable years. Millet, sorghum, and kafir are planted on a few farms for winter feed. These crops do well and seldom fail to furnish forage.

As on most of the soil in this county live stock is the principal source of farm income. Beef cattle are raised almost exclusively, although nearly every farmer owns a few milk cows and sells his surplus dairy products. Many farms have a small herd of horses. The beef cattle are usually shipped in the fall after coming off summer pasture, though a small number are run on the range throughout the year, hay being fed during severe weather. The principal breeds are grade Herefords and Shorthorns.

The yields of all crops show wide variations from year to year, depending mainly upon the amount and distribution of the rainfall. The average yield of wheat is 15 bushels; rye, 20 bushels; oats, 30 bushels; corn, 15 bushels; and potatoes, 75 bushels per acre. When cut for fodder, corn yields from 1 to 5 tons per acre.

The sod land is usually broken to a depth of 3 or 4 inches with plows or tractors, and as soon as possible thereafter it is disked or harrowed to fill up the space between the furrow slices, a practice necessary to prevent excessive loss of moisture. The soil under cultivation is plowed only every 2 or 3 years, but is well disked each year before planting to grain. Most of the corn is listed in, though some is planted on sod breaking. Small grain is planted with a press drill. Many tractors are in use on the type and the plowing, disking, and seeding is sometimes done in one operation.

The small grain is cut with a binder or header and stacked for later thrashing. A few farmers own "combines" and do their own thrashing. Crop rotation is not practiced, and little or no manure is applied to the land.

The Rosebud loam sells for \$60 to \$75 an acre, depending upon its improvements and location.

As with the Rosebud silt loam the conservation of soil moisture is the most important factor in farming this type. Fall plowing for spring planting and constant stirring of the surface soil should greatly increase the productive power of the land.

#### ROSEBUD SILT LOAM.

The surface soil of the Rosebud silt loam, which has an average depth of 10 inches, consists of a loose, mellow silt loam containing varying portions of fine sand and very fine sand. The material is usually brown in color, but ranges from light brown to dark brown, the shade depending on the content of organic matter. The darker and deeper soils occur on the flatter areas, where weathering is well advanced. The upper subsoil is a light-brown silt loam passing into a yellow or grayish-yellow, almost pure silt. Below about 20 inches it gradually becomes lighter in color and at 24 inches is usually a white to ashy-gray, loose, floury silt or silty clay. This material continues below the 3-foot level.

The dark layer of the upper subsoil is often slightly compact when undisturbed, but easily reduces to a loose, friable structure. The surface soil has a moderate lime content. The subsoil is calcareous throughout, and the white material forming the lower part is largely composed of lime. Fragments of limestones or calcareous sandstone are often encountered in the lower subsoil. The partially weathered Arikaree formation underlies the entire type at a depth of 4 to 6 feet, and in the more rolling areas it outcrops in places, giving rise to characteristic white spots on the hillsides. The typical Rosebud silt loam is residual in origin, being derived by weathering from the calcareous sandstones of Tertiary age. The weathered products of the White River beds have been included in places, especially along the bluff line bordering the southern table-land.

The Rosebud silt loam is an extensive soil in Banner County. The largest development is in the southeastern part of the county, on the eroded table-land. Scattering areas lie in the southwestern part of the county. The type generally occurs as large irregular-shaped bodies, cut across by and including soils of several other types. A large area, and one of the most uniform, lies in the vicinity of the Kirk School. A small but very typical body occurs around Flowerfield, in the southwestern part of the county.

The topography ranges from almost flat to rolling. The large area in the vicinity of the Kirk School has a generally flat surface. By far the greater part of the type, however, occupies a smooth or very gently undulating plain. The most rolling areas occur around

the heads of streams in the south-central part of the county. The general direction of the drainage is southeast. Even in the almost flat situations there is sufficient slope to afford an outlet for the surface water, and the porous subsoil and substratum insure ample underdrainage.

The type is a very important agricultural soil. It is one of the best dry-land farming soils in the county. About 40 per cent of it is under cultivation, and the rest is used for pasture and hay land. The native vegetation includes grama grass, buffalo grass, wire grass, western wheat grass, and blackroot. The most important cultivated crops are wheat, potatoes, rye, oats, and corn. Wheat occupies the largest acreage and is the chief cash crop; much of the rye produced is also sold. The corn and oats are fed to work horses. Potatoes are not grown so extensively as in some of the other counties of western Nebraska, although the soil is well adapted to their production. After supplying home needs they are sold in the local markets. A relatively small acreage of corn is planted, on account of the shortness of the growing season. The greater part of the type is included in stock farms and ranches, on which beef cattle, principally grade Herefords and Shorthorns are grazed. Dairying is not practiced commercially, though a few milk cows are kept on nearly every farm, and many farmers have a surplus of dairy products for sale. The land supports 40 to 60 head of cattle per square mile the year around.

Corn yields 10 to 40 bushels of grain, with an average of about 20 bushels per acre. When cut for fodder, from 1 to 4 tons are obtained. Wheat yields 8 to 30 bushels; potatoes, 50 to 150 bushels; oats, 15 to 45 bushels; and rye, 10 to 30 bushels per acre. Native hay yields one-fourth to 1 ton per acre. The higher yields mentioned are exceptional and obtained only in very favorable years.

The Rosebud silt loam, when properly managed, can easily be kept in good tilth and is an excellent soil for dry farming. Under present methods of cultivation it retains sufficient moisture to insure good crops, except in seasons of prolonged drought. When plowed wet there is a slight tendency to clod, but the clods are easily reduced. Little or no attention is given to crop rotation as the soil is new and in no immediate danger of becoming exhausted. The land is usually plowed every second or third year. Small grains are generally sowed with a drill on disked corn or stubble land, and corn usually follows small grain, although it is often planted on newly-broken sod. The corn is listed as the moisture conditions are better than when planted in check rows on a level surface.

The selling price of the Rosebud silt loam ranges from \$50 to \$75 an acre, depending upon improvement and location.

The type is naturally a very strong soil, and the crop yields depend in a large measure upon the conservation of soil moisture. Thorough preparation of the seed bed is advisable, even at the expense of a reduction of the acreage. For corn and other tilled crops the maintenance of a surface mulch by frequent cultivation is necessary.

EPPING FINE SANDY LOAM.

The surface soil of the Epping fine sandy loam is a grayish-brown to brown, loose, friable fine sandy loam, 8 to 12 inches deep. There is always present a relatively large percentage of very fine sand and considerable silt. The depth and color of the soil varies with the topography. In the more level areas, where conditions have favored the accumulation of organic matter, it is darker and deeper than elsewhere. The subsoil is a light-brown fine to very fine sandy loam, which becomes lighter in color with depth, and at a depth of about 24 inches, grades into a loose, floury, white to pinkish-white, silty clay, much resembling the lower subsoil of the Epping silt loam and very fine sandy loam types. Both the soil and subsoil are deficient in organic matter. The soil is slightly calcareous and the lower subsoil has a high lime content.

The type is derived by weathering from the consolidated clay deposits of the Brule formation. The light textured surface soil is undoubtedly due to accumulated coarse materials from adjoining types, through the agencies of wind and water.

The Epping fine sandy loam is extensively developed in the northern part of Banner County. It occurs as scattered areas of considerable size throughout the Pumpkin Creek Valley and a few small bodies lie on the north side of Wild Cat Ridge. One of the largest areas occurs on the north side of Pumpkin Creek, in the north-central part of the county, and a very typical body is mapped in the northwestern part, on the west side of Bull Canyon. Nearly all the type lies contiguous to bodies of Bridgeport loamy fine sand, and it has probably derived much of its sandy surface, through the addition of materials blown from that type.

The topography of the Epping fine sandy loam ranges from gently undulating to rolling. By far the greater part occurs on the long, gently rolling slopes between the upland and Pumpkin Creek. The roughest topography is adjacent to areas of Rough broken land, where the slopes become rolling and rather steep.

Drainage is everywhere good. The uneven topography affords ample outlet for all surface water and the porous soil and subsoil insures thorough underdrainage.

The type is not an important farming soil in Banner County. It has a tendency to blow badly when cultivated and is not very re-

tentive of moisture on account of its low organic content. It is nearly all used for pasture and hay land, though there are occasional small fields under cultivation. The native vegetation consists largely of sand grass and stipa. A small amount of buffalo grass, grama grass, and blackroot are encountered on the less sandy areas.

The grazing of live stock is the chief industry. Beef cattle are raised most extensively. Grade Herefords and Shorthorns are the principal breeds. From 8 to 30 head of horses are kept on most farms. On the cultivated land corn is the chief crop, though some small grain is grown. The soil is not adapted to the latter, however, on account of its loose structure.

Average yields of about 12 bushels of corn per acre are obtained. In exceptional years 20 to 25 bushels per acre have been raised. Native hay yields one-fourth to one-half ton per acre. The type will support from 30 to 40 head of cattle throughout the year. The stock is generally shipped when 2 or 3 years old, to eastern markets, as feeders.

The selling price of the Epping fine sandy loam ranges from \$15 to \$20 an acre.

#### EPPING VERY FINE SANDY LOAM.

The surface soil of the Epping very fine sandy loam is a gray to grayish-brown, loose, friable very fine sandy loam, containing a relatively large percentage of silt. The depth of the soil varies with the topographic position. On the more level lying areas where conditions have favored undisturbed weathering and the accumulation of organic matter, it is 8 to 10 inches. Over most of the type, however, the average depth is about 6 inches.

The upper subsoil is a gray very fine sandy loam. This changes gradually into a light-gray silt loam to silty clay, which at about 24 inches becomes a white or pinkish-white, loose floury material resembling the lower subsoil of the Rosebud silt loam. Both the soil and subsoil are deficient in organic matter. The surface material is slightly and the subsoil highly calcareous.

The type is derived by weathering from the underlying Brule formation, which lies in most places from 3 to 5 feet below the surface and occasionally outcrops, giving the fields a spotted appearance. The very fine sand, of which the surface soil is so largely composed, probably represents material blown from the upland and from the more sandy types in the Pumpkin Creek Valley.

The Epping very fine sandy loam is the most extensive valley land soil in the area. It occurs in large, irregular shaped bodies on both sides of Pumpkin Creek. The largest development is on the south side of the stream. The areas vary in size from a few acres to many square miles. They are not as a rule uniform throughout, but are

cut by, and include, numerous areas of other types of soils. One of the more uniform and typical areas occurs north of Bull Canyon, in the northwestern part of the county. The longest and most continuous strip borders the Rough broken land on the north side of Pumpkin Creek.

The topography varies from almost level, as in the flats, to steeply rolling on the valley slopes. By far the greater part of the type occurs as long gradual slopes from the upland to the creek and has a gently rolling surface. The greatest relief is adjacent to areas of Rough broken land, where the streams have cut deep, narrow valleys. The area north of Bull Canyon presents an unbroken, almost flat surface.

Drainage is everywhere good and in a few places excessive. In the level tracts there are often surface irregularities, such as washes and gullies which carry off the surplus water. The loose, porous subsoil affords ample underdrainage.

The Epping very fine sandy loam is not as productive as most of the soils on the table-land, but owing to its large extent is a very important agricultural soil in Banner County. About 15 per cent of it is under cultivation and the remainder is used for pasture and hay land. The native vegetation consists of grama, buffalo, wire, and western wheat grasses, together with the sedge blackroot, which supply excellent pasturage, except during years of prolonged drought. Of the cultivated crops, wheat, rye, oats, and corn are the most important. Wheat is the chief cash crop. It is all sold outside the county. Rye ranks second as a cash crop, though some of it is fed locally to stock. Most of the oats and corn are fed on the farms where produced.

Spring wheat is grown most extensively, though winter wheat is increasing in acreage each year. Kherson and Swedish Select are the chief varieties of oats. Flint corn is planted more extensively than dent varieties.

Stock raising is the principal source of farm income, and about 85 per cent of the land is devoted to this industry. Beef cattle are raised almost exclusively, though every farmer has a few milk cows and a small herd of horses. There are no herds of purebred cattle on the type, but most of the stock shows large admixture of Hereford or Shorthorn blood. The two-year and three-year old animals are usually shipped in the fall and the rest kept on the range throughout the year. Grain is seldom fed to any but the work stock. Hay is added to the pasture ration during severe weather.

Crop yields on this type are somewhat below the average for the county, owing largely to the deficiency of organic matter, which greatly reduces the water-holding capacity of the soil.

Wheat and rye yield from 10 to 14 bushels per acre, oats 20 to 25 bushels, and corn 10 to 15 bushels. During exceptionally dry years corn fails to mature grain and is cut for fodder, yielding from 1 to 4 tons per acre.

Crop rotation is not practiced and no manure is applied to farm crops on this type. The soil is easy to handle and can be cultivated under a rather wide range of moisture conditions. It forms clods if plowed when wet, but these are easily broken down by cultivation.

The selling price of the Epping very fine sandy loam ranges from \$12 to \$35 an acre, depending mainly upon the topography and location as affecting the use to which the land is suited. As most of the land is used for pasture, the price is generally nearer the lower than the higher figure.

*Epping very fine sandy loam, basin phase.*—The soil of the Epping very fine sandy loam, basin phase, is a brown to grayish-brown very fine sandy loam, relatively high in silt. It has an average depth of about 8 inches, being slightly deeper near the center and considerably shallower along the boundaries of the areas.

The subsoil is a gray to light grayish brown loose floury silt loam to silty clay, generally throughout the 3-foot section. In places the lower subsoil—a zone below 24 inches—changes abruptly to a pinkish-white material, much resembling that of the subsoil of the typical soil. The change in color between the soil and subsoil is gradual. Both are deficient in organic matter, though the soil contains a much larger amount of this material than that of the main type. The phase is highly calcareous throughout the 3-foot section.

The phase occupies a lower position than any of the other Epping soils, except the silt loam, basin phase. It has been derived in much the same manner as that phase, but coarser material has entered more largely into the composition of its surface soil.

The phase occurs in scattered areas, chiefly on the south slope of the Pumpkin Creek Valley. Two small areas lie in the northwest corner of the county, on the north side of Bull Canyon. The bodies vary in size from a few acres to 2 or 3 square miles. The largest and most typical one lies around Harrisburg, in the central part of the county.

The surface of the phase is almost flat and presents a basinlike topography. Drainage ways are not well established over most of the phase, but the loose porous soil and subsoil affords ample outlet for the light rainfall of the region.

The phase is not at present an important agricultural soil in this county, and only a small proportion of it is under cultivation. It is better adapted to crops, however, than most of the Epping types and fair yields are obtained in all but the driest years. The native vegetation consists of grama grass, buffalo grass, western wheat grass,

and blackroot, which affords higher yields of hay and better pasture than on most of the soils of the county, on account of the more favorable moisture conditions.

The grazing of beef cattle and horses is the principal industry. The phase will support from 40 to 60 head of cattle per section the year round. The native grasses give one-half to 1 ton per acre, depending upon the rainfall. Wheat, rye, and oats are the principal cultivated crops. Wheat and rye are usually sold outside the county and the oats fed to the work stock on the farms where produced. The average yield of wheat is about 15 bushels, rye 18 bushels, and oats 25 bushels per acre.

The soil is easy to handle and can be cultivated under a wide range in moisture conditions. It is more retentive of moisture than the typical soil, as it has a slightly greater organic-matter content. It is also more favorably situated than the latter for the accumulation of moisture.

The selling price of the phase ranges from \$20 to \$30 an acre, depending upon improvements and location.

By increasing the acreage of cultivated crops, the gross income from the soil could be greatly augmented. It is as well adapted to crops as any of the valley soils, except those of the Tripp series.

#### EPPING SILT LOAM.

The typical soil of the Epping silt loam is a gray to light grayish brown, loose, friable silt loam with an average depth of 6 inches. The type is not uniform over large areas, the depth and color of the surface soil varying with the topography and the progress of erosion. On the more level areas which have favored undisturbed weathering and the accumulation of organic matter, the soil is deeper and darker in color than elsewhere, being a dark grayish brown, mellow silt loam, 8 to 10 inches deep.

The transition in color between the soil and subsoil is rather abrupt. The upper subsoil is a light-gray heavy silt loam. This passes gradually into an almost white or pinkish-white, floury silt loam to silty clay, which generally continues throughout the 3-foot section. In many places, however, the flesh-colored silty clay of the Brule formation is encountered at 20 to 40 inches and it often outcrops, giving the type a spotted appearance, similar to that of the Rosebud soils.

The organic matter content is low in the surface soil and almost zero in the subsoil. There is an abundance of lime throughout the soil profile. In places the surface soil has been considerably modified by wind-blown sands and approaches a very fine sandy loam in texture. Where these areas were of sufficient size to warrant separation, they were mapped as Epping very fine sandy loam.

The Epping silt loam is residual in origin, having weathered from the underlying Brule clay formation. This is a slightly consolidated, pale-pink to almost white clay, which gives the soil its light colored floury character.

The type is not extensive in the county. It occurs mostly on the south slopes of the Pumpkin Creek Valley, the largest body lying 2 miles southeast of Harrisburg. A smaller area occupies a narrow strip along the northern edge of the Rough broken land, about 4 miles southeast of Harrisburg. One of the most typical bodies lies about 2 miles northeast of Bighorn Mountain.

The topography of the type varies from steeply rolling to undulating, the greater part being gently rolling. It is roughest in the areas adjacent to bodies of Rough broken land. In a few places patches of Brule clay are badly eroded, giving locally a typical bad land topography. Drainage is good and in places excessive.

The Epping silt loam is unimportant agriculturally, and a very small proportion of it is under cultivation. The land is mostly used for grazing horses and beef cattle.

The native vegetation consists of buffalo grass, grama grass, blackroot, western wheat grass, and wire grass. On the cultivated areas, wheat, rye, and oats are the principal crops. Spring wheat is grown most extensively. The type is not as productive as most of the table-land soils, on account of its lower organic matter content. Wheat gives an average yield of about 12 bushels, rye 12 bushels, and oats 20 bushels per acre. The land will support from 30 to 35 head of cattle per section the year round, if hay is fed in severe weather.

The soil is easy to handle on account of its loose, friable structure. It has a tendency to clod when plowed wet, but the lumps are easily reduced. No definite system of crop rotation is practiced and manure is not applied to the land.

The selling price of the Epping silt loam ranges from \$12 to \$30 an acre, depending largely upon its topography.

*Epping silt loam, basin phase.*—There is a small body of Epping silt loam, basin phase, in the vicinity of Harrisburg, which deserves special mention, as it differs considerably from the typical material.

The soil is a brown to grayish-brown, loose friable silt loam, 8 to 10 inches deep. It is high in organic matter, which gives the surface a darker color than that of the main type. The upper subsoil differs little either in color or texture from the surface material, but below about 20 inches it becomes slightly lighter in color, being a light grayish brown to gray floury silt.

The underlying Brule clay formation is nowhere more than 4 feet below the surface and is exposed in places along shallow road cuts.

The surface of this phase is very flat. It occupies the lowest position in the general basin surrounding Harrisburg. The type has

been derived partly by weathering from the underlying Brule formation under conditions of poor drainage and partly by transported silts, carried down from the upland by streams. The drainage in general is inadequate. Surface drainage is not established, though the soil is sufficiently porous to absorb most of the light rainfall.

The phase is of no agricultural importance. It contains alkali in spots, and this, together with the nearness of the bedrock to the surface, has prevented its being used for cultivated crops. It is all included in pasture and hay land. The native vegetation consists of a thick growth of grama grass, buffalo grass, and western wheat grass, together with a large admixture of blackroot. These yield one-half to 1 ton of hay per acre, depending upon the season.

From \$30 to \$50 an acre is asked for land of this phase. The relatively high price is due to nearness to Harrisburg and not to the agricultural value of the soil.

#### VALENTINE LOAMY FINE SAND.

The surface soil of the Valentine loamy fine sand consists of 8 to 12 inches of grayish-brown to brown, loose, friable loamy fine sand. The depth and color of the soil vary with the topography. In the depressional areas, where the accumulation of organic matter has been favored, the soil is deeper and darker than elsewhere. The surface 6 inches contains sufficient organic matter to give the type its loamy character.

The subsoil is a loose, incoherent, light yellowish brown to light-brown fine sand. In places the upper subsoil is in some areas slightly compact but the hand sample crumbles readily under pressure. Here and there the lower subsoil contains a considerable amount of silt and clay, which give it a sticky consistency when wet. The substratum is a loose, incoherent, gray sand, much resembling the subsoil of the Dunesand. Both soil and subsoil are comparatively low in organic matter and noncalcareous.

The origin of the Valentine loamy fine sand is difficult to determine. It was originally released by weathering from Tertiary rocks, but has been so shifted by wind and water, redeposited, and subsequently weathered that it is not possible to make any positive classification in regard to origin.

The type is not extensively developed in Banner County, though there are a few areas of considerable extent along the north county line. The largest area lies east of the head of Pumpkin Creek.

The topography is gently undulating to rolling. The surface is broken by small knolls and ridges and may be characterized as "hummocky." Drainageways have not been developed, as the rainfall readily sinks into the porous sand and there is practically no run-off.

On account of its incoherent structure and the danger of drifting when the protective covering of grasses is destroyed the type is not used for crop production. The native vegetation consists of a heavy growth of stipa, grama grass, and sand grasses. Hay is the most important crop. Yields of one-half to three-fourths ton per acre are common. The type will carry from 40 to 50 head of cattle per square mile throughout the year and about 90 head when pastured only during the winter or summer. It is the common practice to graze cattle on the hard land during the summer months and to use this type for winter range. The stipa and sand grasses have longer stems and are more accessible during snowy weather.

The price of the Valentine loamy fine sand ranges from \$15 to \$20 an acre.

It is possible by careful management to use parts of this type for cultivated crops. In other counties of western Nebraska it has been found to be well adapted to the White Eureka and Cobbler potatoes. By planting the crop in lister furrows the surface of the soil can be kept sufficiently rough to minimize the damage from drifting.

#### VALENTINE VERY FINE SANDY LOAM.

The surface soil of the Valentine very fine sandy loam is a brown to dark grayish-brown, loose, friable, very fine sandy loam, 8 to 10 inches deep. It generally contains a relatively high proportion of silt. The organic content of the surface 6 inches is comparatively high, giving that part of the soil a darker color than the deeper layers.

The subsoil gradually becomes lighter in color and more sandy with depth and grades at about 30 inches into a light grayish brown very fine sandy loam to very fine sand. In a few places the lower subsoil contains a larger proportion of the coarser grades of sand than the soil or upper subsoil. The content of organic matter decreases with depth, and below 24 inches there is little present. Both soil and subsoil are noncalcareous.

The origin of the type is not definitely understood. It was originally released from Tertiary material and has been transported, weathered, and reassorted in much the same manner as the Valentine loamy fine sand.

The Valentine very fine sandy loam is one of the least extensive soils in the county; it occurs in but three small bodies. The largest one is in sections 21 and 22, T. 20 N., R. 58 W. Another is in section 19, T. 20 N., R. 55 W., and the third in section 36, T. 20 N., R. 53 W.

The topography is similar to that of the Valentine loamy fine sand. Surface drainage, however, is somewhat better established. The type has ample underdrainage, owing to the loose, porous nature of the soil and subsoil.

The land is not used for cultivated crops on account of its small extent. It is all included in pasture land. The native vegetation consists of stipa, sand grass, and some grama. From 10 to 12 acres are required to pasture a cow or steer throughout the year.

No selling price can be given for the soil in this county on account of its small acreage. In adjoining counties, where it is extensively developed, it sells for \$20 to \$25 an acre, depending upon improvements.

The type is well adapted to the production of all crops common to the region, and, where of sufficient acreage to be profitably cultivated, ranks very favorably with the Rosebud very fine sandy loam.

MITCHELL VERY FINE SANDY LOAM.

The surface soil of the Mitchell very fine sandy loam is a light-brown to grayish-brown very fine sandy loam, 6 to 10 inches deep. There is usually present considerable silt, though there is very little sand of the fine and medium grades.

The typical material has no noticeable textural change between the soil and subsoil, though the latter becomes slightly lighter in color below 30 inches, grading into a light grayish brown very fine sandy loam to silt loam. In places the lower subsoil is composed of alternate layers of silt and very fine sand. The type is deficient in organic matter. It has, however, a higher content of this material than most of the soils of the Epping series. It is unusually retentive of moisture, considering its organic content. The lower subsoil is highly calcareous.

The type differs from the Tripp soils, which it closely resembles, in its more uniform soil profile and darker colored subsoil.

The Mitchell very fine sandy loam is not extensively developed in Banner County. It occurs chiefly along the northern edge. A small body is mapped along one of the tributaries of Willow Creek, about  $3\frac{1}{2}$  miles west of Harrisburg, while a larger body is mapped along the main stream near Gabe Rock. The largest and most uniform area occurs in the northwest part of the county, about  $2\frac{1}{2}$  miles north of Bull Canyon. The type represents alluvial and wind-blown materials derived from the Brule, Gering, and Arikaree formations.

The topography is almost flat to gently undulating, but even the flatter tracts have sufficient slope to afford excellent drainage.

None of the type is under cultivation in Banner County, chiefly on account of its distance from market. It is all used as pasture and hay land. The native vegetation consists of grama, buffalo, and needle grasses, together with blackroot, which afford good pasture during average years.

The type will support from 30 to 40 head of cattle per section when grazed throughout the year and about 80 head when pastured only during the summer months. The yield of hay ranges from one-fourth to one-half ton per acre, depending upon the rainfall.

Land of this type sells from \$20 to \$25 an acre.

The type is as well adapted to dry farming as the Mitchell silt loam and better than any of the Epping soils except the very fine sandy loam, basin phase. It could be easily tilled and cultivated under a wide range of moisture conditions, and by careful management grain crops would greatly increase the gross income from the type.

#### MITCHELL SILT LOAM.

The surface soil of the Mitchell silt loam is a brown to light grayish brown silt loam, 6 to 8 inches deep, containing a relatively high percentage of very fine sand, the texture in a few places approaching a very fine sandy loam. The subsoil is somewhat variable in character. Over most of the type it differs little from the soil, becoming slightly lighter in color and having a somewhat higher content of very fine sand. In a few places it passes at about 20 inches into a light-gray to gray very fine sandy loam stratum, varying in thickness from 2 to 6 inches, this being underlain by a light-gray silt. Locally the subsoil has a higher silt content than the surface material, being a light-brown, loose, floury silt to silty clay. While the soil and subsoil are rather deficient in organic matter, they contain a higher percentage than the Epping silt loam, as is indicated by their somewhat darker color. Both soil and subsoil are calcareous.

Only one area of the Mitchell silt loam is mapped in Banner County. This lies in the northeast corner. The surface is flat, gently sloping to the north. It is more nearly and uniformly level than the surface of any other type in the county. It represents colluvial and wind-blown materials, derived principally from the Brule clay and to a lesser extent from the Gering and Arikaree formations. Stream channels are not well established on this type, but with the low rainfall even the slight slope existing affords excellent drainage.

The Mitchell silt loam is of little importance in this county; it is of small extent, and a very small proportion is under cultivation. The native vegetation consists of western wheat grass, grama grass, buffalo grass, and blackroot. These afford excellent pasturage, except during the driest years. Beef cattle and horses are grazed extensively.

Of the cultivated crops, wheat, rye, and oats occupy the largest acreages. Some corn is planted. Wheat and rye are the chief cash crops. Oats and corn are fed to stock on the farms where produced.

The average yield of wheat or rye is about 20 bushels per acre.

Oats yield from 20 to 40 bushels and corn 15 to 25 bushels per acre, the return fluctuating with the amount of rainfall.

Land of this type sells for \$25 to \$35 an acre, the difference in price being dependent mainly upon the character and condition of improvements.

The Mitchell silt loam is one of the best dry-land farming soils in the lowland part of Banner County. The soil is naturally retentive of moisture and is well adapted to all crops common to the region. In Scotts Bluff County much of the type is under irrigation. It is one of the easiest soils to irrigate in the High Plains region, on account of its smooth, gently sloping surface. When cultivated without irrigation the surface soil drifts badly, unless planted to winter cover crops or plowed early in the spring and seeded down.

#### BRIDGEPORT GRAVELLY SANDY LOAM.

The surface soil of the Bridgeport gravelly sandy loam to a depth of 8 to 10 inches is a grayish-brown to brown, loose, incoherent sandy loam, containing an abundance of fine and coarse gravel. The immediate surface is much darker than the lower part of the layer, owing to a relatively large admixture of organic matter. There is little textural change throughout the 3-foot section, though material forming the subsoil gradually becomes lighter in color with depth, being in the lower part a gray to light grayish brown, gravelly, sandy loam. The gravel of this type consists chiefly of crystalline rocks, of many different kinds, together with a small quantity of fragments of white calcareous grit.

The type differs from the Rosebud gravelly sandy loam chiefly in its lower lime content and its mode of formation. The Rosebud type is derived by weathering in place from the coarser strata of the Ogallala formation, while the material comprising the Bridgeport gravelly sandy loam represents colluvial sands and gravels, transported from the adjoining uplands by wind, water, and gravity.

The type is very inextensive in Banner County, though it occurs in numerous areas on the south slopes of the Pumpkin Creek Valley. The bodies are extremely small, however, seldom exceeding 50 acres. One of the largest lies  $1\frac{1}{2}$  miles northeast of Harrisburg. A smaller body occurs about three-fourths mile southeast of this town. A very typical area lies 1 mile southeast of Willow Springs.

In topography this soil varies from smooth and gently sloping to steeply rolling. The areas in many places lie upon the crests and around the edges of hilltops and narrow ridges. Drainage in most places is excessive.

The type is of little agricultural importance. Its unfavorable location, coarse texture, and droughty nature prevent its use for culti-

vated crops, and it is all included in pastures on which beef cattle and horses are grazed. The native vegetation consists of a sparse growth of sand grass, stipa, grama grass, and blackroot, the last a sedge.

It is difficult to estimate the value of this soil, as it is generally sold in connection with other types. Where it comprises a considerable part of the farm land, however, it greatly lowers the selling price.

#### BRIDGEPORT LOAMY FINE SAND.

The Bridgeport loamy fine sand in Banner County has the same color, texture, structure, and other characteristics as that mapped in Morrill County, joining on the east. The surface soil is a loose, incoherent, light-brown to brown loamy fine sand, 8 to 10 inches deep. A small amount of organic matter in the upper 6 inches gives this layer a slightly darker color than that of the material below. It is this organic matter that gives the type its loamy character. Scattering gravel are found on the surface.

The upper subsoil is a light grayish brown to gray loamy fine sand to fine sand, and the lower subsoil from about 24 inches down is a loose, incoherent, gray to light-gray fine sand. Both soil and subsoil contain relatively large percentages of very fine sand. The type is low in organic matter and is not easily built up on account of its loose, open structure. The lower subsoil is calcareous. This type differs from the Valentine loamy fine sand, chiefly in the gravel scattered over the surface and in the calcareous nature of the lower subsoil.

The Bridgeport loamy fine sand is an extensive soil in Banner County. It occurs in scattered areas over the colluvial slopes, on both sides of Pumpkin Creek. The largest developments lie on the south side of the stream. One body was mapped on the north side of Wild Cat Ridge, in the northeastern part of the county. The areas vary in size from a few acres to 4 or 5 square miles. They are generally uniform in character and little spotted with areas of other types of soils. One of the larger bodies lies on the north side of Pumpkin Creek, in the northern part of the county. A much smaller though typical area is mapped near the mouth of Indian Springs Canyon.

As with the other soils of the Bridgeport series, the type is composed of materials that have been blown by the wind or washed down by water from the adjoining uplands. Torrential rains have undoubtedly played an important part in washing down the soil material. Much of the type, however, has been so modified by wind-blown material that its exact mode of formation is uncertain.

The type occupies flat to gently undulating slopes, the surface of which is modified by occasional depressions and low, rounded hum-

mocks. Drainage is good and as a result of the loose porous soil and subsoil in many places excessive. Very few of the smaller drainage ways are continuous, but the water sinks into the sand and passes underground to the main stream.

Although the type is extensively developed in Banner County, little or none of it is under cultivation on account of its loose, incoherent structure and the tendency to drift badly when the protective covering of sod is removed. The native vegetation consists of stipa, sand grass, and small amounts of grama grass, and blackroot. The soil is all included in large ranches and stock farms, on which the raising of beef cattle, principally grade Hereford and Shorthorn is the principal industry. A small herd of horses is kept on nearly every ranch. The type will support from 35 to 40 head of stock per square mile the year round. The soil is preferred by many ranchers for winter grazing, as the long stemmed stipa and sand grass is more accessible when snow covers the ground than the short-stemmed grasses of the hard lands.

The Bridgeport loamy fine sand ranges in selling price from \$15 to \$25 an acre.

It is doubtful if this type should be used for cultivated crops on account of its tendency to drift when disturbed.

#### BRIDGEPORT SANDY LOAM.

The Bridgeport sandy loam is a light-brown to grayish-brown sandy loam, 6 to 12 inches deep, and loose and incoherent in structure. In most places pebbles are scattered through the surface material. The depth and color of the soil varies with its topographic position. It is deeper and darker on the more level areas, lying at a considerable distance from bodies of Rough broken land.

The subsoil consists of a light-brown to light grayish brown, incoherent, sandy loam to sand, which becomes gradually lighter in color with depth. Small gravel is often encountered below 30 inches. The soil and subsoil are deficient in organic matter. The latter is faintly calcareous.

The type is of small extent. It occurs chiefly in the southeastern part of the county, and represents colluvial and alluvial material washed from the uplands. One of the largest bodies lies on the east side of Bighorn Gulch. A smaller area occurs on the south side of Lawrence Fork, near the eastern county line.

The areas consist of gradual to fairly steep slopes, having a flat to gently undulating surface. The slopes are steepest along the borders farthest from stream channels. The drainage is generally excessive, owing to the porous nature of the subsoil. It is difficult to trace drainage channels across the type, as much of the surface water sinks into the sand.

The soil is not important agriculturally on account of its small extent and low-moisture retaining power. It is all used as pasture and hay land. The native vegetation consists largely of stipa and sand grasses, with which there is a small admixture of grama grass. The type is capable of supporting from 25 to 35 head of cattle per square mile throughout the year, or about twice that number when grazed only during the summer season. The native grasses yield one-fourth to one-half ton of hay per acre, depending upon the rainfall.

The Bridgeport sandy loam sells for \$15 to \$25 an acre. It is usually sold in connection with surrounding soils.

It is possible to cultivate part of the type and by careful management fairly good crops could be obtained. The soil should be plowed and seeded early, however, as there is danger of drifting when the surface is left unprotected. Only the more level areas, where conditions are most favorable for the accumulation of organic matter and moisture, should be cultivated.

#### BRIDGEPORT FINE SANDY LOAM.

The surface soil of the Bridgeport fine sandy loam is a brown to grayish-brown, loose, friable fine sandy loam, with an average depth of 10 inches. There is present in most places a relatively large percentage of very fine sand and a few small, water-worn pebbles. The depth and color of the soil varies with the topography. The immediate surface layer is considerably darker than the lower portion, as it contains a larger amount of organic matter.

Over most of the type the subsoil differs little from the soil, except that it becomes slightly lighter in color and the sand content increases with depth. In a few places the material below 30 inches is a light-gray, loose, incoherent, medium to fine sand. Locally numerous small pebbles are encountered below 24 inches.

The surface soil of this type, while somewhat deficient in organic matter, contains a much larger amount than that of the Bridgeport loamy fine sand, which, together with its larger silt and very fine sand content, gives it greater coherency. The lower subsoil is slightly calcareous.

The type occurs on both sides of Pumpkin Creek throughout the county. The largest developments are on the south side of the stream. A small area was mapped in the northeastern corner of the county, on the north side of Wild Cat Ridge. The bodies vary in size from a few acres to several square miles. They are relatively continuous and uniform in texture. One of the largest areas occurs about 4 miles north of Harrisburg, on the south side of Pumpkin Creek. A very typical area of much smaller extent lies about 2 miles northwest of Gabe Rock.

The type represents alluvial and colluvial slope material. Torrential rains and strong winds have undoubtedly played an important part in its formation.

The soil occupies rolling to gently undulating slopes. Both the surface and subsurface drainage are good, though in no place excessive.

The type is a relatively important agricultural soil in Banner County, on account of its large extent. It is not so well adapted to cultivated crops as some of the finer textured types, but with careful management gives fairly good yields in average years. About 15 per cent of it is under cultivation, and the rest is included in large stock farms and ranches on which beef cattle and horses are grazed. The native vegetation consists of stipa, sand grass, grama grass, and a small amount of blackroot.

Of the cultivated crops, wheat occupies the largest acreage and is the chief cash crop. Rye, oats, and corn are grown to a considerable extent. Most of the rye is sold outside the county, though some is fed on the farms where produced. Corn and oats are all fed to stock. Spring wheat is grown more extensively than winter wheat, though the latter is gaining in acreage each year. Only the earliest maturing varieties of corn are planted, on account of the shortness of the growing season. Wheat yields 12 to 15 bushels, rye 15 to 18 bushels, oats 20 to 30 bushels, and corn 12 to 15 bushels per acre.

Beef cattle are generally shipped in the fall, when 2 or 3 years old, to eastern markets as feeders.

No crop rotation is practiced. The soil is easily handled and can be cultivated under any moisture conditions without injury. It has, however, a tendency to blow badly unless carefully managed.

The land of this type sells for \$20 to \$30 an acre, depending upon the improvements and location.

The cultivated areas should either be seeded to winter cover crops or plowed and seeded very early in the spring in order to prevent the soil from drifting. It is advisable to grow crops requiring the minimum amount of tillage and when cultivating to leave the surface soil as rough as possible.

#### BRIDGEPORT VERY FINE SANDY LOAM.

The surface soil of the Bridgeport very fine sandy loam consists of 8 to 14 inches of loose, mellow, brown to grayish-brown very fine sandy loam. The surface 6 inches is generally darker in color than the lower portion, owing to a slightly larger content of organic matter. In places the surface soil contains an unusually large amount of very fine sand and approaches a loamy very fine sand in texture. There is little change in the color or texture of the material until a

depth of 24 inches is reached. Below this the subsoil is a light-gray, loose, incoherent very fine sandy loam to very fine sand. The type contains scattered gravel throughout the 3-foot section. The lower subsoil is calcareous.

The Bridgeport very fine sandy loam is inextensive in this county. It occurs as small scattered bodies in the eastern part. One of the largest areas lies on the south side of Pumpkin Creek, just east of Bighorn Gulch, and a very typical body along the Banner-Morrill County line, east of Chalk Creek.

The type represents colluvial and alluvial wash from the uplands, greatly modified by wind-blown material from the Ogallala and Arikaree formations. The soil is of comparatively recent origin, as is shown by the uniformity of color and texture throughout the 3-foot section.

Areas of this soil occupy smooth to gently undulating slopes. Drainage is good though not excessive, considering its loose structure.

Owing to its small extent, the type is not used for cultivated crops in Banner County, but it is all of some value as pasture and hay land. The native vegetation consists of stipa, sand grass, grama grass, buffalo grass, and blackroot. These afford excellent pasturage in all but the driest years. When not grazed, from one-fourth to one-half ton of hay can be obtained from an acre of land. The type will support from 30 to 50 head of cattle per section, the number varying with the growth of the grasses, which is controlled by the rainfall.

Land of this type sells for \$20 to \$25 an acre. It rarely forms an entire farm or ranch, so that this is the price it brings in connection with other types.

The Bridgeport very fine sandy loam is well adapted to farming in a region of light rainfall, and where it occurs in large bodies is a very important agricultural soil. In Morrill County a considerable acreage of the type under irrigation is being used in the production of sugar beets, potatoes, wheat, corn, oats, and alfalfa.

#### CHEYENNE GRAVELLY SANDY LOAM.

The surface soil of the Cheyenne gravelly sandy loam consists of about 10 inches of light-brown sandy loam, containing much small gravel. The soil is usually low in organic matter, though the surface 6 inches is somewhat darker than the lower portion, as the result of admixture of a small amount of this material. The change in color and texture is very gradual throughout the 3-foot section, but the subsoil below 24 inches is a light grayish brown, loose, gravelly sandy loam containing little or no organic matter. The gravel occurring throughout this type is composed of a great variety of crys-

talline rocks, together with numerous small fragments of calcareous sandstone.

The Cheyenne gravelly sandy loam is not an extensive soil in Banner County. It occurs as narrow strips along the dry drainage ways in the southern part of the area. The largest development is along Rocky Hollow, on the east side of the Kimball-Minatare-Alliance highway. Smaller bodies lie along Long Canyon and Willow Creek.

The type is composed of alluvial terrace material, that has been transported from the uplands, chiefly, during torrential rains and deposited along the stream channels.

The topography is flat. Drainage, however, is in most places excessive on account of the loose, open structure of the soil and subsoil.

The type is all included in pasture lands. The native vegetation consists of a sparse growth of grama, sand grass, and stipa. The type is not considered very valuable even as grazing land, and it has a tendency to reduce the selling price of farms in which it occurs.

#### CHEYENNE SANDY LOAM.

The surface soil of the Cheyenne sandy loam consists of 10 to 14 inches of brown to grayish-brown sandy loam containing a relatively large proportion of fine and very fine sand and some fine gravel. The organic content of the surface 6 inches is comparatively high, the upper layer of the soil being darker on this account.

The upper subsoil differs little from the surface material in texture, though gradually becoming lighter in color. The subsoil, below about 24 inches, is a loose, porous mass of sand and gravel much resembling that of the gravelly sandy loam and loam types. The organic matter is usually entirely lacking below 30 inches.

The soil is of small extent in this county, although it occupies a larger acreage than any of the other Cheyenne types. It occurs chiefly along the larger drainage ways, contiguous to bodies of Cheyenne gravelly sandy loam, in the southern part of the area. One of the largest bodies lies along Willow Creek. A typical development is mapped along Lawrence Fork in the southeastern part of the county, and narrow strips along Chalk Creek, Hackberry Creek, Bighorn Gulch, Indian Springs Canyon, and Long Canyon. The type represents alluvial terrace material, derived in the same manner as the other Cheyenne types.

The topography is flat with a gentle slope toward the stream channels. Drainage is in most places excessive, on account of the loose porous character of the soil and subsoil.

The type is of little agricultural importance in this county, and only a few small patches are under cultivation. Practically all the

land is included in pastures on which the grazing of beef cattle is the principal industry. The native vegetation consists of a fair growth of sand grass, stipa, and grama grass. The type affords better grazing than the Cheyenne gravelly sandy loam but makes poorer pasture than the loam type.

The selling price of this soil ranges from \$12 to \$15 an acre, depending upon improvements and location.

It is doubtful if the type should ever be used in crop production, on account of its droughty character. It drifts badly when the native grasses are destroyed.

#### CHEYENNE LOAM.

The soil of the Cheyenne loam is a brown to light-brown, coarse textured loam, 10 to 12 inches deep. The surface 6 inches is relatively high in organic matter and is considerably darker than the lower part of the soil. The subsoil gradually becomes coarser in texture with depth, and at 24 inches consists of a loose mass of coarse sand and gravel, of gray to grayish-brown color.

This soil does not differ materially from the gravelly sandy loam and sandy loam types, except in the texture of its surface soil.

This type is very inextensive in Banner County. It occurs as a few scattered bodies along the drainage ways in the upland division, the largest body extends northeastward from near Lovers Leap to a point about 1 mile north of the Harrisburg-Scottsbluff highway.

The type is composed of terrace material, washed down from the upland during torrential rains and deposited in the stream valleys. It differs from the Tripp soils chiefly in the coarser texture of its subsoil.

The surface of the type is almost flat, sloping gently down the valley and toward the stream channels. Drainage is generally excessive and the type is somewhat droughty.

Owing to its small extent and low moisture retaining power, the Cheyenne loam is used only for pasture land. It supports a fairly good growth of native grasses, chief among which are the western wheat grass, grama grass, and buffalo grass. The pasturage will maintain one cow or steer throughout the year on from 12 to 15 acres of land.

#### TRIPP FINE SANDY LOAM.

The soil of the Tripp fine sandy loam is a grayish-brown to brown, loose, friable fine sandy loam, 8 to 12 inches deep, with the material of the upper 6 inches somewhat darker than that below. The subsoil is a light grayish brown to light-gray, loose, floury silt loam to very fine sandy loam. In a few places the soil shows no textural change within the 3-foot section, though the subsoil is invariably

lighter in color than the soil and highly calcareous. Over small areas the soil contains a larger proportion of fine and medium sand than is typical and approaches a loamy fine sand in texture, and in places there is so little fine material present that the soil is subject to wind erosion when plowed.

This type is not extensive in Banner County, although it occupies a larger acreage than any of the terrace or first bottom soils in the area. It occurs chiefly as a narrow, elongated strip, varying in width from a few rods to three-fourths of a mile, along both sides of Pumpkin Creek. Smaller bodies are mapped along the larger tributaries to this stream. The type is composed of sediments carried down from the adjoining uplands and deposited along stream channels when they were flowing at a higher level than at present. It represents terrace material in an advanced stage of weathering.

In the western part of the county, about 3 miles west of Bull Canyon, there is a small body which does not show evidence of alluvial origin. It has a typical Tripp profile, however, and so was included with the series.

The topography of the Tripp fine sandy loam is almost flat, the surface sloping gently down the valleys and toward the stream channels. Drainage is good, the slope being sufficient to carry off the surplus surface water and the subsoil structure favoring under-drainage.

The type is not an important agricultural soil in the county, chiefly on account of its small extent. About 20 per cent of it is under cultivation and the rest is used for pasture and hay land. Sand grass, grama grass, buffalo grass, and a small amount of western wheat grass comprise the native vegetation.

The soil is well adapted to all crops common to the region. Wheat, rye, oats, corn, potatoes, and alfalfa are the leading crops. A few farmers grow small patches of millet, sorghum, and emmer for feed. Wheat and rye are the principal cash crops. Oats, corn, and alfalfa are produced primarily as feed for stock. Potatoes are grown only for home consumption. As on most of the soils of Banner County, the grazing of live stock is the principal industry, and beef cattle and horses are raised extensively. There are a few milk cows, chiefly of the beef breeds, on every farm.

The yields of the grain crops are about the same as those obtained on the Tripp very fine sandy loam. Potatoes yield 75 to 150 bushels per acre, depending upon the season. Alfalfa, which is cut twice, gives a total average yield of 2 tons per acre.

Crop rotation is not practiced, and no fertilizer is used, as the soil is new and in no immediate danger of becoming exhausted.

The land is either plowed in the fall and seeded to winter wheat or stirred as soon as the frost is out of the ground in the spring and

planted to wheat, oats, or corn. Some corn is planted on newly broken sod. Wheat is occasionally drilled in between the corn rows in the fall.

The land is easily handled and does not require heavy teams or strong farm machinery for its cultivation. It can be plowed under any moisture condition without injury. The soil is somewhat incoherent and has a slight tendency to blow when not carefully managed.

The selling price of the Tripp fine sandy loam ranges from \$20 to \$30 an acre, depending upon its improvements, and location with respect to roads and markets. Owing to its small extent on most farms where it occurs, it is usually sold in connection with soils of other types and has a tendency to increase the general value of the land.

The soil should not be left longer than is necessary without a protective covering. Applications of barnyard manure help to check drifting and at the same time apply needed organic matter.

#### TRIPP VERY FINE SANDY LOAM.

The Tripp very fine sandy loam, to a depth of 8 to 10 inches, is a brown to grayish-brown, very fine sandy loam. In places it is slightly compact, but for the most part it is loose and friable. The soil is relatively high in the finest grade of sand and silt and low in material coarser than fine sand.

The surface 6 inches contains slightly more organic matter than is found in the Tripp fine sandy loam and for this reason is more coherent. In a few places the soil, having been modified by wind-blown material, approaches a loamy very fine sand in texture.

The upper subsoil consists of a light-brown to ashy-gray silt or very fine sandy loam, which at about 20 inches generally changes into an almost white, loose, floury calcareous silt, much resembling the lower subsoil of the Rosebud very fine sandy loam. Locally the subsoil does not differ in texture from the surface material, being a very fine sandy loam throughout the 3-foot section.

The type occupies a relatively small area in Banner County. It occurs in scattering bodies on the higher terraces and benches, chiefly along Pumpkin Creek and its tributaries. The largest area lies south of Funnel Rock, and extends up one of the tributaries of Pumpkin Creek. Two small bodies were mapped on the west side of Willow Creek. On the south side of Pumpkin Creek, in the sec. 25, T. 19 N., R. 53 W. there occurs a small but typical area. The soil is composed of material brought down from the Ogallala, Arikaree, and Brule formations, reworked and deposited by streams.

In the extreme western part of the county, along the Nebraska-Wyoming boundary line, there is a body of very fine sandy loam

which has probably been accumulated as colluvial or alluvial wash from the uplands and in this respect resembles the Bridgeport very fine sandy loam. It has, however, a more calcareous and distinctly lighter colored subsoil than any of the Bridgeport types and was for this reason included with the Tripp very fine sandy loam.

The topography of the Tripp very fine sandy loam is flat to very gently undulating. Drainage is good. The greater part of the type has sufficient slope to carry off the surplus water and the loose, porous soil and subsoil affords excellent underdrainage.

The type is of small extent, and only about 10 per cent of it is under cultivation. The rest is used for pasture and hay land.

The native vegetation consists of grama grass, buffalo grass, wire grass, western wheat grass, and blackroot.

Wheat, rye, oats, and corn are the principal cultivated crops, and stock raising is the chief source of income. Beef cattle, chiefly grade Herefords and Shorthorns, are the leading breeds. Most of the ranches also raise horses. Wheat yields from 15 to 20 bushels, rye 20 to 25 bushels, oats 20 to 40 bushels, and corn 15 to 25 bushels per acre.

Land of the Tripp very fine sandy loam sells for \$20 to \$30 an acre.

The type is one of the best agricultural soils in the High Plains region, and where it occurs in large areas as in Box Butte, Dawes and Sheridan Counties, is extensively used in the production of alfalfa and grain crops. It is especially adapted to alfalfa, and good yields are obtained in all but the driest years.

#### SCOTT SILT LOAM.

The soil of the Scott silt loam is a brown to grayish-brown heavy silt loam, 6 to 8 inches deep. It is unusually high in silt and contains very little coarse material. In places the soil content of clay is high, the texture approaching a silty clay loam.

The material in the surface 4 inches is rich in organic matter and has a much darker color than that part of the soil below this depth. The subsoil is a dark-gray to almost black, compact clay, having an average thickness of about 4 feet. This material is almost impenetrable, with a soil auger on account of its stiff compact structure. In places the subsoil changes abruptly at about 30 inches into a light-gray, loose friable very fine sandy loam. The change in color and texture between the soil and subsoil is unusually gradual. The type is calcareous throughout the 3-foot section.

Less than one-half square mile of the Scott silt loam occurs in Banner County. It forms a few isolated areas on the upland in the south-central part. The areas are small, seldom exceeding 10 acres in size.

One of the most typical developments occurs on the east side of the Harrisburg-Kimball road, about 5 miles south of Harrisburg.

The soil has been deposited in shallow, circular basins or depressions, locally called "buffalo wallows." These depressions occur only on the table-land in the southern part of the area. The soil consists of sediments washed in from the surrounding types.

Owing to the impervious nature of the subsoil and to its basinlike topography, water often accumulates in small ponds after rains. It disappears very slowly, and poor drainage exists over the greater part of the type.

The soil is not used for crop production, but is valuable as pasture and hay land. The native vegetation consists of grama grass, buffalo grass, and western wheat grass, the last doing exceptionally well, on account of the favorable moisture conditions. About 8 acres are required to support each head of stock, hay being fed in severe weather. The native grasses yield one-half to three-fourths ton per acre, depending upon the rainfall. Grasses suffer from lack of moisture during protracted droughts, as the soil cracks badly upon drying and evaporation becomes excessive.

It is difficult to give land values on this type, as it comprises but a small percentage of the farms and ranches on which it occurs. When it occupies a considerable acreage the selling price of the farm is greatly reduced. It is doubtful if the Scott silt loam should ever be used for crop production. Some farmers haul manure and straw on this type in an effort to increase its water-holding capacity, and prevent surface accumulation. It is doubtful, however, if this method will give the desired result; as it is the heavy, impervious subsoil and not the soil that is the cause of the poor drainage.

#### LAUREL FINE SANDY LOAM.

The Laurel fine sandy loam consists of 8 to 12 inches of a light-brown to grayish-brown, loose fine sandy loam. In a few places it contains a relatively large percentage of very fine sand and silt and approaches a very fine sandy loam in texture.

The surface, 6 inches, is high in organic matter, but this constituent rapidly decreases with depth. The upper subsoil is a gray to light-gray, loose, incoherent fine to very fine sand, which below about 20 inches gradually becomes coarser in texture, with considerable sand and fine gravel encountered at 30 inches. The lower stratum is often mottled with rusty-brown streaks as a result of poor drainage. Both soil and subsoil are calcareous.

The type is inextensive in Banner County. It occurs as an almost continuous strip, varying in width from a few rods to one-fourth

mile, along Pumpkin Creek, and represents recent alluvium, which in many places is still in the process of formation.

The topography of the type is flat and most of the soil is poorly drained. It lies only 2 or 3 feet above the stream channel and is subject to frequent overflow. Owing to its small extent and poor drainage, it is nearly all included in pasture and hay land, although some alfalfa is grown on the better drained areas. The native vegetation consists of big bluestem grass, grama grass, western wheat grass, and wire grass. A few scattering cottonwood, willow, boxelder, and chokecherry trees occur near the stream channel. The grasses on this type afford better pasturage and more hay than on any of the other soils in the county, on account of the more favorable moisture conditions. From one-half ton to 1½ tons of hay is obtained from each acre in average years. Where alfalfa can be grown, it yields a total of 2 to 2½ tons per acre, from two cuttings. The price of this land ranges from \$20 to \$30 an acre.

It is advisable to keep the areas of the Laurel fine sandy loam in the native grasses, except the land which is sufficiently well drained to produce alfalfa. When planted to crops requiring cultivation, the soil drifts badly and much of the organic matter is removed by the wind.

#### LAUREL VERY FINE SANDY LOAM.

The surface soil of the Laurel very fine sandy loam is a grayish-brown, loose friable, very fine sandy loam, 8 to 12 inches deep. The material is rich in organic matter. The upper subsoil is a light-gray to light grayish brown loamy fine sand. In places it is slightly more compact than the surface soil, this condition resulting from a larger silt and clay content. Below 24 inches the subsoil generally becomes a loose, gray fine sand to very fine sand, in many places mottled brown or drab owing to poor drainage. In some places fine gravel and coarse sand are encountered at 30 inches. The subsoil is highly calcareous.

This type occupies a very small acreage in Banner County, being mapped in only three small bodies. These are narrow strips along the channel of Pumpkin Creek. The largest and most typical body lies at the mouth of Chalk Creek, in sec. 25, T. 19 N., R. 53 W. The type represents recent alluvium and is still in the process of formation. The topography is flat and the drainage poor. The soil lies but a few feet above the normal flow of the creek and is subject to inundation with each slight rise.

The soil is not used for crop production owing to its small extent and poor drainage. It supports an excellent growth of native grasses, however, which, because of the favorable moisture condi-

tions, afford good hay and pasturage even during the driest years. Grama grass, big bluestem, wire grass, and western wheat grass are the most important species. From 6 to 8 acres are required to support a cow or steer throughout the year, hay being fed in severe weather. Wild hay yields three-fourths to one and one-half tons per acre, depending upon the rainfall. The land ranges in selling price from \$20 to \$35 an acre.

Where the type is extensively developed it is one of the best hay soils of the High Plains region and on the better drained areas in Morrill, Box Butte, Dawes, and Sheridan Counties, it is used for the production of alfalfa and grain crops with excellent results.

#### ROUGH BROKEN LAND.

The type mapped as Rough broken land includes extensive areas of badly eroded stream slopes and bluffs which are unsuited for agriculture, with the exception of included stream valleys and a few small areas that have escaped excessive erosion. The topography is extremely rough and broken; steep slopes, canyons, and gullies abound. Rock outcrops over a considerable proportion of the type, forming in many places cliffs and vertical walls. The greater part of the type has been carved from the underlying Tertiary sandstone, which is readily broken into a rough topography where erosion is active. There is usually present a considerable quantity of white calcareous stones, fragments of the underlying sandstone formations.

The type is one of the most extensive in Banner County. It occurs chiefly in the northeastern and southeastern parts. The largest body occupies Wild Cat Ridge. The type also occurs as an irregular jagged though almost continuous strip bordering the north edge of the table-land throughout the county. Extensive areas were mapped along Rocky Hollow, a tributary of Lawrence Fork, in the southeastern part of the county. Drainage over most of the type is excessive, owing to the steep slopes.

The type is used exclusively as grazing land. There is a good growth of grasses, except in those areas where erosion has been extremely rapid. Grama grass, buffalo grass, and western wheat grass are the most important species. Blackroot, a sedge, is also important. Scrub pine grows on the narrow ridges and steeper slopes, while in the canyons elm, cottonwood, ash, boxelder, willow, hackberry, and chokecherry constitute the tree growth.

Rough broken land will support 25 to 35 head of cattle per section when grazed throughout the year. The rough topography affords protection to stock during severe weather. The land is valued at \$12 to \$15 an acre.

## DUNESAND.

The areas mapped as Dunesand consist of a gray to yellowish-gray or brownish-gray sand of fine to medium texture, with fine sand predominating. There is almost no change in texture to a depth of 3 or more feet. The structure is usually very smooth and incoherent, with little variation from soil to subsoil. In a few places a stratum of slightly coarser material, varying in thickness from 1 to 3 inches, is encountered at depths between 24 and 36 inches.

There is generally some organic matter in the surface 6 inches, but this is never sufficient to hold the soil against drifting when the native grasses are destroyed. Neither the soil nor the subsoil is calcareous.

Dunesand is not extensively developed in Banner County. It occurs as small isolated bodies in the Pumpkin Creek Valley. The largest and most typical area lies north of the creek, in the northern part of the county. A smaller body occurs  $2\frac{1}{2}$  miles northeast of Harrisburg.

The materials forming this type have been accumulated by wind action from the surrounding sandy soils.

The topography is sharply rolling on a miniature scale. Small hummocks of wind-lodged sand, hollows, and blow-outs are of common occurrence. In a few places the sand is heaped into dunes 20 to 30 feet high. Only a small proportion of the type is under active wind erosion at the present time.

There are no continuous waterways through the areas of Dunesand, as the loose, porous sand is so absorptive that there is little run-off, even on the steepest slopes. The type is unusually retentive of moisture, considering its loose structure.

The Dunesand is of no importance in crop production, but has considerable value as pasture land. The surface in most places is well sodded with grasses, of which long-leaved reed grass, western stipa, and redfieldia are the most common. Soapweed or yucca is occasionally encountered. During the spring and summer the native grasses afford excellent pasturage, but in the winter they are killed by frost and can not be depended upon for grazing. The type will support from 40 to 50 head of cattle per section during the summer months.

Dunesand sells for \$12 to \$15 an acre, the price depending mainly upon the covering of grasses.

The preservation of the native grasses is essential to the utilization of this type. Patches along old roads, where the wind has had an opportunity to work on the bare surface, plainly show the disastrous effects of disturbing the soil-binding roots. Care must be taken to control fires which burn off the protective covering of grasses.

## SUMMARY.

Banner County is situated in western Nebraska, bordering the State of Wyoming. It comprises an area of 745.5 square miles, or 477,120 acres. The county lies in the western part of the Great Plains Province. The surface varies from flat or gently undulating to rough and dissected. The elevation ranges from 3,940 feet to 5,240 feet above sea level.

Drainage is generally good throughout the county. The northern part is drained by Pumpkin Creek and the southern part by Lawrence Fork and its tributaries.

Settlement of the county began in 1885 and in 1889 the county was organized. The 1910 census gives the population as 1,444. It is all classed as rural and mostly as native-born whites. Harrisburg, the county seat, is located in the central part of the area.

There are no railroads in the county. All the public highways are of earth. In the southwestern and northwestern parts they are in good condition; elsewhere they do not, as a rule, follow section lines and are not well maintained.

There are no markets within the county. The grain and live-stock products are shipped from Kimball or Scottsbluff to eastern markets.

The climate of Banner County is characterized by cold winters and relatively short summers. There are wide extremes of heat and cold. The mean annual temperature is 47.4° F. and the average growing season is 129 days. The mean annual rainfall is about 16 inches, three-fourths of which falls during the growing season. High winds may occur at any time during the year, but are seldom destructive to property.

The early agriculture consisted of stock raising on the open range. This was followed by a decline in the stock-raising industry and most of the farmers depended largely upon grain crops. The dry years following 1890 made grain growing unprofitable, and the farmers have gradually adopted a combined system of grain growing and cattle ranching.

Wheat occupies the largest acreage among the cultivated crops and is the chief cash crop. Corn, oats, flax, rye, and potatoes rank in importance in the order named. Alfalfa is the principal hay crop. It occupies an acreage about twice that from which wild hay is harvested.

By far the greater part of Banner County is used as grazing land and live-stock raising is the most important industry. According to the 1910 census, the value of live-stock products exceeded that of all crops combined. Cattle and horses are the chief source of income. Hogs are raised only in an experimental way. There are only a few sheep in the county.

The best farmers attempt to follow the natural adaptation of soils to crops in planting. The prevailing methods of agriculture are generally applicable to dry-farming conditions, except that no definite rotation is followed and most of the farm manure is wasted. Nearly all the farms have the necessary equipment.

Farm labor is rather scarce during the busy season, and most of the farmers use their own efforts and those of the family to carry on the work. Good wages are paid for farm labor.

In 1910 there were 368 farms in the county, with an average size of 863.5 acres. Most of the farms range in size from 160 to 640 acres. The great majority of the farmers and ranchers operate their own farms. The cash and crop-rental systems are equally followed in the case of leased farms. Land values range from \$12 to \$75 an acre.

The soils of Banner County may be grouped into four main divisions: (1) Residual soil, (2) colluvial and alluvial fan soils, (3) alluvial or stream deposited soils, and (4) eolian or wind-blown soils. Ten soil series, embracing 26 soil types, are recognized in Banner County.

The Rosebud series is quite extensive. It occurs chiefly in the southern part of the county. The loam and silt loam types are well adapted to the production of small grain.

The Dunlap silt loam is of very small extent and is mostly used for pasture land. It is a fertile, strong soil, however, and where it occurs in areas of large extent, is one of the best dry-farming soils in the High Plains region.

The Epping soils occur chiefly in the Pumpkin Creek Valley. The heavier members, including the silt loam and very fine sandy loam, are well adapted to dry farming. The lighter textured types, however, are somewhat droughty and subject to drifting when left unprotected.

The Valentine soils are chiefly used for the production of hay and as pasture land. The loamy fine sand type is low in organic matter and blows badly when the protective covering of grasses is removed.

The Mitchell silt loam and very fine sandy loam types are inextensive in Banner County and are of little agricultural importance.

The Bridgeport soils occupy the alluvial and colluvial fan slopes in the Pumpkin Creek Valley. The fine sandy loam is the most important type of this series.

The Cheyenne soils are developed in the high terraces along the larger intermittent drainage ways. Most of the types are of a droughty nature on account of the loose, porous subsoil.

The Tripp soils are of relatively small extent in this county. They are well adapted to grain growing.

The Scott silt loam occupies small depressions and basins in the table-land forming the southern part of the county. The soil is of

little agricultural importance on account of its heavy, impervious subsoil and consequent poor drainage.

The Laurel soils occur as a narrow strip in the flood plain of Pumpkin Creek. Most of them are poorly drained and valued only for the pasturage and hay they produce. The better drained areas are adapted to the production of alfalfa.

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