SOIL SURVEY OF MADISON COUNTY, NEBRASKA.

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DESCRIPTION OF THE AREA.

Madison County is situated in the northeastern part of Nebraska, about 90 miles northwest of Omaha and 60 miles southwest of Sioux City. The county is almost a square in outline, each boundary being 24 miles long. It comprises an area of 576 square miles, or 368,640 acres, by planimeter measurement.

The county lies within the loess region of the Great Plains province. The original surface, however, has been considerably modified by erosion, so that only part of it remains to mark the level of the former loess mantle. The county has a rolling to sharply rolling topography, except on the broad flat terraces and flood plains along the Elkhorn and North Fork of Elkhorn River and the narrow alluvial lands along the larger creeks. For convenience in reference the county may be described as consisting of two topographic divisions, the broad, shallow valley of the Elkhorn River, which includes most of the northeastern half of the county, and the higher lying eroded loess plains, comprising the southwestern half.

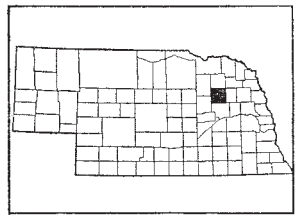

FIG. 7.—Sketch map showing location of the Madison County area, Nebraska.

The Elkhorn Valley, including the valley of the North Fork of Elkhorn River, extends in a southeasterly direction across the northeastern half of the county, and is composed largely of first bottoms or flood plains, terraces or second bottoms, and long gradual valley slopes.

The first bottoms, which are subject to frequent inundation, for they lie but slightly above the flood stage of the streams, comprise the greater part of the alluvial lands. They occur as continuous strips along the Elkhorn River and the North Fork and along the larger tributaries to these streams. They vary in width from 2 to about 4 miles and lie from 5 to 15 feet above the normal stream level and from 4 to 10 feet below the terrace lands. The surface is flat, modified in places by slight depressions and overflow channels. There is usually a gentle slope down the valley and toward the streams.

The terraces or second bottoms of the Elkhorn Valley are not as extensive as the bottom lands. They usually occur as independent bodies and strips between the first bottoms and the valley slopes, but in places they occur immediately bordering the stream channels. Most of the terrace land is on the south side of the Elkhorn River. The topography varies from gently undulating to almost flat and is further modified in places by numerous shallow depressions. The surface of the terraces grades slightly down the valley and toward the streams. The slope is usually very gradual and in many places

almost imperceptible. Locally the terraces grade into colluvial areas bordering the first bottoms.

The valley slopes comprise by far the greater part of the Elkhorn Valley. They consist of long, gradual, gently rolling to steeply rolling slopes extending from the alluvial lands to the eroded loess plain on the south and to the uplands beyond the northern county boundary on the north. The more steeply rolling lands lie north of the river and comprise two small areas of silty loess material which lends itself readily to the formation of a deeply gullied and rough topography.

South of the Elkhorn Valley lies the eroded loess plain division. This occupies the highest position in the county. It represents a remnant of the original loess plain, which has been so modified by erosion that only the hill crests and broader divides remain to mark the level of the former loess mantle. The surface varies from almost flat to hilly, and is broken in places by narrow strips of alluvial land along the larger creeks and drainage ways. The flatter areas occupy the crests of the broader divides where erosion channels have not become established. The slopes to the larger streams are usually gradual, and the valleys are broad and shallow. In a few places, however, the slopes are steep and consist of a succession of narrow shelves formed by small landslides and known as "cat steps." The heads of secondary drainage channels are usually narrow and in places steep sided, but the channels become broader in their lower courses. The flood plains bordering the larger creeks are flat. They lie from 6 to 15 feet above the stream level and about 100 feet below the adjoining upland.

The elevation of the alluvial land in the vicinity of Norfolk, in the northeastern part of the county, is about 1,520 feet above sea level, and in the vicinity of Tilden, about 1,675 feet. According to the Nebraska Geological Survey the elevation of Norfolk is 1,525 feet, Battle Creek 1,581 feet, Meadow Grove 1,637 feet, Tilden 1,679 feet, Warnerville 1,602 feet, Madison 1,581 feet, and Newman Grove, 1,756 feet. It is estimated that the eroded loess plain lies about 120 to 160 feet above the first bottoms on the average. The total range in elevation in the county is probably not over 250 feet. There is a general slope toward the east.

The drainage of the county is effected through the Elkhorn River and its tributaries, and through the drainage systems of Shell and Union Creeks. The Elkhorn River is the largest stream in the county. This stream with its tributaries drains the northern half and most of the western part of the county. The channel varies in width from 3 to 10 rods, is extremely shallow, and subject to shifting during flood stages of the river, which occur in most years, causing considerable damage to crops and other property. The largest tributary is the North Fork of Elkhorn River. It has an average width of about 2 rods and varies in depth from 3 to 5 feet. The channel is very meandering, and the river sometimes overflows, causing serious damage. The only permanent tributary on the south side of the Elkhorn River is Battle Creek, which drains most of the western and central parts of the county. The extreme southwestern part of the area is drained by Shell Creek, and the southern, east-central, and southeastern parts by Union Creek.

The rivers, creeks, and intermittent drainage ways afford ample drainage for most of the county. All parts of the eroded loess plain are reached by drainage except the flat areas of Marshall silt loam. As a rule the divides are narrow and stream branches numerous, but in some places the relief is not so pronounced, the surface being more gently undulating. In a few places on the southern slope of the Elkhorn Valley in the eastern part of the county drainage channels are not well established and water stands on the flatter areas for a considerable time after rains. The most imperfectly drained areas in the county are the first bottoms. Very frequently the smaller channels of the upland streams become filled with sediment where they issue into the bottoms, and the water collects in depressions or spreads over the lowlands before it evaporates. The larger creeks are deeply intrenched in their flood plains and overflow only during abnormal seasons.

The first settlement in Madison County was a colony of Germans, who located in 1857 near the present site of Norfolk. Later settlement came from Missouri. The county was organized in 1867. Norfolk was incorporated in 1881. White persons of native birth constitute 87.7 per cent of the total population. The census of 1920 shows Madison County with a population of 22,511, of which 61.6 per cent is classed as rural. The rural population, which includes towns of less than 2,500 inhabitants, averages about 24 persons to the square mile and is fairly evenly distributed, although it is densest in the vicinity of the towns and upon the eroded loess plains.

Norfolk is situated in the northeastern part of the county and has a population of 8,634. The city is an important railroad, manufacturing, and commercial center and is the chief distributing point for farm implements and supplies. Madison, the county seat, with a population of 1,735, is located in the southeastern part of the area. Newman Grove, with 1,260 inhabitants, is a local trading center in the extreme southwestern part of the county. Battle Creek has 743 inhabitants, Meadow Grove 449, and Tilden 1,101. These towns furnish local markets for the central and northwestern parts of the county.

The northern, eastern, and southern parts of Madison County have good transportation facilities. A branch line of the Union Pacific from Columbus to Norfolk extends nearly across the eastern part of the county. Madison, Norfolk, Enola, and Warnerville are on this line. A line of the Chicago, St. Paul, Minneapolis & Omaha Railway between Sioux City and Norfolk enters the northeastern corner of the county. The main line of the Chicago & Northwestern Railway between Omaha and Chadron crosses the northern part. Norfolk, Battle Creek, Meadow Grove, and Tilden are on this line. One branch of the Chicago & Northwestern extends northwest from Norfolk to Winner, S. Dak., and another branch extending from Scribner to Oakdale loops into the southwestern part of the county, passing through Newman Grove.

Madison County has a number of good roads. These follow land lines regardless of topography, except in places along the Elkhorn River where bridges have not been constructed. The more important roads are well graded and are dragged after each rain. Little attention is given to the upkeep of secondary roads. There are many substantial bridges and culverts on the main roads between towns,

but the stream crossings on the secondary roads are often in poor condition. The building of concrete culverts is receiving increased attention.

The markets for most of the surplus agricultural products of the county are Omaha and Sioux City. The surplus wheat and corn is usually hauled to local elevators, where it is either sold or stored until the market is satisfactory. Norfolk furnishes a local market for much of the poultry and dairy products.

CLIMATE.

The climate of Madison County is typical of eastern Nebraska and is well suited to grain farming and stock raising. The long, warm summers are especially favorable for corn, and though the winter temperature is sometimes low, crops seldom suffer winter killing, owing to the protection of snow.

The table below, compiled from the records of the Weather Bureau station at Norfolk, covering a period of 35 years, gives the normal monthly, seasonal, and annual temperature and precipitation for the county:

Normal monthly, seasonal, and annual temperature and precipitation at Norfolk.

(Elevation, 1,532 feet.)

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1894).	Total amount for the wettest year (1905).
	°F.	°F.	°F.	Inches.	Inches.	Inches.
December	23.8	72	−29	0.83	1.00	T.
January	19.0	64	−39	.47	.20	0.94
February	21.3	72	−35	.87	T.	.72
Winter	21.4	72	−39	2.17	1.20	1.66
March	33.8	92	−15	1.03	.49	.88
April	48.0	102	10	2.71	2.59	3.83
May	59.4	101	21	4.06	1.30	9.88
Spring	47.1	102	−15	7.80	4.38	14.59
June	68.6	103	35	4.60	2.74	4.43
July	74.1	108	42	3.89	1.82	4.31
August	72.3	106	37	3.60	1.68	3.28
Summer	71.7	108	35	12.09	6.24	12.02
September	63.4	106	20	2.89	.49	6.14
October	50.6	92	8	1.57	1.49	.82
November	35.5	83	−12	.86	T.	2.45
Fall	49.8	106	−12	5.32	1.98	9.41
Year	47.5	108	−39	27.38	13.80	37.68

The mean annual temperature is 47.5° F. January is the coldest month, with a mean of 19° F.; July is the warmest, with a mean of 74.1° F., but the mean for August is only 1.8° lower. There is a range in temperature of 55.1° F. between the means of the coldest and warmest months. The lowest temperature recorded is −39° F. in January, and the highest is 108° F. in July.

The average date of the last killing frost in the spring is May 7, and that of the first in the fall October 3. This gives an average growing season of 148 days, which is ample for the maturing of ordinary farm crops. In 20 years, 1895 to 1914, there were four seasons in which the last killing frost in the spring was 10 days or more later than the average and five seasons in which the earliest in the fall was 10 or more days earlier. The date of the latest recorded killing frost is May 27, and of the earliest, September 12.

The mean annual precipitation is 27.38 inches, of which 12.09 inches or about 44 per cent falls during the principal part of the growing season, June, July, and August. The total precipitation in the driest year on record (1894) was 13.8 inches, and in the wettest year (1905), 37.68 inches. The driest months are November, December, January, and February, the mean annual precipitation of each being less than an inch.

In the summer the precipitation usually occurs as heavy thundershowers, but torrential rains are rare. Severe droughts are almost unknown during May and June, but in the latter part of July and during August the rainfall varies considerably, and short dry spells may occur. However, crops seldom suffer severely for lack of moisture when proper cultural methods are followed, as most of the soils have a high water-retaining capacity. Serious droughts are practically unknown. The amount of snowfall varies annually from a few inches to several feet.

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

AGRICULTURE.

The land included in Madison County originally supported a luxuriant growth of prairie grasses, with marginal strips of forest along the larger streams. The early settlers located along the streams, where there was an abundance of fuel. The first small tracts were broken about 1858 and planted to corn and wheat, which, with dairy products, game, and pork, formed the chief foods. Small quantities of potatoes and other vegetables, buckwheat, rye, oats, and barley were raised on a few claims to supply the home needs. As there were neither local markets nor transportation facilities, the early development of agriculture was slow. The construction of railroads gave the first marked impetus to the development of farming.

The census reports give the value per farm of all farm property, including land, buildings, implements, and domestic animals, as $2,029 in 1880, $4,665 in 1890, $6,617 in 1900, $17,088 in 1910, and $39,030 in 1920. Between 1880 and 1910 the number of farms in the county increased from 776 to 1,777. According to the census of 1920, there are 1,647 farms in the county, with an average size of 196.3 acres. The percentage of the county in farms was 37.9 in 1880, 81.2 in 1890, 77.6 in 1900, 88.3 in 1910, and 87.7 in 1920. The percentage of farms operated by owners was 98.8 in 1880, 72.02 in 1890, 62.2 in 1900, 55.2 in 1910, and 54.1 in 1920. These figures indicate that more farms are being rented each year.

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

the county in 1879, 1889, 1899, 1909, and 1919, and shows the general trend of agriculture:

Acreage and production of principal crops in 1879, 1889, 1899, 1909, and 1919.

Crop.	1879		1889		1899		1909		1919	
	Area.	Production.	Area.	Production.	Area.	Production.	Area.	Production.	Area.	Production.
	Acres.	*Bushels.*	*Acres.*	*Bushels.*	*Acres.*	*Bushels.*	*Acres.*	*Bushels.*	*Acres.*	*Bushels.*
Corn	18,309	646,165	77,767	2,892,459	110,222	3,449,970	119,076	4,219,304	104,670	3,130,328
Oats	5,514	158,540	26,802	762,113	44,740	1,425,870	61,335	1,208,883	56,980	1,566,955
Wheat	14,768	111,332	9,831	124,486	42,313	517,590	9,746	174,473	11,604	120,053
Rye	768	7,609	398	5,197	1,976	24,570	1,339	13,204	4,944	42,516
Barley	376	5,903	864	14,905	1,181	26,760	927	22,830	1,502	32,691
Flaxseed	.....	.....	699	4,955	.....	.....	33	102	.....	.....
Potatoes	.....	33,343	1,037	93,508	1,008	107,968	1,074	92,729	815	47,990
		Tons.		*Tons.*		*Tons.*		*Tons.*		*Tons.*
Hay and forage	8,642	14,062	42,864	58,224	35,197	48,874	42,853	68,452	39,195	67,317

The present agriculture consists of the production of grain, hay, and live stock. Corn, oats, alfalfa, wild hay, wheat, rye, mixed clover and timothy, barley, and potatoes are the leading crops, ranking in acreage in the order named.

Corn is by far the most important crop, and on farms where it is not fed to live stock it is the chief cash crop. The census of 1920 reports 104,670 acres, or nearly one-third of the land included in farms, in corn for grain during 1919, with a production of 3,130,328 bushels. On farms operated by owners the greater part of the corn is fed to hogs, beef and dairy cattle, and work stock. There are 46 silos in the county, and considerable corn is grown for silage. It is a common practice to husk corn from the standing stalks and pasture cattle and horses in the fields during the fall and winter. Many farmers fence off a few acres and allow hogs to feed on the unhusked corn. Part of the crop is cut for winter roughage. On rented farms most of the corn is sold.

On many farms corn is grown on the same land five or six successive years. Much better yields, however, are obtained where it is grown in rotation with small grains and a legume, either clover or alfalfa. In recent years some attention has been given to the improvement of the seed corn, but in the county as a whole little interest is taken in seed selection. Varieties of corn recommended by the Nebraska Experiment Station as being well adapted to this county are Reid Yellow Dent, Nebraska White Prize, and Iowa Silver Mine. Corn is raised on nearly all the soils of the county but the loessial soils of the uplands and the better drained parts of the alluvial lands are preferred on account of the higher yields.

Sweet corn is produced in the vicinity of Norfolk for the canning factory located at that place. This crop does best on the Wabash and Waukesha silt loams, though some is grown on the upland soils. The yields range from 1½ to about 5 tons per acre. The ears are usually snapped when in the dough stage and delivered to the factory by the farmer. The stalks furnish early fall feed and also make good silage. The waste from the factory is used as part of the ration in fattening cattle and hogs.

The oat crop ranks second in acreage. The census reports 56,980 acres in oats in 1919, with a production of 1,566,955 bushels. The

average yield was 27½ bushels per acre. This yield is often greatly exceeded, and yields as high as 90 bushels have been obtained. Kherson and Green Russian are the leading varieties. The Kherson has a short, stiff stem and is well adapted to the bottom soils where crops are likely to lodge. Very little effort is made to control smut, although the disease often lowers crop yields during wet seasons. Oats are usually cut with a binder and either threshed from the shock or stacks. The grain is used mainly as feed for horses and other stock, though some is sold. The straw is used for roughage, the stock being allowed to feed around the stacks. A little straw is baled and shipped. Seed is frequently obtained from other sections. The crop is grown on most of the soils of the county, but does best on the heavier soils. It is not well adapted to the sandy soils on account of the danger of the soil blowing and exposing the roots.

Wheat is not as important in the crop system as it was 20 years ago. According to the census, 11,604 acres were in wheat in 1919. The Nebraska State Board of Agriculture reports 3,234 acres in wheat in 1920, with a total yield of 39,117 bushels. Both winter and spring wheat are grown, the former occupying about three times the acreage of the latter. The average yield of winter wheat is reported as 13 bushels per acre and that of spring wheat as 8 bushels. The yield of winter wheat fluctuates less than that of the spring varieties. Winter wheat yields better than spring wheat, can be sown in the fall at a time when the farm work is light, and matures before the dry weather and hot winds occur. There is some danger of winterkilling, but this is much less when the hardy Turkey variety is grown. Several varieties of spring wheat are grown, but little effort is made to keep the strains pure. Rust rarely injures winter wheat, but is very destructive to spring wheat. Some damage is caused by smut on both winter and spring wheat, and yields are sometimes reduced by the Hessian fly. Wheat is usually cut with a binder, except during exceptionally dry seasons, when the stems are too short for binding and the grain is headed. The crop is shocked or stacked for threshing. Most of the grain is sold direct from the threshing machine, though there is a tendency in some sections of the county to store it until the market is satisfactory. The straw is usually left in the field, and stock is allowed to feed upon the stack.

Rye ranks next to wheat in acreage. The census report shows 4,944 acres in rye in 1919, with a production of 42,516 bushels, and an average yield of 12 bushels per acre. The crop is grown chiefly upon the heavier soils, and generally for the grain, but it is also raised to some extent for hay and pasture. It is more drought resistant than wheat and will flourish on poorer soils. The lower selling price of the grain, however, has tended to check increased acreage. In cutting the crop either a binder or header is used, depending upon the length of the stems. Rye in bundles is threshed from shocks or from stacks, but headed rye is invariably threshed from stacks. The greater part of the crop is shipped out of the county, but some is fed locally to stock.

Barley was grown on 1,502 acres in 1919, and produced 32,691 bushels. Emmer occupied 64 acres. These crops are usually cut with a binder and used for feed.

Alfalfa is the most important hay crop. According to the census it was grown on 18,643 acres in 1919 and produced 36,580 tons of

hay. The report of the Nebraska State Board of Agriculture shows 23,342 acres in alfalfa in 1920, with a production of 70,026 tons. The average yield is 3 tons per acre. Alfalfa is usually cut three and occasionally four times during the season. In general, Madison County is well situated for the growing of alfalfa. The crop does well on all but the sandier soils and the poorly drained bottoms. It is especially well adapted to the eroded areas of Knox silt loam, on account of their high lime content, and it is a most valuable crop for protecting these areas from surface wash. Alfalfa not only has a high nutritive value and produces large yields, but is valuable in increasing the productiveness of the soil for grain crops, particularly corn and oats. It is equal to red clover as a soil improver, although less suited to short rotations. Most of the hay is stacked and fed to live stock on the farms, but some is baled and marketed. Many farmers run hogs in the fields during the summer. Cattle, however, are seldom allowed to graze on green alfalfa on account of the danger of bloating. Alfalfa sod usually is allowed to stand for a considerable period of years.

The census report shows 1,825 acres in timothy and clover mixed, with a total yield of 2,605 tons in 1919. The crop is grown on bottom lands and poorly drained areas of the terrace soils. It will withstand considerable excess moisture and for this reason is well adapted to these areas. The first crop after seeding is almost pure clover, the second about an equal mixture of the two, and the third almost pure timothy. The hay is fed to stock on the farms and is preferred for work animals. Timothy alone, clover alone, and other tame grasses are grown to some extent.

Wild hay ranks next to alfalfa in acreage. The census reports the production of 20,970 tons from 15,423 acres in 1919. Wild hay is cut chiefly from large areas of bottom land which are untilled on account of deficient drainage and other extensive areas of Valentine soils which may drift badly when the protective covering of grasses is removed. Very little of the loessial upland remains in wild grasses. The highest yields are obtained on the poorly drained alluvial soils. The quality, however, of the upland hay is much better; it grows less rank, is of finer texture, and has a higher feeding value. The hay is stacked in the field and either baled for market or hauled to the feed lots as needed. Most of it is used as feed for work stock.

Potatoes are grown on many farms to supply home needs. The census reports 815 acres in potatoes, yielding 42,987 bushels, in 1919. The potatoes are turned to the surface with a stirring plow, are gathered by hand, and stored for use in winter.

Watermelons and muskmelons are grown in a small way on the sandier soils of the Elkhorn Valley. They are sold mainly in Norfolk and the surrounding towns. A few small apple orchards occur throughout the county. Not enough fruit is produced to supply the local demand, and it would seem that apple growing could be profitably extended, especially on the terrace soils. Trees usually do not do so well upon the upland on account of the deficiency of moisture, which is largely compensated on the terrace lands by the nearness of the water table to the surface. Of the wild fruits, plums and grapes are the most important. They grow chiefly along the Elkhorn River and its North Fork.

As a source of income the live-stock industry of Madison County holds a prominent place. According to the census, there were 25,919 beef cattle and 8,273 dairy cattle in the county in January, 1920. There are only a few herds of purebred beef cattle, though many purebred bulls have been introduced in recent years to improve the grade stock. The quality of the beef cattle in general is very good. Grade Hereford, Shorthorn, and Galloway form the bulk of the herds. Some of the beef cattle are fed for market, but large numbers are sold as stockers and feeders. A few farmers annually ship in cattle for winter feeding. There is an abundance of pasture land in the county, and many farmers purchase stock for summer grazing.

Dairying is not an important industry. It is gradually being extended in conjunction with general grain farming. There are only a few purebred dairy cattle, but the number is sufficient to serve as a basis for the development of the dairy industry. The abundance of alfalfa, to balance the corn ration, and the good marketing facilities combine to favor the extension of dairying. From six to eight cows are kept on the average farm. Most farmers have a cream separator. Many farmers milk grade beef cows, while a few are engaged in dairying exclusively. There is considerable need for more purebred bulls of dairy breeds. At present the Holstein is the prevailing breed in the improved herds.

Hog raising is an important branch of the live-stock industry. The census reports 74,309 hogs in the county in January, 1920. Nearly every farmer fattens a few hogs each year, and some are raised in connection with the feeding of beef cattle. There are several pure-bred herds, and the quality of the grade stock in general is very good. The principal breeds are Duroc-Jersey, Poland-China, and Berkshire; the Chester White is raised to a less extent. Hog raising has been disastrously affected at times by the prevalence of hog cholera. Much attention is being given to the elimination of hog cholera through vaccination and sanitation.

Sheep raising does not receive much attention, and there are only a few flocks of sheep in the county. The census reports 5,026 sheep in the county in January, 1920. Some farmers buy a carload or more of sheep in the fall, fatten them on corn and pasturage, and sell them when the prices are favorable. The favorable climatic conditions and the abundance of nutritive feeds would seem to warrant an extension of the sheep industry. Large numbers could be fattened in the corn fields in the fall at a minimum expenditure of feed and sold at a good profit.

Many farmers raise their own work stock and sell a team occasionally. Most of the horses are of heavy draft types, the Percheron being the chief breed. Much improvement in horses has been made within the last 15 years, following the introduction of purebred stallions. Some mules are raised, but the local demand for these animals is greater than the supply. In January, 1920, there were 10,757 horses and 973 mules in the county.

Poultry is kept on practically all farms and constitutes an important source of income. There is a good local demand for poultry products, and the poultry industry deserves increased attention. No specialized poultry farms occur in the county. The Leghorn, Barred Plymouth Rock, Rhode Island Red, Orpington, and Wyandotte are the most popular breeds of fowls. The census of 1920 reports the

production of 638,906 dozen eggs and 192,366 chickens in the county in 1919.

The adaptation of crops to certain soils has not been carefully studied. It is recognized, however, that corn does better upon the Marshall silt loam than upon the Knox silt loam and produces highest yields on the well-drained heavier soils of the terraces. The sandy terrace soils and those of the Valentine series are well adapted to truck crops, including watermelons and muskmelons. Small grains do best upon the heavy upland and terrace soils. They are not adapted to the sandier members of the Valentine series on account of the danger of soil drifting. Alfalfa does well upon the well-drained terrace lands and the Knox silt loam areas, but is poorly adapted to the Valentine soils on account of their low lime content.

The importance of careful preliminary preparation of the seed bed and the subsequent care of crops is receiving increased attention. Most of the corn is listed, the single-row lister ordinarily being used. A considerable part is check rowed. The listed corn is more quickly planted and is thought to withstand drought better. The results obtained over a period of years, however, are not so good as those from a more thoroughly prepared seed bed. The listed corn is subject to severe washing in seasons of heavy rainfall, and on rolling areas or slopes entire rows are sometimes washed away. On bottom lands the plants are often covered with sediment or are drowned by water standing in the furrow.

In preparing for small grain the more progressive farmers usually plow the ground to an average depth of 6 inches and thoroughly harrow or disk it. The seed is sown with a press drill. In preparing old corn or stubble land for small grain, many of the tenant farmers plow only every second or third year, but they thoroughly disk the ground before seeding.

Alfalfa is sown on a well-prepared seed bed in the late spring or early fall. It is often planted with a nurse crop of wheat or oats. The stand is usually left from 6 to 10 years. A field of alfalfa is rarely frozen out. A stand is easily obtained, except on the sandier soils, which require liming. Barnyard manure is very beneficial to this crop.

Potatoes are usually planted in the plow furrow. The cuttings are dropped by hand, about 2 feet apart in every third furrow, and covered by the next furrow slice. The potato beetle is very injurious to the crop, and it is often necessary to spray the vines with poison in order to control the insect.

Changing crops from year to year on any field is recognized as being good practice. Few farmers, however, have adopted systematic crop rotations. A rotation that is sometimes followed consists of corn for 1 or 2 years, or rarely, 3 years, then a crop of oats, followed by clover and timothy, and back to corn. This may be varied by growing a crop of alfalfa or occasionally wheat and alfalfa. The most successful farmers do not grow corn more than 2 years in succession on the same ground. Many of the tenant farmers, however, do not change crops until yields begin to decline. Alfalfa is not adapted to short rotations, as most of the farmers prefer to keep the stand for 6 or 10 years. There is a growing tendency to shorten the period of use of any one field for alfalfa, and the experience of alfalfa growers indicates that to

obtain best results alfalfa should be changed once in 5 years. This method results in increased yields of all grain crops.

Practically no commercial fertilizer is used in Madison County. Considerable barnyard manure is produced, but in most instances little care is taken to preserve it. On many farms the manure is piled outdoors without protection, and much of its fertilizing value is lost by leaching. The more progressive farmers haul the manure direct from the barns to the field, applying it mainly to the corn and oats land. On the tenant farms the land in the immediate vicinity of the barnyard usually receives the largest part of the manure, regardless of its needs.

With few exceptions the farm improvements are exceptionally good. The farm buildings, especially the houses, are kept painted and in good repair. Nearly all the farms are fenced and cross-fenced, mostly with barbed wire, though a few farms are inclosed with "hog-tight" woven-wire fencing. The work stock consists of medium to heavy draft horses and mules. Several tractors are in use on the more level parts of the county. The Nebraska State Board of Agriculture reports 145 gas tractors and 1,574 automobiles on farms in 1920. Modern labor-saving machinery is in general use over the entire county, most farms being equipped with manure spreaders, grain drills, mowers, rakes, binders, riding cultivators, and disk harrows, and a few in addition have corn binders and hay balers. As a rule the farm machinery is not kept under shelter.

Farm laborers are scarce. Wages[1] range from $50 to $75 a month, with board and room. Day laborers receive $3 to $4 a day, and harvest hands have been paid as high as $6 a day with board. Corn shuckers receive 8 to 9 cents a bushel. The farm laborers are all white. Many farmers hire help by the year, and in this way insure against lack of labor at critical periods.

According to the 1920 census, 87.7 per cent of the county is in farms. The farms vary considerably in size, ranging from less than 50 acres to about 2 square miles. Most of them, however, contain between 80 and 320 acres. According to the report of the Nebraska State Board of Agriculture, 236,640 acres of the farm land is under cultivation.

Of the total number of farms in Madison County, 54.1 per cent were operated by owners and 44.4 per cent by tenants in 1920. The cash system of land rental is the most common, and leases generally cover only one year. The rent varies widely, ranging from $6 to $10 per acre. Pasture rent is commonly paid in a lump sum, and the average rate per acre can not be determined. On a few farms the renter is allowed the use of the pasture land without additional charge. Under share-rent contracts, the tenant usually furnishes all equipment, labor, and seed, and receives from two-fifths to one-half of the crops.

Prices of farm land range from $100 to $350 an acre, with an average of about $150 for the county as a whole.[2] The lowest-priced land includes areas of the Valentine sand, which can be used only for grazing on account of the tendency to drift when the sod is disturbed. The highest-priced land occurs throughout the southwestern half of the county and upon the well-drained alluvial terraces along the Elkhorn River and its North Fork.

[1] The wages given apply to the season of 1920.
[2] These prices prevailed in 1920 and probably represent the peak of high prices for land.

SOILS.

The soils of Madison County have been developed under climatic conditions intermediate between those of the north-central Mississippi Valley and those of the semiarid high plains. Lacking an abundant supply of moisture the surface soils, although they have developed under a native vegetation of grasses, have not accumulated such large amounts of organic matter as the black soils farther east, nor have they been so completely leached of their carbonates within the 3-foot section. The typical surface soil, which prevails over the greater part of the upland, as seen in the undisturbed virgin soil, has a rather dark brown color and a loose or granular structure. This horizon extends to a depth ranging from 6 to 15 inches. The soil is underlain by a rather compact brown or yellowish-brown horizon having a somewhat granular structure. This layer may be very thin, or, in some areas of the heavy-subsoil phase of the Marshall silt loam, it may extend to a depth of more than 3 feet. The average depth to which it extends is 20 inches. It is underlain by pale-yellow or grayish-yellow friable parent material, which contains a high percentage of carbonates. In Madison County this group includes the soils of the Marshall series and the heavier members of the Shelby series.

Another group of soils having a characteristic profile have, in the county, been developed only on terrace and colluvial materials. The surface soil is similar in color and structure to that of the Marshall group. The upper subsoil, which extends to a depth of 20 to 30 inches, has a brown color and a rather compact granular structure. This is underlain by a more friable yellowish-brown material, which, unlike the Marshall at a corresponding depth, does not contain any large amount of carbonates. These soils show evidence of having been developed under conditions of good surface and subsoil drainage, which has favored more thorough leaching and oxidation. The soils of the Waukesha and Judson series belong to this group. The O'Neill series may also be classed with the well-drained, well-oxidized group, but the material of the lower subsoil is sandy and gravelly.

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

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

Some soils of the county have been developed under imperfect drainage conditions, and oxidation has been much retarded. The surface soils as a rule are dark colored, but the subsoils are gray or

mottled yellow and gray. In this county such soils are water-laid. The group includes the Wabash and the Cass soils in the first bottoms and the Scott and Gannett in depressions. None of these soils have retained any large amount of carbonates.

The soils of Madison County may be divided, with respect to the origin of the parent material, into three groups—glacial, loessial, and alluvial.

The glacial materials are composed of débris brought in from the north by two or more ice sheets. The exact age and the relations of the glacial materials have not been determined. It is thought, however, that the material lying upon the bedrock belongs to the Nebraska drift sheet, though no exposures have been discovered.

Exposures of a glacial sand sheet, probably resting upon the Nebraska drift, occur throughout the Elkhorn Valley and in the deeper drainage ways of the upland. The geological origin of this sheet is not clearly understood. It ranges in thickness from 0 to 62 feet, being thickest in the northeastern part of the county. In a few places the material has been little changed since its exposure and consists of a loose incoherent mass of fine to medium sand containing scattered pebbles. It ranges in color from gray to reddish brown. Over most of the area of its occurrence, weathering and the addition of organic matter have produced soils of a fine sandy loam to loamy sand texture. In many places the lighter and smaller sand particles have been whipped up and transported by the wind until they cover large areas. These wind-laid soils are entirely free from gravel and have a lighter color and finer texture. They are classed with the sands of the Valentine series.

In addition to furnishing the material for the soils of the Valentine series, the sand sheet has modified the physical characteristics of the lower lying alluvial lands. The gradual washing down of the sand and its deposition upon the terraces and flood plains has greatly influenced the texture and structure of their soils. In a few places within the Valentine soils are small depressional areas having poor drainage, which are either covered with water or decidedly wet during the greater part of each year. These areas were included with the Gannett series.

Lying unconformably upon the sand sheet is later drift, probably the Kansan. This sheet underlies the entire county, except in parts of the valley of the Elkhorn River and its larger tributaries, where it has been removed by stream erosion. It is exposed in only a few places, as most of it has been covered by colluvial wash from the uplands or by wind-laid soils from the surrounding areas. The largest exposure occurs about a mile west of Norfolk and consists of irregular masses of gravel, pebbles, and small stones, usually mixed with considerable silt, clay, and sand. In most of the area of its occurrence, however, there is a large proportion of clay and a noticeable absence of material coarser than fine gravel. The drift has seldom influenced the texture of the surface soils under which it lies, on account of the thin covering of transported material. It has, however, greatly influenced the character of the subsoil, and for this reason the soil material derived from it has been included with the Shelby series.

The loessial material is of Recent age. It rests upon the glacial drift, except where removed by erosion, as in most of the Elkhorn River Valley and along the larger creeks. It represents a remnant of a flat, gently eastward sloping plain, which, in comparatively recent geological times, covered the eastern part of Nebraska. The loessial deposit occupies the southwestern half of Madison County and also occurs in the Elkhorn Valley as isolated hills and divides that have escaped destructive erosion.

In its unweathered condition the loess is an even-textured material composed largely of very fine particles. It is characterized by a tendency to split into vertical planes producing perpendicular bluffs along water courses and roads and other places subject to erosion. The color ranges from light brown to yellowish brown. The nearest approach to the typical loess in its original condition is along the southern edge of the Elkhorn Valley and in the more eroded loess bodies within the valley. Since deposition, most of the loess material has undergone decided changes, owing to climatic influences, the accumulation of organic matter, and various physical and chemical agencies. The surface material over large areas is black, owing to the accumulation of organic matter. The dark-colored material is deeper on the smooth, level areas, which favor the accumulation and decay of vegetable material. The maximum accumulation has taken place in depressional areas on the smooth table-land; and the minimum accumulation in eroded areas of steep surface relief, where the run-off is great and the leaching of organic compounds is rapid. On the flatter areas the loessial material is characterized by a heavier and more compact layer than usual between the average depths of 1 and 4 feet. This is due to the downward leaching and concentration of the finer surface particles through the agency of percolating water in areas of restricted drainage.

The soils on the eroded parts of the loess plain, from which most of the organic material has been removed, are classed with the Knox series, and those on the more level areas, having a deep black surface soil, are classed with the Marshall series. Small basinlike depressions upon the loess plains, where the subsoils are very heavy and compact, are included with the Scott series.

The alluvial material of recent age falls into two divisions: (1) Terraces, sometimes called benches or second bottoms, and (2) first bottoms or flood plains. The terraces lie above the limits of overflow; the first bottoms are subject to flooding in many places. The original loess plain was eroded or cut through by various streams and their tributaries, creating large valleys. Subsequently these valleys were filled with sediment to the level of the highest terraces. Later intrenchment by the streams below the terrace levels and the subsequent deposition of sediment during floods has created the present flood plains. The character of the sediment deposited by the streams depended largely upon its origin and upon the depth to which the streams had cut. In the Elkhorn Valley, where the streams had reached the drift and sand sheets underlying the loess plain, the sediment was naturally of a sandy nature. The upland creeks passing through areas of loess soils carried only fine-textured silty materials. The merging of these streams carrying particles of such different sizes gave rise to soils varying in texture from coarse sands to silts. These soils, where occurring upon the well-drained terraces, have

been classified with the Waukesha and O'Neill series, and where lying within the first bottoms and subject to overflow have been included with the Wabash, Cass, and Sarpy series.

In many places throughout the uplands the lower slopes immediately bordering the flood plains and terraces are very gradual and locally have been covered with surface wash from the higher levels. The deposit is usually thickest near the edge of the alluvial lands. This material of colluvial origin has been included with the Judson series.

In the system of mapping employed by the Bureau of Soils the soils are grouped in series on the basis of common characteristics in color, structure, and origin. The series are divided into types on the basis of texture, or the relative proportion of different-sized mineral particles. Twelve series, including 23 types of soil, are recognized in Madison County.

The Marshall series, derived from loess materials, includes types with dark-brown to black surface soils and a lighter yellowish brown subsoil. It is characterized and distinguished from the lighter colored Knox series by the large quantity of organic matter in the surface soil. Two types, the Marshall very fine sandy loam and silt loam and a heavy-subsoil phase of the silt loam, are mapped in this county.

The Knox series, derived from loess materials, includes types that have typically light-brown surface soils and a yellow to grayish-yellow subsoil. The material has undergone less change in physical characteristics since deposition than that of the Marshall series. The most important change from the original loess is the darker color of the surface soil, due to oxidation and a slight accumulation of organic matter. Although this material is subject to severe erosion and leaching, it contains more lime than the Marshall soils. Only one type, the Knox silt loam, is mapped in this county.

The surface soils of types of the Shelby series are dark brown to brown; the subsoil is a yellow, reddish-yellow, or light-brown sandy clay. Three types, the Shelby loamy sand, fine sandy loam, and very fine sandy loam, are recognized in Madison County.

The Valentine series consists of types with brown to dark-brown surface soils. The subsoil differs but little from the surface soil, except that it is slightly lighter in color, owing to a lower content of organic matter. As occurring in this county, the materials are derived largely from the sand sheet underlying the Kansan drift. Wind action, however, has played an important part in their assortment and distribution. Two types, the Valentine sand and loamy sand, are mapped.

The surface soils of types of the Scott series are typically brown to black, and the subsoil is a drab to grayish heavy plastic clay. The Scott soils consist of lake-laid material, eroded from the higher lying surrounding soils and deposited by surface waters in temporary lakes or ponds occupying local sinklike depressions. The series is represented in Madison County by a single type, the Scott silt loam.

The Gannett series comprises types with dark-gray or black surface soils and a grayish or pale-yellowish subsoil. They occupy shallow poorly drained depressions in the Elkhorn River Valley. The soils differ from those of the Scott series in the sandier and less coherent nature of both soil and subsoil. Only one type, the Gannett loamy sand, is mapped.

The Judson series comprises soils of alluvial and colluvial origin. The surface soils are dark brown to almost black, and the subsoil is lighter brown. The types are found on terraces above overflow and on colluvial slopes bordering the first bottoms and terraces. The soil material is mainly wash from loess or silty drift soils. One type, the Judson silt loam, is mapped in Madison County.

The types of the Waukesha series are dark brown to brown in the surface layer and yellowish brown or brown in the subsoil. They are derived from water-assorted deposits of loessial and glacial materials and occupy the terraces along the larger streams. The soils closely resemble those of the Marshall series, but differ in position and mode of formation. Four types, the Waukesha loamy sand, fine sandy loam, very fine sandy loam, and silt loam are recognized in this county.

The O'Neill series consists of types with brown to dark-brown surface soils and a light-brown, loose, incoherent subsoil. They are the result of water deposition and occupy terraces, chiefly along the Elkhorn River. The series is represented by two types, the O'Neill fine sandy loam and loamy sand, and a light-colored phase of the O'Neill sand.

The surface soils of types of the Wabash series are dark brown to black in color and have a high content of organic matter. The subsoil is drab to grayish drab and usually heavier in texture than the surface soil. The types occupy first-bottom positions. The material has been derived by wash from the loessial and associated uplands. One type, the Wabash silt loam, occurs in Madison County.

The Cass series comprises types with dark-brown to black surface soils and a brownish-gray sandy subsoil. They occupy first-bottom positions and differ from the Wabash soils chiefly in the more sandy and less coherent nature of the subsoil. The series is represented by three types, the loamy fine sand, fine sandy loam, and very fine sandy loam.

The soils of the Sarpy series differ from the Cass soils in the light-brown to grayish-brown color of the surface soil. They differ from the Wabash soils in having a loose silty or sandy subsoil, distinctly lighter in texture than the surface soil. Owing to their low position in this county the Sarpy soils are in general rather poorly drained. The series is represented by one type, the Sarpy sand.

The table below shows the actual and relative extent of each soil type mapped in this county:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Marshall silt loam	134,400	43.7	O'Neill loamy sand	7,104	1.9
Heavy-subsoil phase	26,560		Waukesha silt loam	4,416	1.2
Valentine loamy sand	28,352	7.7	Scott silt loam	3,136	.8
Valentine sand	24,832	6.7	O'Neill sand, light-colored phase	2,816	.8
Wabash silt loam	22,720	6.2	Sarpy sand	2,432	.7
Marshall very fine sandy loam	19,328	5.2	Waukesha loamy sand	2,304	.6
Cass very fine sandy loam	15,744	4.3	Waukesha fine sandy loam	1,856	.5
Shelby loamy sand	13,888	3.8	Waukesha very fine sandy loam	1,792	.5
Cass loamy fine sand	12,224	3.3	Gannett loamy sand	1,728	.5
Shelby fine sandy loam	11,904	3.2	Judson silt loam	1,600	.4
Knox silt loam	9,920	2.7	O'Neill fine sandy loam	1,152	.3
Cass fine sandy loam	9,472	2.6			
Shelby very fine sandy loam	8,960	2.4	Total	368,640	

MARSHALL VERY FINE SANDY LOAM.

The surface soil of the Marshall very fine sandy loam is a dark-brown to brown, loose, friable very fine sandy loam, with an average depth of 10 inches. In places the soil approaches a loam in texture. The subsoil is a light-brown friable very fine sandy loam to silt loam, changing at about 18 inches into a light yellowish brown or grayish, friable clay. At an average depth of 30 inches a yellowish-gray silty clay is encountered, which continues to great depths. Lime concretions from one-eighth to one-fourth inch in diameter occur scatteringly in the lower part of the soil section and are quite numerous below the 3-foot depth. The subsoil is highly calcareous. In a few places reddish-brown iron stains are encountered below 30 inches. The surface soil is rich in organic matter. The change from soil to subsoil is very gradual, and usually there is an intermediate brownish layer from 2 to 4 inches thick between the two zones. The material of the lower subsoil and substratum has a columnar structure.

The Marshall very fine sandy loam occurs on the eroded loess plain, chiefly as a narrow strip from one-fourth to 1½ miles wide, along the northern boundary of the Marshall silt loam. A large body lies in the northeastern part of the county on the north side of the Elkhorn River. Most of the type occurs in close association with the Marshall silt loam and the finer textured types of the Shelby series. The soil is in reality Marshall silt loam, the surface material of which has been so intermixed with wind-blown sand from the Shelby and Valentine soils that it has acquired the texture of a very fine sandy loam. A few small bodies were mapped within areas of the Shelby and Valentine soils.

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

The topography of the type differs little from that of the Marshall silt loam, and is in general moderately rolling. The large area in the northeastern part of the county has a strongly rolling surface. Drainage on the type is everywhere good, and in the more steeply rolling areas is excessive in places, causing erosion to become a serious factor.

The type, though not very extensive, is an important agricultural soil in Madison County. It is naturally strong and fertile and compares very favorably with the Marshall silt loam in crop production, and can be tilled under a somewhat wider range of moisture conditions. About 80 per cent of it is under cultivation, and the remainder, including the more strongly rolling areas, is used for pasture and hay land. Of the cultivated crops, corn, wheat, oats, and alfalfa are the most important. A few farmers feed cattle during the winter, though cattle feeding is not practiced so extensively as

on the Marshall silt loam. Hogs are raised for market on every farm. The average yield per acre of corn is about 40 bushels, wheat 18 bushels, oats 25 bushels, and alfalfa 3½ to 4 tons from three cuttings. The yield of wheat is slightly lower than on the Marshall silt loam.

Land of this type is tilled in much the same manner as the silt loam. It is slightly easier to handle and can be cultivated with less power and lighter machinery.

The selling price of the Marshall very fine sandy loam ranges from $175 to $250 an acre, depending largely upon its topography, improvements, and distance from markets.

The methods for maintaining and increasing soil fertility and preventing erosion that are recommended for the Marshall silt loam will apply admirably to this type.

MARSHALL SILT LOAM.

The surface soil of the Marshall silt loam consists of a black to dark-brown moderately heavy silt loam, 6 to 15 inches deep. The typical soil is high in silt and contains a relatively small proportion of particles coarser than very fine sand. The soil is rich in organic matter, has a very smooth and velvety feel, and breaks down into a fine powder. The subsoil is a lighter brown, slightly more compact silt loam, changing below about 20 inches to a yellowish-brown silt loam with a relatively high content of clay. This either continues throughout the 3-foot section without change or becomes heavier with depth until at about 30 inches the material consists of a compact yellowish-brown silty clay faintly mottled in places with gray. At depths of 30 to 36 inches or more the subsoil frequently grades into a yellowish to brownish friable silt loam containing light-gray mottlings, reddish stains, and scattering concretions of lime. This condition becomes more pronounced in the substratum, as shown in deep road cuts. An intermediate layer occurs between the surface soil and subsoil, usually of a brownish color and from 2 to 4 inches thick. The structure of the surface soil and upper subsoil is granular, and that of the lower subsoil and substratum is columnar. The subsoil is highly calcareous.

The type as mapped includes variations, mainly in the depth of the surface soil and the texture of the subsoil. On the gradual slopes to streams the surface soil in places has a dense black color and is prevailingly deeper, often extending to 24 inches without change in color or texture. On the smoother almost flat divides the surface soil is 18 to 20 inches deep in places, and the subsoil consists of a yellowish-brown, heavy, slightly compact silty clay, which continues throughout the 3-foot section. On the sharper divides, steep slopes, and shoulders of hills the surface soil is very shallow. In these situations numerous spots, too small to indicate on the map, are almost or entirely devoid of their original surface soil, and the yellowish-brown subsoil, with its limy concretions, is exposed. The material in these spots resembles the Knox silt loam where erosion has removed the entire surface soil, and the Knox silt loam, dark-colored phase, where only a thin veneer of the surface soil remains. Some of these light-colored areas are noticeably heavier in texture than the typical soil. Along the northern border of the

type, in the vicinity of areas of the Marshall very fine sandy loam and of the Shelby soils, erosion and wind action have caused a rather intricate mixing of silt and sand particles, giving rise to areas of a loamy texture, but these are too small to show on the map. Narrow strips of colluvial material along intermittent streams are included with this type, but where of sufficient size to warrant mapping, these strips were classed as Judson silt loam.

The Marshall silt loam is the most extensive and important soil in Madison County. It is developed on the eroded loess plain and occurs as an almost continuous body covering the southwestern half of the county. Its northern boundary touches the western county line about 1 mile south of Tilden and extends in a southeasterly direction to the eastern line near Union Creek. The type does not occupy this area exclusively, but includes numerous bodies of Knox, Scott, and Judson silt loams, and Marshall silt loam, heavy-subsoil phase, within its borders. Narrow strips of alluvial soils extend in many directions throughout the region. A few small bodies of the Marshall silt loam occur on the north side of the Elkhorn River.

The topography ranges from almost flat to sharply rolling, the greater part being gently rolling. The more nearly level areas occur on the divide between Battle and Union Creeks, which is almost flat in places and has gentle slopes. The most rolling topography occurs around the heads of the larger streams in the southern part of the county and along the west side of the North Fork of Elkhorn River in the northeastern part of the county, where the surface is characterized by steep slopes and narrow crestlike divides. The surface of the rest of the type consists of broad U-shaped valleys separated by moderately wide well-rounded divides. All of the type has adequate surface and subsoil drainage. In the strongly rolling areas the drainage is excessive and erosion is a serious factor. In these localities the acreage of the Knox silt loam, which is formed by the removal of the surface soil of the Marshall silt loam, is steadily increasing.

This type was originally covered with a thick growth of prairie grasses, chief among which were big bluestem, little bluestem, grama grass, and buffalo grass. About 90 per cent of the type is under cultivation, and only the rougher areas are used for pasture and hay land. By far the greater part of the improved land is in corn, and the rest is devoted mainly to wheat, oats, and alfalfa. Small patches of millet, barley, and rye are grown on many farms for feed. The type is recognized as one of the best upland corn soils of the Mississippi Basin. Cattle raising is not practiced extensively, though the fattening of live stock is becoming a highly specialized industry. All the cattle raised locally, except a few kept for dairy purposes, are fattened for market, and in addition many animals are shipped in from Omaha for feeding. The cattle on this type are chiefly grade Herefords and Shorthorns. Hogs are raised on every farm and a few farmers have large herds. The principal breeds are Poland-China and Duroc-Jersey. All live stock intended for market is fattened on corn and alfalfa and is shipped to Omaha.

The yield of corn varies widely from year to year, depending upon the rainfall. Good yields are obtained in normal years, and in dry years the yields are probably higher than the average for eastern Nebraska on account of the moisture-retaining power of the soil. The average yield is about 40 bushels per acre, and yields of 60 to 65

bushels are common under good management. The average yield of wheat is about 20 bushels, though yields of 25 and 30 bushels are not uncommon. The acreage in wheat has been increased during the last few years on account of the pressing demand and high prices for this crop. Oats yield from 30 to 40 bushels per acre. This crop is grown for feed on nearly every farm. Alfalfa yields 3½ to 4 tons per acre from three cuttings. In exceptionally long seasons a fourth cutting is sometimes obtained. This crop is very beneficial to the land, as it adds both humus and nitrogen and also prevents destructive erosion.

Crop rotation is not systematically practiced on this type. A few farmers use a rotation consisting of corn 1 or 2 years, followed by oats or wheat 1 year and alfalfa 6 or 7 years. Many farmers grow the same grain crop continually for several years. The most improved machinery is used. On the steeper slopes the operation of heavy implements is rather difficult. Four-horse teams are used in most of the farm work. Tractors are well adapted to the more level areas and are being used on more farms each year. Most of the corn is planted in checkrows, though some of it is listed in. Wheat is usually sown in the spring, as it is often difficult to prepare the land in time for fall planting. Winter wheat, however, usually produces slightly higher yields and is grown by many farmers. Wheat is drilled in on plowed ground and double-disked on corn or stubble ground. The land to be used for oats is prepared in the same manner as for wheat. Alfalfa is sown broadcast on well-prepared stubble ground. No commercial fertilizer is used on the Marshall silt loam. Manure is applied when available, and is generally used on the more eroded areas where the surface soil is rather shallow.

Land of the Marshall silt loam sells for $175 to $250 an acre, depending upon topography, improvements and location with respect to markets.

This type is a naturally fertile soil, and every possible means should be used to keep up its present producing capacity. In the absence of an adequate supply of manure, the productiveness of the type can not be long maintained unless a leguminous crop such as alfalfa or clover is grown at least once in every four years. Where live stock is not kept in considerable numbers, clover may be plowed under as green manure the year following the season of seeding. It is good practice to plow the entire crop under when the soil is very deficient in nitrogen. The yield of winter wheat is materially increased by early plowing. Most farmers realize that thorough preparation of the seed bed for corn is superior to the method of listing the crop.

The control of erosion is important in the more steeply rolling areas of the type. With the gradual depletion of organic matter and the continued washing away of the surface material, the soil is left in a much less productive condition, and the land becomes gullied and uncultivable. The tendency to wash may be retarded by deep cultivation to facilitate the absorption of water and by having the rows, especially of listed corn, follow contour lines. Alfalfa is also very beneficial to land subject to severe erosion.

Marshall silt loam, heavy-subsoil phase.—The surface soil of the Marshall silt loam, heavy-subsoil phase, is a very dark brown to

almost black heavy silt loam 8 to 15 inches deep. It contains a relatively high percentage of clay, which gives it a more granular structure and heavier texture than usually occurs in the average silt loam. The surface 6 inches is rich in organic matter, which gives the soil its dark color. The subsoil is a grayish-brown to reddish-brown compact silty clay, which grades into a more compact silty clay or clay of reddish-yellow color. The subsoil is stiff and plastic when wet, but becomes hard and brittle upon drying. Below depths of 30 to 40 inches the subsoil is looser in structure and has a pale-yellow or reddish-yellow color, mottled in places with light gray. In a few places red mottlings occur below 24 inches. The heavy character of the subsoil is due to a concentration of clay in the second or third foot of the soil section, the clay being carried down from the surface by percolating waters. As observed in banks and road cuts the material of the first 3 feet usually has a granular structure and below that a vertical flakelike structure. The subsoil is not calcareous within the 3-foot section, but below about 4 feet it usually effervesces with dilute hydrochloric acid.

The surface soil varies considerably in depth and color, depending upon its topographic position. On the flat divides the material is a black heavy silt loam 12 to 15 inches deep. On the shoulders of hills and along gullies it is brown in color and from 6 to 8 inches deep. On the steeper slopes and along narrow crestlike divides the surface material has been entirely removed in spots, exposing the grayish-brown silty clay of the subsoil. On the lower slopes below these exposures the surface soil is usually dark in color and very deep. Within the type are narrow strips of colluvial material along the intermittent streams. The soil in these localities is a black silt loam underlain by a subsoil of much the same color and texture to depths below 3 feet. All of these variations are so small in extent that they can not be satisfactorily shown on a map of the scale used in this survey.

Small areas of the typical Marshall silt loam occur within the boundaries of this phase, but owing to the close association of the two soils and the almost imperceptible gradation from one to the other it is often impracticable to separate them, and in many places the boundary lines are arbitrarily drawn. The phase differs from the type chiefly in its subsoil, which has a darker color, usually with a decidedly reddish cast, its heavier texture, more compact structure, and a smaller amount of calcareous material within the 3-foot section. The topography as a rule is more nearly level than that of the type, and the phase is less subject to erosion.

The Marshall silt loam, heavy-subsoil phase, is extensive in this county. It occurs in numerous irregular-shaped areas throughout the southwestern half of the county. The phase is usually surrounded by the typical Marshall silt loam and occupies the higher and flatter divides within the type. The areas vary in size from a few acres to several square miles. The most typical development of the phase occurs along the southern county boundary 6 miles south of Madison. A very uniform area lies 6 miles east of Newman Grove. One of the largest and most continuous bodies occupies a part of the divide between Union and Battle Creeks. No bodies of this phase occur outside of the areas of the Marshall silt loam.

The phase has been developed in the same manner as the typical Marshall silt loam. The topography, however, has especially favored the accumulation of organic matter and the concentration of clay in the subsoil. The surface of the phase is flat to gently rolling, by far the greater part presenting an almost flat, level topography. Drainage is generally good, as there is usually sufficient slope to carry off the surplus water. In a few shallow depressions, seldom exceeding an acre in extent, water stands for a considerable period after heavy rains.

This phase is better adapted to general farming than any other upland soil, owing to its high fertility and level topography. Practically all of it is under cultivation. The principal crops are corn, wheat, oats, and alfalfa, ranking in acreage in the order named. Rye, barley, sorghum, and millet are often grown in small patches for feed. Wheat is the chief cash crop. The average yield of wheat is about 20 bushels, corn 30 bushels, oats 30 to 36 bushels, and alfalfa 3½ tons per acre from three cuttings. Cattle raising is not practiced extensively, though every farmer keeps a few cows for dairy purposes, and most farmers sell some dairy products. Hogs are raised on every farm; they are fattened on corn and shipped mostly to the Omaha market.

The soil of this phase can be handled under a rather wide range of moisture conditions, considering its heavy silty texture. The land has a tendency to clod if plowed when wet, but the lumps are easily reduced. Corn is usually planted on prepared ground, though many farmers prefer to plant with a lister. Wheat is usually drilled in on old corn or stubble ground after thorough plowing and harrowing. Most of it is winter wheat. A few farmers drill wheat between the corn rows in the fall of the year. Oats is planted in the same manner as wheat. Alfalfa is sown broadcast on well-prepared stubble ground. The stand is usually allowed to remain for six or seven years. No commercial fertilizer is used, but barnyard manure is applied to the land when available.

The selling price of land of the Marshall silt loam, heavy-subsoil phase, ranges from $200 to $250 or more an acre, depending upon improvements and location.

KNOX SILT LOAM.

The surface soil of the Knox silt loam is a light-brown or yellowish-brown mellow silt loam 4 to 7 inches deep. The material is largely composed of silt and has a smooth floury feel. It contains very little organic matter, as the color indicates. The subsoil is a grayish-yellow to very light grayish brown friable silt, which continues to great depths. White mottlings and reddish-yellow iron stains are encountered below 30 inches. Both soil and subsoil are highly calcareous, and lime concretions are common on the surface and throughout the soil section. The material has a pronounced open and columnar structure.

A few minor variations occur in the type as mapped. In local areas where erosion has been less severe the surface 2 to 6 inches is a brown to grayish-brown silt loam underlain by 2 to 4 inches of a lighter brown silt loam, which passes into the light calcareous subsoil material. These areas represent an intermediate stage between

the true Marshall and Knox soils, and if they were of sufficient size they would be mapped as Knox silt loam, dark-colored phase. In many places where erosion has been especially severe the surface soil has been entirely removed, exposing the calcareous subsoil. Some of these exposures are heavy in texture, consisting of a silty clay loam to silty clay, the heavy texture being due to the concentration of clay particles in the subsurface layer, which has been exposed by erosion.

This type may be regarded as an eroded phase of the Marshall silt loam, from which it differs mainly in having a lighter colored and shallower surface soil. When exposed to the air under conditions favorable to the accumulation of vegetable matter, the soil approaches the Marshall silt loam in physical characteristics. That type was formed by a constructive process, whereas the formation of Knox silt loam through erosion of the dark-colored surface soil is a destructive process.

Areas of the Knox silt loam are scattered throughout the areas of the Marshall silt loam and very fine sandy loam, in bodies ranging in size from a few acres to about 1 square mile, but seldom exceeding 60 acres in extent. The type is found wherever the surface soil of the Marshall silt loam has been largely or entirely removed by erosion. It occupies steep slopes, hilltops, and the sharp crests of ridges. In many places the gradation between the Marshall and Knox soils is so gradual as to be almost imperceptible, and arbitrary lines were often drawn to separate them. In general the Knox silt loam was confined to those areas having a light-colored surface soil. Drainage is excessive over all the type, and erosion is a serious factor.

Owing to its small extent, unfavorable topography, and low content of organic matter, the type is of comparatively little agricultural importance, although it is productive when well managed. About 80 per cent of it is under cultivation. The same crops are raised as on the Marshall silt loam, and fair yields are obtained. The soil is handled in the same manner as the Marshall silt loam, except that greater care is usually taken to prevent erosion and most of the manure produced on the farm is applied to this type. The supply of manure, however, is seldom sufficient for best results. Land of this type is usually held in farms with the Marshall silt loam and slightly reduces the value of the farms.

The type can be protected from washing to a greater extent than at present by plowing along contour lines and to a greater depth. The use of a larger acreage for leguminous crops, to which the soil is well adapted, would be beneficial. The type is recognized as a strong soil for small fruit. In Madison County the climate apparently limits the production of certain kinds of fruit, but fruit growing could undoubtedly be made profitable.

SHELBY LOAMY SAND.

The surface soil of the Shelby loamy sand is a brown to dark-brown loamy sand, 8 to 15 inches deep. The upper subsoil is a yellowish-brown sandy loam which grades into a reddish-brown or yellowish-brown, heavy, compact material consisting largely of sand and clay. The surface soil contains only a moderate content

of organic matter and sometimes drifts when the protective sod covering is removed. Neither soil nor subsoil is calcareous, but in places the substratum between 4 and 5 feet contains sufficient lime to effervesce with hydrochloric acid.

The type includes some variations. In many places the surface soil approaches a fine sandy loam in texture and is considerably darker in color than the typical material. Locally the subsoil consists of layers of sand or fine sand alternating with sandy clay or fine sandy clay. In a few places it consists of a compact very fine sandy clay below a depth of 12 inches, and elsewhere the material below 24 inches is a grayish fine sand. Sand pockets occur here and there throughout the type. Where these were large enough to map they were included with the Valentine soils.

The Shelby loamy sand is derived mainly from the sandy formation underlying the loess. It is usually free from gravel and bowlders but contains considerable coarse sand. The heavy nature of the subsoil is due to a concentration of the finer soil particles carried downward by leaching. The type differs from the true Shelby soils as mapped elsewhere in Nebraska. It was classed in this series, however, on account of its heavy sandy clay subsoil and the occasional exposure of the underlying drift from which the true Shelby soils are derived. The glacial drift appears to have been so extensively reworked, intermixed, and covered with sand that the soil derived from this mixture represents an intermediate stage between the true Shelby and the Valentine soils.

The type does not occupy a large total acreage, but it is the most extensive of the Shelby soils in this county. It occurs throughout the northern half of the county in numerous scattered areas, mostly of irregular outline, and ranging in size from a few acres to about 3 square miles. One of the largest bodies lies along the northern county line about 6 miles northeast of Battle Creek. A smaller body occurs around the state asylum in the northeastern part of the county. A large, somewhat irregular and not very uniform body lies 6 miles southeast of Battle Creek.

The topography of the Shelby loamy sand varies from gently undulating to rolling. The valleys are broad and shallow and the intervening divides well rounded. The uneven topography and the porous nature of the soil and subsoil afford ample surface and internal drainage, but drainage is rarely excessive.

The type is relatively unimportant among the agricultural soils of the county. About 50 per cent of it is under cultivation and the rest is used as pasture and hay land. The native vegetation consists of grama grass, bluestem, considerable sand grass, and some stipa. Corn, wheat, and oats are the most important cultivated crops, ranking in acreage in the order named. Small patches of rye, sorghum, and millet are occasionally grown. The type is not so well adapted to small grain as the heavier soils of the county on account of the open structure of the surface soil. Cattle raising is practiced extensively on this type, but very little feeding is done, the animals being shipped as feeders to the Omaha market in the fall. Dairy farming is not practiced, though most farmers sell some dairy products. Hogs are raised on every farm and are fattened on corn.

The type will support from 25 to 30 head of cattle per section, or will yield one-half to three-fourths ton of hay per acre. Yields

of the cultivated crops vary widely from year to year, depending upon the rainfall. The average yield of corn is about 18 bushels, wheat 15 bushels, and oats 20 bushels per acre.

Land intended for small grain is usually double disked in the spring, and the grain is planted with a press drill. Corn is either listed or check-planted, the latter method being used most extensively because the crop can be more easily cultivated than when listed in. No commercial fertilizer is used and manure is seldom applied to the land.

Land of the Shelby loamy sand usually sells for $120 to $150 an acre, depending upon improvements, but small bodies exceptionally well situated and improved often command as high as $200 an acre.

SHELBY FINE SANDY LOAM.

The surface soil of the Shelby fine sandy loam consists of a brown to dark-brown loose fine sandy loam, 6 to 10 inches deep. The immediate surface is rich in organic matter, which gives it its dark color. The upper subsoil is a slightly more compact fine sandy loam of somewhat lighter color and heavier texture. Below about 20 inches there is a noticeable increase in the content of clay, and the subsoil is a heavy, plastic, gritty clay of light-brown to brown color, which usually continues throughout the 3-foot section. The heavy nature of the lower subsoil is due to a concentration of clay carried down by percolation. In many places the lower subsoil is mottled with red and yellow iron stains, and locally the entire subsoil has a reddish cast.

The soil does not stand up in vertical banks as do the loess soils. Lime concretions are seldom encountered in the subsoil, but occur quite frequently below an average depth of 4 feet. On the rather flat divides and near the foot of slopes the surface soil is deeper, but on the shoulders of hills and along gullies it seldom exceeds 4 to 6 inches in depth. Within areas of the type along intermittent streams there are small strips of colluvial material.

The Shelby fine sandy loam as found in this county differs from the type as mapped elsewhere in Nebraska. It does not usually have the decidedly reddish cast in the subsoil of the true Shelby series. It also contains a much larger proportion of the finer grades of sand and a smaller proportion of gravel throughout the soil section. The type represents an intermediate stage between the true Shelby and the Valentine soils. It has been greatly modified by wind-blown sands from the adjoining types and by the sandy formation underlying the loess. In many places these sands have covered the underlying parent drift material so deeply that the heavy sandy clay subsoil is not reached within the 3-foot section. Where these areas were of sufficient size to warrant mapping they were classed with the Valentine soils. In a few places a reddish-brown loam to clay loam containing considerable coarse sand and fine gravel was encountered below 30 inches.

The Shelby fine sandy loam, which is relatively inextensive, occurs in small scattered areas throughout the northern half of the county. A typical development lies along the northern county line about 5 miles northwest of Meadow Grove. Another somewhat larger and uniform area lies about 2 miles southwest of Battle Creek. The largest area, which is not very uniform, occurs about 4 miles northeast of Battle Creek.

The topography ranges from gently rolling to almost flat. The greater part of the type occupies flat to gently undulating slopes. Drainage is everywhere good and in no place excessive. The uneven topography affords excellent surface drainage and the porous subsoil permits water to percolate freely.

Owing to its small extent the type is of only local agricultural importance. It is a good farming soil, and about 80 per cent of it is under cultivation; the rest is used for pasture and hay land. The native vegetation consists of big bluestem, little bluestem, grama grass, and small amounts of bunch grass and sand grass. Corn, wheat, and oats are the most important cultivated crops, ranking in acreage in the order named. The type is not so well adapted to wheat as some of the heavier soils on account of its loose sandy nature. Cattle raising is not practiced extensively, though every farmer has a small herd. Hogs are raised on every farm; they are fattened on corn and marketed in Omaha.

Corn yields from 20 to 50 bushels per acre, depending upon the rainfall, the average being about 25 bushels. Wheat yields 10 to 20 bushels, and oats 20 to 30 bushels per acre.

The type is handled in much the same manner as the Shelby very fine sandy loam. It can be cultivated under almost all moisture conditions without serious injury to the soil. No commercial fertilizer is used and barnyard manure is seldom applied to the land, as the soil is new and in no immediate danger of becoming exhausted.

The selling price of the Shelby fine sandy loam ranges from $125 to $200 an acre, depending upon improvements and location with respect to markets.

The table below gives the results of mechanical analyses of samples of the soil and subsoil of the Shelby fine sandy loam:

Mechanical analyses of Shelby fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
373611	Soil	0.0	1.3	4.0	31.8	18.4	30.6	13.9
373612	Subsoil	.0	.9	2.1	29.5	22.4	32.0	13.1

SHELBY VERY FINE SANDY LOAM.

The surface soil of the Shelby very fine sandy loam is a dark-brown, loose, friable very fine sandy loam, 6 to 10 inches deep. It contains a relatively large proportion of silt and very little material coarser than very fine sand. The upper surface soil is considerably darker than the lower part owing to a large amount of organic matter. The change from surface soil to subsoil is rather abrupt. The subsoil is a grayish-brown, loose, friable very fine sandy clay to very fine sandy silt, mottled with reddish-brown and white stains. Below about 20 inches the material is slightly more compact. Below a depth of 30 inches the sand content usually is larger and in many places the lower subsoil approaches a fine sandy clay in texture, and is stiff and plastic. In a few places the subsoil contains little sand and closely resembles the subsoil of the Marshall very fine sandy loam. In other places, where the type borders or lies near bodies of Valentine soils,

the subsoil is much coarser in texture, often approaching a fine sandy clay below 20 inches. Gravel or small pebbles are rarely found either in the soil or subsoil. The lower subsoil is usually calcareous, the lime being present chiefly in the form of small specks. Concretions such as occur in Marshall and Knox soils are rarely found in this type. Black iron oxide and other oxidized iron concretions are abundant in a few places below 24 inches.

Like the other types of the Shelby series in Madison County, this type varies from the typical Shelby soils. It does, however, resemble this series more closely than any other, and therefore was classed as Shelby. The type appears to have been derived in part from the Aftonian sand sheet underlying the loess and in part from the glacial drift, but the original material has been so modified that its source can not be positively determined.

The type is not extensive in this county. It occurs chiefly along the valley slopes on the south side of the Elkhorn River, with only a few small areas on the north side of the river. The areas are scattered and small, ranging in size from a few acres to about 3 square miles. One of the largest areas lies 1½ miles south of Meadow Grove. Another occurs as a narrow strip extending from Enola in a southeasterly direction for several miles. Two small bodies lie 2½ miles northeast of Madison.

The topography ranges from gently undulating to rolling, the greater part of the type having a slightly rolling surface. The valleys are broad and shallow and the divides well rounded. The gently rolling surface and the porous nature of the subsoil afford ample surface and internal drainage.

Owing to its small extent the type is of little agricultural importance. It ranks favorably with the best upland soils of the county for general crop production, and practically all of it is under cultivation. The principal crops, named in order of their acreage, are corn, wheat, oats, and alfalfa. Crop yields vary greatly from year to year, depending upon the rainfall. The average yield of wheat is about 20 bushels; corn, 25 bushels; oats, 25 bushels; and alfalfa, 3 tons per acre, from 3 cuttings. Small patches of millet, sorghum, and rye are often planted for feed. Potatoes are grown for home consumption. Wheat is the chief cash crop. Hogs are raised on nearly every farm, but cattle raising is not practiced extensively.

Most of the wheat is spring wheat. The land is prepared as early in the spring as possible. Old corn or stubble ground is double disked, and the grain sown with a press drill. A few farmers drill in winter wheat between the corn rows in the fall of the year. Oats are sown in the same manner as spring wheat. Corn is usually check planted, though many farmers prefer listing, as they believe the crop withstands a drought better when planted in this way. Alfalfa is sown broadcast on double-disked and leveled stubble ground, and is usually harrowed in. No commercial fertilizer is used, and barnyard manure is seldom applied, as the land is new and in no immediate danger of becoming exhausted.

Land of the Shelby very fine sandy loam sells for $175 to $220 an acre, depending upon improvements and location.

VALENTINE SAND.

The surface soil of the Valentine sand consists of a loose, incoherent, gray to grayish-brown sand, 10 to 14 inches deep. The upper layer of 4 inches is usually somewhat darker than the lower part, owing to organic matter, but the content is not sufficient to prevent the soil from drifting when the protective vegetation is removed. The subsoil is a gray, loose, incoherent sand which extends to depths below 3 feet. It is practically devoid of organic matter. Both soil and subsoil are noncalcareous. In a few places small pebbles are scattered on the surface of the type. In local areas the soil contains enough organic matter to approach a loamy sand in texture, but most of these areas were too small to warrant mapping.

The Valentine sand occurs quite extensively in the eastern and northern parts of the county. The largest area, containing about 14 square miles, extends from Enola northward to beyond Warnerville and northwestward to within a few miles of Battle Creek. This area is very irregular in outline, but is fairly uniform in texture. A smaller area lies about 2 miles northeast of Warnerville. Several large areas of this soil are mapped on the north side of the Elkhorn River. On these areas small gravel is scattered over the surface here and there.

The Valentine sand is derived in part from the sand sheet underlying the loess and in part from sands blown from the surrounding types. The original material has been reworked to such an extent that it is difficult to determine its origin definitely.

The topography varies from almost flat to gently rolling, but the greater part of the type has a gently undulating surface modified by occasional low rounded knolls and ridges. Drainage is everywhere good and in many places excessive. There is very little run-off, as the porous sand absorbs the water as fast as it accumulates.

The Valentine sand is of little value for crop production on account of its low content of organic matter and low water-retaining capacity, and the danger of drifting when the native sod is destroyed. A few of the more favorably situated areas are used in the production of corn, but the yields are usually low except in the most favorable years. Most of the land retains its original covering of grasses and is used for cattle grazing and hay production. The native vegetation consists of sand grass, stipa, big and little bluestem, and some grama grass. These grasses will support from 200 to 300 head of cattle per square mile during the grazing season from about June 1 to October 1, or will yield from 350 to 500 tons of hay per section, depending upon the rainfall. Most of the cattle are raised on the ranches and shipped as feeders to Omaha when 2 or 3 years old. A few ranchers ship in cattle for summer grazing. Grade Hereford and Shorthorn are the principal breeds. Dairying is not practiced extensively, although every ranch is well supplied with dairy products and many farmers sell butter and cream in the local markets.

Land of the Valentine sand sells for $50 to $100 an acre. The price depends largely upon the improvements, topography, and location of the land with respect to markets.

It is extremely doubtful if this soil should be used for crop production on account of its low water-retaining capacity and the danger of drifting when its native sod is destroyed.

VALENTINE LOAMY SAND.

The surface soil of the Valentine loamy sand is a brown to light-brown loamy sand 8 to 15 inches deep. It is largely composed of fine and medium grades of sand with barely sufficient organic matter to give it a loamy texture. The subsoil consists of a gray, loose, incoherent sand, which continues to great depths with little change in color or texture. Neither soil nor subsoil is calcareous. The depth and color of the surface soil varies considerably with topographic position. On the flatter areas, where conditions have favored the accumulation of organic matter, the soil is in places a dark-brown, loamy fine sand 12 to 15 inches deep. On the low ridges and knolls the soil is very shallow and low in organic matter. In a few places small waterworn pebbles are scattered over the surface. The soil differs from the Valentine sand only in the larger humus content and darker color of the surface material.

The type occurs chiefly in the eastern and northern parts of the county in irregular-shaped areas varying in size from a few acres to several square miles. One of the largest and most typical developments occurs about 4 miles northeast of Enola. Another area of about 7 square miles lies southeast of Meadow Grove on the west side of Battle Creek. A much smaller though very uniform body lies in the vicinity of Warnerville and another 2 miles south of this town. Other areas occur north of Elkhorn River in the north-central part of the county.

The origin of the Valentine loamy sand is difficult to determine. It probably represents material derived originally from the sand sheet underlying the plains loess. It has, however, 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 surface is flat to gently undulating, broken by small ridges and knolls composed of nearly pure sand. Surface drainage has not been established, as the rainfall readily sinks into the porous sand and there is practically no run-off.

Owing to its small extent and low content of organic matter the type is of little agricultural importance. Unless carefully managed the soil blows badly when the protective covering of grasses is removed. The native vegetation consists largely of sand grasses, needle grass, grama grass, and bluestem. Most of the type is used for grazing and hay land, and about 30 per cent is used in the production of grain crops. Corn ranks first in acreage, followed by oats, wheat, alfalfa, and potatoes.

Yields of all crops are somewhat lower than those produced on the heavier soils, on account of the loose incoherent nature of the type and its low organic content. Corn yields about 20 bushels per acre; oats from 18 to 20 bushels; wheat, 15 to 18 bushels; potatoes, 100 to 150 bushels; and alfalfa, 2½ to 3 tons from three cuttings.

The low lime content of the soil greatly shortens the life of the alfalfa plant, and the stand usually dies down or becomes very thin after 2 or 3 years. Nevertheless alfalfa is an excellent crop for this soil, as it prevents drifting and adds nitrogen and organic matter. The native grasses on virgin areas of this type will support from 150 to 200 head of cattle per section during the summer grazing season, or will yield one-half to three-fourths ton of hay per acre.

The soil is easy to handle and can be cultivated under almost all moisture conditions without injury. Great care must be exercised, however, to prevent drifting, and the land should not be left longer than is absolutely necessary without a protection of vegetation.

The selling price of the Valentine loamy sand ranges from $75 to $150 an acre, depending upon improvements, location with respect to markets, and adaptability to grain crops.

SCOTT SILT LOAM.

The surface soil of the Scott silt loam is a very dark brown to black heavy silt loam 6 to 12 inches deep. It contains a relatively large proportion of clay, and in a few of the more poorly drained areas it approaches a silty clay in texture. The upper subsoil is a black heavy clay to an average depth of 18 inches. Between this depth and 24 inches the material gradually becomes lighter, but below 24 inches it is a dark-gray to slate-colored, heavy, stiff and compact clay. When dry the lower subsoil has a decidedly grayish cast. Rusty-brown mottlings occur in places below 30 inches. The change in color throughout the soil section is very gradual. The material usually is not calcareous within 3 feet of the surface, though in a few places the lower subsoil is a less compact gray silty clay which is highly calcareous. Locally a layer of ashy-gray silt, 2 to 4 inches thick, is encountered between the surface silt loam and the heavy clay of the subsoil.

The type occupies small basinlike depressions, locally known as "buffalo wallows," in the areas of Marshall soils. The basins are few in number and scattered, and seldom exceed 30 acres in extent. The drainage is poor, and in the spring after heavy rains water stands on the surface for periods of a few days to several weeks.

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

Owing to its small extent and poor drainage the type is not used for crop production. The native vegetation consists of sedges and other water-loving plants, with prairie grasses along the borders of the areas. Most of the type is used for grazing land. Some wild hay is cut.

This type has no separate selling value, as it usually occupies only a small part of the farms on which it occurs. Its presence tends to lower slightly the general value of the land.

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

GANNETT LOAMY SAND.

The surface soil of the Gannett loamy sand is 8 to 12 inches deep, dark brown to dark grayish brown in color, and composed of medium, fine, and very fine sand and a relatively large proportion of well-decayed organic matter. The color and structure of the soil vary with the organic content. Where conditions for plant growth

and decay have been most favorable the soil is jet black in color, spongy in structure, and noticeably light in weight. In a few places the organic content is so high that the soil resembles muck. The subsoil is a gray to light grayish brown, incoherent fine sand, relatively low in organic matter and lacking the porous, compressible structure of the surface soil. It continues to great depths. In a few places where drainage is exceptionally poor a thin layer of dark-gray sandy clay is encountered below 30 inches. Both soil and subsoil are usually calcareous.

The Gannett loamy sand occurs chiefly in the east-central part of the county on the south side of the Elkhorn River. The areas are scattered and small, seldom exceeding 300 acres in size. They commonly occur as basinlike depressions within areas of the Valentine soils. One of the largest areas, situated about 2½ miles northeast of Enola, is elongated in outline and varies in width from about 20 rods to one-half mile. The remaining areas contain from 10 to 80 acres.

The type is largely derived from the same material as the Valentine soils, modified by the growth and decay of vegetation. A shallow water table, permitting the heavy meadow grasses to make a rank growth, is characteristic of the type. The topography is flat to very gently undulating, and the drainage in most of the areas is poor, the lower ones in many places being occupied by shallow lakes or marshes.

Owing to its small extent and poor drainage the soil is of little agricultural importance. All of it is used for pasture and hay land. The native grasses will support one cow or horse per acre when grazed during the summer season, or will yield about 1 ton of hay per acre. The hay produced on the type is somewhat coarse and does not command so high a price as that obtained from most of the upland soils, but its greater yield in large measure offsets its lower value. Most of the hay is fed on the farms where produced; some is baled and shipped to outside markets.

The selling price of the Gannett loamy sand is difficult to determine, as the soil forms only a small proportion of a farm. It tends to lower the general value of the farm on account of its poor drainage.

JUDSON SILT LOAM.

The surface soil of the Judson silt loam consists of a very dark brown to dense black friable silt loam 12 to 18 inches deep. The subsoil is much the same in color and texture, but usually slightly more compact than the surface soil. In many places a thin surface layer contains a large proportion of very fine sand, and a few areas have a very fine sandy loam texture. The greater part of the type, however, is either a silt loam or carries but little more very fine sand than called for by the standards of this class. Both soil and subsoil are rich in organic matter, which gives the dark color existing throughout the 3-foot profile. The slightly heavier nature of the subsoil is due to a downward leaching and concentration of the finer soil particles. The material is usually noncalcareous throughout the soil section, but in a few places a light-gray highly calcareous silt or silty clay is encountered below 30 inches. Locally the subsoil is slightly lighter in color than the surface soil, being a brown to light-brown friable silt loam.

The Judson silt loam occurs in small scattered bodies bordering the bottom lands throughout the areas of the Marshall soils. The bodies are usually elongated in shape and seldom exceed 100 acres in extent. One of the most typical developments is a small area on the south side of Union Creek about 3½ miles northwest of Rising Sun School. Many other areas occur bordering the bottom lands along Union and Battle Creeks and their tributaries.

The type represents colluvial silt recently washed down from the adjoining uplands and deposited at the foot of the more gradual valley slopes. The surface is flat, with a gentle slope toward the main drainage channel. In a few places the surface is almost level, and the land has a terrace form, but sufficient time has not elapsed to develop the distinctly lighter colored subsoil so characteristic of the alluvial terraces. The gentle slope and the porous nature of the soil and subsoil afford ample surface and internal drainage. The type is retentive of moisture, and crops seldom suffer from drought.

The Judson silt loam is one of the most productive soils of the region, but it is of little agricultural importance in this county, because of its small extent. All of it is under cultivation, and any crop common to the region can be successfully grown. Corn, wheat, oats, alfalfa, and potatoes are the chief crops. The yields are about the same as on the Marshall silt loam, and the soil is handled in much the same manner as that type. Commercial fertilizer and barnyard manure are not used, and continued cropping does not appear to reduce the productive power of the soil. The colluvial wash from the adjoining uplands tends to prevent the soil from becoming exhausted. A definite selling price can not be stated, as this soil seldom constitutes more than a small part of the farms on which it occurs. Its presence tends to raise the general value of the farms.

WAUKESHA LOAMY SAND.

The surface soil of the Waukesha loamy sand is a brown to dark-brown fine to medium sand 8 to 10 inches deep. It contains an abundance of organic matter, which gives it its dark color and loamy character. The soil is loose and rather incoherent, considering its high content of organic matter, and is locally subject to drifting when left without vegetative protection. The subsoil to an average depth of 20 inches is a dark-brown sandy loam with a relatively high content of clay. Between 20 and 30 inches a heavy, compact, brown to grayish-brown sandy clay is encountered, but below 30 inches the material is more friable in structure, being a grayish to yellowish-brown heavy sandy loam. The subsoil usually is not calcareous, although lime concretions are present here and there below the 30-inch level and are quite numerous in the substratum. Locally the compact subsoil layer is absent, and the material is a heavy sandy loam to sandy clay loam below 10 inches. The type differs from the O'Neill loamy sand in having a heavier and more clayey subsoil.

The Waukesha loamy sand occurs in a few small scattered areas upon the terraces of the Elkhorn River. The largest area, containing about 800 acres, lies 5½ miles east of Battle Creek. A small typical development occurs in the vicinity of Meadow Grove. Very little

of the type is mapped on the north side of the Elkhorn River. The soil represents alluvial material carried down and deposited by the river when it was flowing at a higher level.

The topography is flat to gently undulating. The relief, though moderate, is more pronounced on this type than on the heavier types of the Waukesha series. In a few places, where the soil has been exposed for a considerable period without protection, low rounded hummocks and shallow blow-outs occur. Drainage is everywhere good. Surface channels are not well established, as the porous soil and subsoil absorb the rainfall as fast as it accumulates.

Owing to its small extent the type is of very little agricultural importance in this county. It is a productive soil, and practically all of it is under cultivation. The same crops are grown as upon the heavier members of the series. The type is not well adapted to small grains, and yields are usually somewhat lower than upon the heavier soils because of the loose and rather incoherent nature of the surface soil and the difficulty encountered in preparing a compact seed bed.

Land of the Waukesha loamy sand sells for $150 to $200 an acre, depending upon improvements and location.

The main factor in handling this soil is to prevent the removal of the organic matter by the wind. Hay crops like alfalfa and clover are very beneficial, as they prevent wind erosion and enrich the soil with organic matter and nitrogen. Corn should be listed in between ridges running perpendicular to the direction of the prevailing winds. In planting small grain, the soil should not be disturbed until seeding time.

WAUKESHA FINE SANDY LOAM.

The surface soil of the Waukesha fine sandy loam is a dark-brown, loose, friable fine sandy loam 8 to 10 inches deep. It is rich in organic matter and under natural field conditions is almost black. The subsoil is a brown sandy clay to an average depth of 20 inches, underlain by a heavy compact sandy clay of yellowish-brown color which usually continues to a depth greater than 3 feet. In many localities, however, the subsoil is less compact below 30 inches and slightly lighter in color than typical. The surface soil and upper subsoil are not calcareous. Lime concretions are encountered here and there below 30 inches, and the substratum is rich in lime.

The type occurs in a few small areas on the terraces formed by the Elkhorn River in the northwestern part of the county. The largest area lies around Meadow Grove on the south side of the river. A smaller area lies about 3 miles east of this town. The total area of the type does not exceed 3 square miles.

The topography is flat to very gently undulating, and the drainage is everywhere good. Surface channels are not well established, but internal drainage is excellent.

The type is of little agricultural importance in Madison County on account of its small extent. It is a very strong, fertile soil, and practically all of it is under cultivation. It is adapted to all crops common to the region. Corn, wheat, oats, and alfalfa are grown chiefly. Cattle feeding is practiced by a few, and every farmer raises hogs for market.

Crop yields vary greatly from year to year, depending upon the rainfall. The average yield of corn for a period of several years is about 35 bushels, wheat 18 bushels, oats 30 bushels, and alfalfa 3 to 3½ tons per acre from three cuttings. The type is not considered so well adapted to small grain as the heavier terrace soils on account of the loose, porous nature of the surface soil, which prevents the preparation of a compact seed bed.

The soil is handled in much the same manner as the Marshall silt loam, but it can be cultivated under a wider range of moisture conditions and with lighter machinery and draft animals. Commercial fertilizer is not used and barnyard manure is applied only occasionally. Crop rotation is not systematically practiced. The more progressive farmers are planting more alfalfa each year, raising more live stock, and applying manure to the land in an effort to maintain the high producing power of the soil.

Land of the Waukesha fine sandy loam sells for $250 to $275 an acre, depending largely upon improvements. A few farms in the immediate vicinity of Meadow Grove may command $300 or more an acre.

WAUKESHA VERY FINE SANDY LOAM.

The surface soil of the Waukesha very fine sandy loam is a dark-brown, loose, friable very fine sandy loam, 8 to 12 inches deep. It contains a large proportion of decayed organic matter, which gives it its dark color and mellow structure. The subsoil is quite variable in texture. Over most of the type it is a light-brown, mellow, very fine sandy loam to an average depth of 18 inches. Below this depth the material gradually becomes heavier in texture, grading at about 24 inches into a yellowish-brown, stiff, compact sandy clay, which continues to a depth of 3 feet or more. The subsoil is usually non-calcareous. In a few places the heavy sandy clay of the lower subsoil does not extend below 30 inches, and the substratum is a light-gray, relatively loose and friable, calcareous sandy clay.

Throughout two small areas, one of which lies within the town of Battle Creek and the other about 2 miles east of Madison, the subsoil contains little or no sand and resembles the subsoil of the Waukesha silt loam. Below 30 inches the material becomes more friable and the substratum consists of a mottled gray and yellow heavy silt loam. The subsoil in these areas is strongly calcareous below 24 inches.

The Waukesha very fine sandy loam occurs in scattered areas on the terraces bordering Union Creek, Battle Creek, and Elkhorn River. One area, containing about 3 square miles, lies in the vicinity of Battle Creek. Most of the other areas do not exceed 200 acres.

The type represents old alluvial material deposited by streams when they were flowing at higher levels. Subsequent deepening of the channels has left the deposits as terraces. The topography is flat, usually with a gentle slope toward the streams. Drainage is generally good. The surface of the type lies from 10 to 15 feet above the stream channels and from 3 to 4 feet above the present flood plains. In a few places the slope is insufficient to carry off the surplus water during periods of heavy rainfall, but the underdrainage is usually adequate and water seldom stands on the type longer than a few hours.

Owing to its small extent the Waukesha very fine sandy loam is of little agricultural importance in this county. It is a very productive soil. About 90 per cent of it is under cultivation, and the rest, including the poorly drained areas, is used for hay land. The native grasses consist of grama grass, buffalo grass, bluestem, and some slender wheat grass. All cultivated crops common to the region can be successfully grown. Corn, wheat, oats, and alfalfa rank in acreage in the order named. Hog raising is practiced quite extensively. Many farmers feed cattle during the winter months.

The yields of crops and the methods of handling the soil are about the same as on the Waukesha silt loam. On account of its higher sand content the type can be cultivated without impairing its physical condition under a somewhat wider range of moisture conditions.

Land of the Waukesha very fine sandy loam sells for $200 to $300 an acre, depending largely upon improvements, drainage, and nearness to markets. The higher priced land is in the immediate vicinity of Battle Creek, and some farms may bring considerably more than $300 an acre in this locality.

The table below gives the results of mechanical analyses of samples of the soil and subsoil of the Waukesha very fine sandy loam:

Mechanical analyses of Waukesha very fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
373631	Soil	0.0	0.0	1.4	30.5	34.2	23.5	10.4
373632	Subsoil	.0	1.4	3.2	49.5	15.8	19.8	10.3

WAUKESHA SILT LOAM.

The surface soil of the Waukesha silt loam consists of a very dark brown to black mellow silt loam 10 to 15 inches deep. It usually contains an unusually high percentage of very fine sand, and possibly small areas of Waukesha very fine sandy loam are included with this type as mapped. The material is rich in organic matter which gives it its dark color. The upper subsoil is a light-brown to yellowish-brown heavy silt loam, which extends to an average depth of 20 inches. This is underlain by 10 or 12 inches of a brownish-yellow compact silty clay loam. Below 30 inches this layer usually gives way to a more friable substratum mottled gray and yellow, which extends with little change in color or texture to depths of 10 or 12 feet. The compact intermediate layer in the subsoil is formed by the downward translocation of the finer clay particles from the surface material by the action of percolating water. The surface soil and upper subsoil are not calcareous, but lime concretions are usually encountered below 30 inches. The soil has a structure similar to that of loess, but it is somewhat heavier, and the subsurface layer is more compact. The deeper cuts along the slopes show a profile similar in color and structure to that of the loess underlying the upland.

The Waukesha silt loam occurs in a few scattered areas upon terraces bordering the larger streams. The largest development,

containing about 2 square miles, lies along the south side of Battle Creek in T. 22 N., R. 3 W. A much smaller but very uniform area lies along the west side of the North Fork of Elkhorn River in the northeastern part of the county. The texture of the large area north of the Elkhorn River in the extreme northwestern part of the county is very ununiform and represents a condition intermediate between the Waukesha silt loam and very fine sandy loam.

The type is derived from material deposited by streams when they were flowing at higher levels. The topography of the type is smooth, with a gentle slope down the valley and toward the stream. Drainage is good. The surface lies from 10 to 15 feet above the first bottoms and is not subject to overflow. Owing to its high organic content and friable structure the soil is retentive of moisture and withstands drought well.

The type is a naturally fertile soil, and where it occurs in large bodies it is very important agriculturally. It was originally in prairie sod and supported the same grasses as the Marshall silt loam. Approximately 90 per cent of the type is under cultivation, and the rest is used for pasture. All crops common to the region can be successfully grown. Corn, wheat, oats, and alfalfa rank in acreage in the order named. The average yield of corn is about 40 bushels; wheat, 20 bushels; oats, 30 to 40 bushels; and alfalfa, 3½ to 4 tons per acre from 3 cuttings. Dairying is practiced in a small way on a few farms. The milk cows are mostly grade Herefords and Shorthorns, though a few farmers have grade Holstein herds. The cream and butter are usually shipped to Norfolk. Hog raising is practiced quite extensively, and many farmers feed cattle during the winter. Most of the stock to be fed is shipped in from Omaha.

The Waukesha silt loam is handled in much the same manner as the Marshall silt loam. No definite crop rotation is practiced. The general tendency is to grow less corn, more wheat and alfalfa, and to keep more live stock.

The selling price of the Waukesha silt loam ranges from $200 to $275 an acre, depending largely upon improvements.

O'NEILL SAND, LIGHT-COLORED PHASE.

The surface soil of the O'Neill sand, light-colored phase, is a light-brown to brown, loose, incoherent sand 8 to 10 inches deep. In the upper 6 inches it is slightly darker than in the lower part owing to the presence of a little organic matter, but it does not contain enough organic material to prevent the soil from drifting when left bare. The sand consists of about equal parts of the medium, fine, and very fine grades. The upper subsoil is a light grayish brown medium sand containing traces of organic matter. Below 18 inches no organic matter is apparent, and the subsoil is a loose, incoherent, gray sand, which extends below the 3-foot section. The sand below 20 inches is usually considerably coarser than that of the surface soil and upper subsoil. Both soil and subsoil are noncalcareous. The phase differs from the O'Neill loamy sand chiefly in the lower content of organic matter and lighter color of the surface soil. It represents a terrace equivalent of the Sarpy sand.

This phase occurs in small scattered areas upon the terraces bordering the Elkhorn River flood plain, most of it being on the south side

of the river. The largest area occurs west of Meadow Grove. A smaller area lies 4 miles east of Battle Creek, and another is mapped along the eastern county line in sec. 25, T. 24 N., R. 1 W. The phase is composed largely of alluvial sands deposited on a former flood plain, which has been left as a terrace by the subsequent deepening of the channel.

The topography is flat to very gently undulating, modified in a few places by low rounded sand hummocks and ridges. There is a gradual slope down the valley and toward the river. Both surface and internal drainage are good, the latter being excessive in places on account of the porous nature of the subsoil. Crops sometimes suffer during prolonged droughts.

This phase is not an important cropping soil on account of its low moisture-holding capacity and tendency to drift when not carefully managed. About 40 per cent of it is under cultivation and the rest is used for pasture and hay land. The native vegetation consists of sand grasses, grama grass, and bluestem. Corn is the chief cultivated crop. Very little small grain is grown on this soil on account of the injury sustained by the young plants during dry windy weather. Watermelons and muskmelons are raised on a few farms. The soil seems well adapted to these crops during years of normal rainfall, but in dry seasons the soil moisture is insufficient for best results. Areas not under cultivation are used for grazing beef cattle. Hereford and Shorthorn are the principal breeds. Most of the cattle are native, though a few ranchers ship in stock for summer grazing. Cattle feeding is not practiced extensively, although a few farmers fatten one or two carloads each winter. Hogs are raised on nearly every farm; they are fattened on corn and shipped to the Omaha market.

The grasses on this soil will support 200 to 300 head of cattle per square mile during the summer season, or will yield 300 to 400 tons of hay, depending upon the rainfall. Corn yields 18 to 20 bushels per acre. During dry years the grain sometimes fails to mature.

The selling price of this land ranges from $75 to $200 an acre, depending upon improvements, location, and adaptability to farm crops.

The main factor in handling this soil is to prevent wind erosion and increase the water-holding capacity through the addition of organic matter. The plowing under of heavy vegetation, large applications of manure, and careful tillage should greatly increase the productiveness of the type. It is not advisable to bring more of this soil under cultivation unless it is to be very carefully managed, for careless cultivation soon exhausts the low content of organic matter and causes the soil to drift badly.

O'NEILL LOAMY SAND.

The surface soil of the O'Neill loamy sand is a brown to grayish-brown loose loamy sand, 8 to 12 inches deep. The material consists largely of fine and medium sand, but carries sufficient organic matter to give the soil its dark color and loamy character. Usually there is not enough silt and clay to prevent drifting when the sod is destroyed and the soil left unprotected. A few small pebbles are scattered upon the surface in places. The upper subsoil in this county differs

little from the surface soil. Below 20 inches the subsoil gradually becomes lighter in color and looser in structure, and below 30 inches it is a loose, incoherent, gray to grayish-brown sand containing little or no organic matter. The type is noncalcareous throughout. In a few places the subsoil below 12 inches is composed of nearly pure gray sand, and in local spots the surface soil has been entirely removed by the wind, exposing the sand of the subsoil. Where these areas were of sufficient size, they were mapped as O'Neill sand, light-colored phase.

This type does not occupy a large total area, although it is the most extensive terrace type in the county. It occurs chiefly on the benches bordering the first bottoms of the Elkhorn River, most of it south of the river. The largest area, containing about 4 square miles, lies between Warnerville and the eastern county line. This body is not uniform, but includes numerous areas of other types within its borders. A smaller but uniform body lies about 3 miles east of Battle Creek. Small patches lie in the vicinity of Tilden, Meadow Grove, Enola, and Norfolk.

The surface of the type varies from flat to gently undulating, with a gradual slope down the valleys and toward the stream channels. Drainage is everywhere good and in a few places excessive, owing to the porous nature of the subsoil. Local spots are somewhat droughty.

The O'Neill loamy sand is not considered an important agricultural soil on account of its loose and rather incoherent structure, somewhat droughty nature, and tendency to drift. About one-half its area is used for crop production and the rest for grazing and the cutting of wild hay. The native vegetation consists of grama grass, bluestem, sand grasses, and stipa or needle grass. Corn is the principal cultivated crop. Oats, wheat, and alfalfa are planted less extensively. Melons are grown for sale and home consumption on a few farms. Melon growing is becoming more important, as the numerous towns in the county afford excellent markets. Small grain does not do so well as on the heavier soils. The roots sometimes become exposed during dry windy weather and the crops suffer from lack of moisture. The grazing of beef cattle is practiced rather extensively. Most of the stock is native, though a few farmers ship in cattle for summer grazing. The cattle are chiefly grade Herefords and Shorthorns.

Native hay yields from one-half to three-fourths ton per acre. When used for grazing the land will support 200 to 250 head of cattle per square mile. The yields of cultivated crops vary widely from year to year, depending largely upon the rainfall. The average yield of corn is about 20 bushels; oats, 18 bushels; wheat, 12 bushels; and alfalfa, 2½ to 3 tons from three cuttings.

The selling price of the O'Neill loamy sand ranges from $75 to $150 an acre, depending upon location and improvements.

In handling this soil the chief problems are the prevention of wind erosion, the maintenance and increase of the supply of organic matter, and the conservation of soil moisture. It is doubtful if any more of this type should be brought under cultivation. The land already in use for crop production should not be left without a cover of vegetation longer than is absolutely necessary. Corn should be

listed in, as this method aids in conserving moisture and reduces the danger of drifting. Liberal applications of barnyard manure, besides its direct influence on crops, would prove beneficial in stabilizing the soil and increasing its water-holding capacity.

O'NEILL FINE SANDY LOAM.

The surface soil of the O'Neill fine sandy loam is a dark-brown, loose, friable fine sandy loam, 8 to 12 inches deep. Usually it contains a relatively high percentage of very fine sand and medium sand and a low percentage of silt. In a few places the sandy material predominates and the soil approaches a loamy fine sand in texture. The surface material is rich in organic matter, which gives it its dark color. The upper subsoil is a grayish-brown, loose, rather incoherent loamy fine sand to sandy loam. At a depth of 20 inches the material changes rather abruptly to a loose, incoherent, gray to yellowish-brown sand, which continues to depths below 3 feet. Neither the soil nor the subsoil is calcareous. The type differs from the Waukesha fine sandy loam in having a sandier and less coherent subsoil.

In a few places the pure sand of the lower subsoil lies immediately below the surface soil, and coarse sand and small gravel occur below 30 inches. In other places the gray sand is not reached within the 3-foot section, the entire subsoil being a loose and rather incoherent loamy fine sand to sandy loam. These variations are of small extent and scattered occurrence and could not be shown on the map.

The O'Neill fine sandy loam in Madison County has a total area of less than 2 square miles. It occurs in small scattered areas upon the terraces bordering the Elkhorn River in the northern part of the county. The largest development, containing about 320 acres, lies 1½ miles southeast of Battle Creek. Two smaller areas lie about 1½ miles southeast of Meadow Grove, and another occurs along Spring Creek in the northeastern part of the county.

The topography is flat to very gently undulating. Drainage is everywhere good, as the slope is usually sufficient to carry off surplus water and the porous material affords excellent internal drainage.

Owing to its small extent, the type is of little agricultural importance. It is droughty during protracted dry spells, and most of it is used for pasture and hay land. The native vegetation consists of grama grass, buffalo grass, bluestem, and some sand grass and stipa. About 30 per cent of the type is under cultivation. Corn, wheat, and oats are the principal crops, ranking in acreage in the order named. The average yield of corn is about 20 bushels; wheat, 12 bushels, and oats, 15 bushels per acre. Native hay yields one-half to three-fourths ton per acre. The grasses will support from 300 to 350 head of cattle per square mile during the summer grazing season. Most of the stock is raised on the farms, though some beef cattle are shipped in, pastured during the open season, and sold in the fall as feeders.

The selling price of the O'Neill fine sandy loam ranges from $100 to $175 an acre, depending upon improvements and location.

WABASH SILT LOAM.

The surface soil of the Wabash silt loam consists of a very dark brown to black heavy silt loam, 10 to 15 inches deep. It contains

large quantities of organic matter, and in a few places a relatively large percentage of very fine sand. The upper subsoil is a brown to dark grayish brown, heavy, slightly compact silty clay. Below about 24 inches it changes to a brown or brownish-drab silty clay, which continues throughout the 3-foot section. Rust-colored mottlings are usually encountered below 30 inches.

The type as mapped includes several variations which are irregular in occurrence and not conspicuous or extensive enough to warrant separate mapping. In many places the material shows no appreciable difference in color or texture throughout the 3-foot profile. Along Shell Creek, near the western boundary in the southwestern part of the county, the subsoil below 30 inches is a gray silt or silty clay similar to the lower subsoil of the Waukesha series. Where this light-colored material is encountered above the 24-inch depth the soil is mapped with the Waukesha silt loam. Throughout the type there are small areas with a typical surface soil underlain at 20 to 25 inches by a heavy, plastic silty clay to clay. In these areas the material below 30 inches in many places has a bluish cast. In another variation the material below 20 inches consists of alternating layers of silty very fine sandy loam and clay, usually grayish brown in color. Where the heavy material predominates the soil is classed with the Wabash series, and where there is a predominance of the light-textured strata it is included with the Cass series.

The most important variation in the surface soil of this type occurs in the vicinity of Norfolk, where in many places the percentage of very fine sand is so high that the soil approaches a very fine sandy loam in texture. In a few small scattered areas, seldom exceeding 1 acre in extent, the surface soil is a gray or ashy-gray heavy silt loam underlain by a black to drab heavy plastic clay. The immediate surface dries into a hard white crust. Such areas are locally referred to as "buffalo wallows" or "alkali spots." They usually occupy poorly drained situations and, if they were of sufficient size to warrant mapping, would be included with the Scott silt loam. The yield of crops on these areas is much below the average for the type, although there are no total failures. Corn is especially susceptible to injury. Oats make a rank growth at the expense of grain. The accumulation of salts in the surface soil is due to the rise and subsequent evaporation of soil water carrying these salts in solution. In a few poorly drained situations where there is considerable seepage from the upland there is a peaty covering a few inches deep over the silt loam.

The Wabash silt loam is quite extensive along Battle, Union and Shell Creeks, and is one of the most important types along the North Fork of Elkhorn River. It is also mapped along many of the tributaries leading to these streams. It is not extensive along the Elkhorn River, as most of the soils there are sandy. The material composing the type is of alluvial origin, having been washed from the adjoining uplands and deposited upon the present flood plains. The decay of the rank vegetation developed under moist conditions accounts for the dark color and high content of organic matter. The flood plains of some of the smaller streams are rather narrow, and in places a slight exaggeration is necessary to show this type on the soil map. The flood plains are 10 to 20 feet above normal water level.

The surface of the Wabash silt loam is usually flat, except where broken by slight depressions and old stream channels. Drainage conditions are extremely variable. The area along Shell Creek, in the southwestern part of the county, and the areas along the North Fork of Elkhorn River, in the northeastern part, lie well above the normal flow of the streams and are seldom subject to floods. Along Battle and Union Creeks, however, extensive areas of the type are poorly drained. They are seldom subject to overflow from the main streams, but rain water often accumulates on the surface on account of the poor drainage. Frequently small intermittent streams from the upland carry the run-off from large areas to the edge of the valley, where on account of the decreased velocity of the current, the channel of the stream becomes filled with sediment, causing the water to spread over the surface.

The Wabash silt loam is a very important type in Madison County. About 70 per cent of it is under cultivation or in temporary pastures. Originally it supported a great variety of water-loving grasses, and narrow strips along the main streams were forested with a dense growth of ash, box elder, cottonwood, elm, and willow, with a few hackberry and linden trees. Corn, oats, wheat, and alfalfa are the principal crops, ranking in acreage in the order named. The acreage of wheat has been greater than usual during the last few years. Hog raising and cattle feeding are practiced quite extensively. The animals are fattened on corn and alfalfa and are shipped to Omaha.

Corn yields 40 to 60 bushels per acre, depending upon the season. Average yields of 40 bushels of oats and 25 to 30 bushels of wheat are obtained in favorable years. Alfalfa yields 3 to 4 tons of hay per acre from three cuttings. The average yield of native hay is almost 1 ton per acre. Short-strawed varieties of oats are grown, as they are less likely to lodge. Turkey is the principal variety of wheat. The Wabash silt loam is the strongest corn soil in the county. Where the water table comes within 4 feet of the surface alfalfa stands do not last so long as on the higher lying areas.

Crop rotation is not systematically practiced. Many fields are kept in corn for 5 or 6 years in succession. No commercial fertilizer is used, but barnyard manure is applied when available. The type is in no immediate danger of becoming exhausted, as the occasional overflows leave an additional deposit of rich upland soil material over the surface.

The price of the Wabash silt loam ranges from $175 to $250 an acre, depending upon improvements, drainage, and location with respect to markets.

CASS LOAMY FINE SAND.

The surface soil of the Cass loamy fine sand is a brown to light-brown fine sand 8 to 10 inches deep. It has a relatively large content of well-decomposed organic matter, which gives it its dark color and loamy structure. The sand in this soil consists of about equal parts of the fine and very fine grades and a considerable percentage of medium sand. The upper subsoil is a lighter brown fine sand, which grades at about 20 inches into a gray, loose, incoherent fine to medium sand. The subsoil is very deficient in organic matter. The entire soil section is usually not highly calcareous.

A few minor variations are included with this type as mapped. In places the subsoil below 30 inches is composed of coarse sand and fine gravel. In the more poorly drained areas rusty-brown mottlings are encountered throughout the subsoil, and the material is slightly compact in places, owing to a small amount of clay mixed with the sand. Locally the lower subsoil is calcareous. The most important variations in the surface soil are either toward a fine sandy loam or a sand, the former being encountered where conditions have been especially favorable for the growth and decay of plant life, and the latter in the more exposed situations where much of the organic matter has been removed by the wind. The surface soil is nearly pure sand in many places adjacent to the stream channels, where the soil material has been deposited so recently that little organic matter has accumulated.

The Cass loamy fine sand is one of the more extensive first-bottom soils in the county. It occurs chiefly in numerous scattered areas on the flood plains of the Elkhorn River, and in small areas along intermittent streams near the eastern county boundary. The areas vary in size from a few acres to about 1 square mile.

The topography is flat, modified in places by numerous depressions, dry channels, and slight elevations. Drainage is variable, but the greater part of the type has adequate surface and internal drainage. There are extensive areas, however, in which the water table lies only 1 or 2 feet below the surface, and crops can not be profitably grown on these. During extremely dry years the subdrainage is often excessive, and crops suffer from lack of moisture.

The Cass loamy fine sand is an important agricultural soil. It is not so well adapted to general farming as some of the heavier first-bottom types, but its large acreage gives it an important position among the flood-plain soils. About 60 per cent of it is under cultivation, and the rest, including the poorly drained areas, is used for pasture and hay land. The native vegetation is the same as on the Cass fine and very fine sandy loam types. Of the cultivated crops, corn occupies the largest acreage, followed by oats, wheat, and alfalfa. Alfalfa does not do well where the water table is near the surface. Hog raising is an important industry on those parts of the type where alfalfa can be successfully grown. The raising of beef cattle is not practiced extensively, although many farmers graze stock where a sufficient acreage of the poorly drained land can be obtained for pasture. A few farmers feed cattle for the Omaha market.

The average yield of corn is about 30 bushels per acre in normal years. In dry seasons the yield is considerably less. Oats yield 20 to 30 bushels; wheat, 10 to 15 bushels; and alfalfa, 1½ to 2 tons per acre from 3 cuttings. Native hay yields three-fourths to 1 ton per acre. The grasses will support from 60 to 80 head of cattle per quarter section during the summer grazing season.

The soil is handled in much the same manner as the Cass fine sandy loam. Its lower organic content, however, tends to make it less productive and enduring than that type.

The land sells for $100 to $200 an acre, depending upon drainage, improvements, and location with respect to markets.

The soil of this type should be very carefully handled to maintain and increase the content of organic matter. The plowing under of crops at frequent intervals, heavy applications of barnyard manure,

and increased acreage of leguminous crops, such as clover and alfalfa, will increase the productive power of the land. The poorly drained areas should be ditched or tiled.

CASS FINE SANDY LOAM.

The surface soil of the Cass fine sandy loam typically consists of a very dark gray fine sandy loam, 8 to 12 inches deep. As mapped in this county it contains a relatively high proportion of very fine sand and silt and in places approaches a very fine sandy loam in texture. The soil is rich in organic matter, which accounts for its dark color. The subsoil is a brown to light-brown, loose sandy loam, underlain at an average depth of 20 inches by a light-gray to grayish-brown, loose, incoherent medium sand. Coarse sand and fine gravel are encountered locally below 30 inches. The lower subsoil is mottled here and there with rusty iron stains.

In a few places the surface soil is very shallow and is underlain by a yellowish-gray to gray incoherent medium sand, which continues to depths below 3 feet. In small local areas, seldom exceeding 2 acres in extent, there is an intermediate subsoil layer of coarse sand and fine gravel, underlain by the loose incoherent sand of the typical subsoil. The soil in these areas is rather droughty and not so well adapted to general farm crops as the surrounding soil.

The Cass fine sandy loam is one of the most extensive types in the flood plains of the Elkhorn and North Fork of Elkhorn Rivers. It occurs in numerous, usually elongated bodies lying in a general way parallel to the stream channels. The areas vary in size from a few acres to about 3 square miles. The largest and one of the most typical areas lies within and about the city of Norfolk. A smaller area lies about 2½ miles northeast of Tilden on the south side of the Elkhorn River. Two small areas are mapped along intermittent streams in the east-central part of the county.

The type represents alluvial material carried down and deposited by the streams during comparatively recent times. The surface is generally flat but modified in places by slight depressions and old stream channels. The surface lies from 8 to 10 feet above the normal flow of the streams and is not often subject to overflow. Drainage over most of the type is sufficient in average years for profitable farming, but in wet years the water level frequently comes within 3 feet or less of the surface, and even in normal years extensive bodies remain too moist for successful farming. In very dry years the subdrainage is excessive, and crops, especially corn, may not do so well as on the types with heavier subsoils.

On account of its large extent the type is an important agricultural soil. About 60 per cent of it is under cultivation and the rest is used for pasture and hay. The native vegetation consists of a great variety of prairie and water-loving grasses, with narrow strips of timber along the stream channels. The trees consist of elm, ash, willow, and cottonwood, with some hackberry and linden. Corn, oats, wheat, and alfalfa are grown on the cultivated areas. The type is not so well adapted to small grain as some of the heavier soils on account of the difficulty encountered in preparing a firm, compact seed bed. Truck crops are grown to a small extent, as the soil warms up early in the spring. Cattle and hog raising are not practiced

extensively, although a few hogs are found on every farm, and cattle are raised on farms that contain enough poorly drained land for pasture.

The average yield of corn is 35 bushels per acre; oats, 30 bushels; wheat, about 15 bushels; and alfalfa, 2 to 2½ tons from three cuttings. Native hay yields three-fourths to 1 ton per acre. In dry years crop yields are very low on account of the droughty nature of the soil.

The Cass fine sandy loam can be easily handled under a wide range of moisture conditions with lighter machinery and less power than is required for the heavier soils. Corn is usually listed in, and small grain is planted with a press drill on well-prepared corn or stubble ground. For truck crops large quantities of manure should be applied, but this is seldom done. Where manure is not available in sufficient quantities for the profitable growing of truck crops it should be supplemented by a fertilizer containing nitrogen and phosphoric acid.

The selling price of the Cass fine sandy loam ranges from $100 to $200 an acre, depending upon improvements, location, and drainage.

Probably the best way to improve the soil is to plow under green-manure crops and stable manure, which will greatly increase the water-retaining power of the land. The poorly drained areas should be tiled or ditched.

CASS VERY FINE SANDY LOAM.

The surface soil of the Cass very fine sandy loam is a dark grayish brown very fine sandy loam, 8 to 10 inches deep. It contains a relatively large proportion of silt and a small percentage of particles coarser than very fine sand. The soil is rich in organic matter, which gives it its dark color. The subsoil consists of a brownish-gray fine to very fine sand, grading at about 24 inches into a gray or grayish-brown, loose, incoherent fine sand, which in many places contains rusty-brown streaks below 30 inches.

The type as mapped includes a few variations which are not of sufficient importance to warrant separate mapping. In many places the subsoil is made up of alternating layers of silt, very fine sand, and clay, the sand predominating. In places the subsoil below 8 inches consists of a gray to almost white fine to medium sand, which may continue to the bottom of the 3-foot section or may be underlain by a stratum of silt loam or very fine sandy loam. A few bodies of Cass fine sandy loam too small to be shown on the map are also included. In local patches, seldom exceeding 1 acre in extent, the surface soil is a dark-brown to black friable loam 8 to 12 inches deep, and the subsoil is a light-brown very fine sandy loam tinged here and there with yellow. Within the body of Wabash silt loam southwest of Norfolk are small patches of Cass very fine sandy loam not separated on the soil map on account of their small extent and irregular occurrence.

The Cass very fine sandy loam occurs extensively in the flood plains of both the Elkhorn and North Fork of Elkhorn Rivers. It is closely associated with the Cass fine sandy loam and loamy fine sand types, the bodies of Cass very fine sandy loam usually lying adjacent to the

terraces or upland and the coarser textured types nearer the stream channel. One of the largest and most uniform areas, containing about 3 square miles, lies just north of the town of Battle Creek. Another large area is west of Norfolk on the north side of the Elkhorn River, and a smaller one lies along the eastern edge of Norfolk.

The type represents recent alluvium washed from the uplands and deposited on stream flood plains. The topography is prevailingly flat, except where interrupted by old stream channels, sloughs, and low ridges. Drainage as a whole is good. The surface of the type lies from 8 to 10 feet above the normal flow of the streams and is not often subject to floods from the main channels. In a few places, however, intermittent streams carrying the surplus water from the uplands spread out over parts of the type, creating in places extensive areas of poorly drained soil. The porous subsoil usually affords ample underdrainage.

The Cass very fine sandy loam is an important agricultural type. It is well adapted to general farming, and all crops common to the region can be successfully grown. About 70 per cent of it is under cultivation, and the rest, consisting mainly of the poorly drained areas, is used for pasture and hay land. The original vegetation consisted of a great variety of prairie and swamp grasses, with narrow strips of forest along the stream channels. The principal cultivated crops are corn, oats, wheat, and alfalfa, ranking in acreage in the order named. Cattle raising is practiced on those farms that include some of the poorly drained land suitable for use as pasture. Hogs are raised more extensively on the farms producing alfalfa than on those not producing it. Most of the alfalfa is cut for hay and fed to cattle and work stock; some is used as pasturage for hogs.

The average yield of corn is about 40 bushels; oats, 40 to 45 bushels; wheat, 20 to 25 bushels; and alfalfa, 2½ to 3 tons per acre. Alfalfa and red clover do well, and the acreage in alfalfa is steadily increasing.

No commercial fertilizer is used on this soil; barnyard manure is applied when available. Manure spreaders are in use on most farms. No systematic crop rotation is practiced, though many farmers plant corn 2 or 3 years, oats 1 year, and wheat 1 year. Corn is usually listed. Heavy draft stock is used, and most of the work is done with labor-saving machinery. The type can be cultivated soon after heavy rains, without serious injury, and it is one of the first soils to warm up in the spring. It is well adapted to fruits and vegetables, but these receive very little attention.

The selling price of the Cass very fine sandy loam ranges from $150 to $250 an acre, depending largely upon improvements and drainage.

Continuous grain cropping on this soil will soon deplete the supply of organic matter, and yields will decrease. The incorporation of green manures, preferably leguminous crops, should receive more attention. With careful soil management commercial fertilizers are not needed. A system of ditches or tile drains would greatly increase the producing power of the soil in the poorly drained areas.

SARPY SAND.

The Sarpy sand consists of a gray to light-gray, loose, incoherent sand, underlain by a subsoil of the same texture and structure to a

depth of 3 feet or more. The surface soil is usually slightly darker than the subsoil, owing to the presence of a small amount of organic matter. The subsoil below 30 inches is mottled here and there with rusty iron stains. In a few places the lower subsoil is almost white, and below 24 inches it is composed of a loose, incoherent mixture of coarse sand and fine gravel. The type differs from the Cass loamy fine sand in its coarser texture, lower organic content, and lighter color.

The soil occurs in many narrow strips along the Elkhorn River throughout its distance across the county, but is of small total extent. One of the largest bodies lies southwest of Norfolk in sec. 34, T. 24 N., R. 1 W. A much smaller area lies on the north side of the river about 1½ miles northwest of Meadow Grove. In many places the type occurs within the inclosures formed by the old cut-off channels and the present stream. The material represents recent alluvium deposited in the flood plain during periods of high water. It has not yet developed a dark-colored surface soil, as sufficient time has not elapsed for the accumulation of much organic matter. In many places the material resembles riverwash as mapped in other surveys, but it is more stable than riverwash and not so greatly influenced by each slight rise of the stream.

The surface, for the most part flat, is modified in places by old cut-offs and depressions and by slight elevations built by wind, which in the more exposed situations whips the loose sand into low rounded knolls and ridges. The surface of the type lies from 4 to 10 feet above the normal level of the stream. Drainage is rather variable. Most of the land is subject to occasional overflow, but little damage results, as the land is not used for cultivated crops. Underdrainage in dry years is excessive and vegetation sometimes suffers from lack of moisture. In wet years, however, the water table often lies within the 3-foot depth, and in the lower lying situations water accumulates on the surface.

Owing to its small extent, low organic content, and incoherent structure, the type is not used for crop production but is all included in pasture and hay land. The native vegetation is sparse, and the land does not have a high value even for pasture. Narrow strips of timber, including a fairly dense growth of ash, elm, cottonwood, and willow, occur along the streams.

There is no established price for this type, as it forms only a small part of farms bordering the river, but its presence tends to lower the price of farms in which it occurs. It is doubtful if any of the type should be used for cultivated crops. The sowing of tame grasses, such as timothy and alsike, in the poorly drained areas, and sand grasses in the drier and more exposed areas, would greatly increase the value of the land for pasture and the production of hay.

SUMMARY.

Madison County is located in the northeastern part of Nebraska, about 90 miles northwest of Omaha and 60 miles southwest of Sioux City. It comprises an area of 576 square miles, or 368,640 acres. The general topography ranges from rolling to sharply rolling, except on the broad flat terraces and flood plains bordering the rivers and larger creeks.

The drainage of the county is effected through the Elkhorn River and its tributaries and through the drainage systems of Shell and Union Creeks.

The average elevation of the county is about 1,600 feet above sea level. The general slope is to the south and east.

The first settlement in the county was a colony of Germans, who located in 1857 near the present site of Norfolk. The county was organized in 1867. In 1920 it had a population of 22,510. Norfolk is the largest town, with 8,634 inhabitants. Madison, the county seat, is located in the southeastern part of the county.

The transportation facilities are generally good. Several railroads cross the county in different directions and there is a comprehensive road system reaching all farming communities. The surplus agricultural products are shipped to Omaha and Sioux City.

The climate of Madison County is favorable for the production of the staple crops commonly grown in this region. The mean annual precipitation is 27.38 inches and the mean annual temperature is 47.5° F. The rainfall is favorably distributed for agriculture. The average length of the growing season is 148 days.

The land included in Madison County originally supported a luxuriant growth of prairie grasses and along the streams belts of forest. The first land was broken about 1858. The early development of the county was slow on account of the absence of transportation facilities.

The present agriculture consists of the production of grain, hay, and live stock. Corn, oats, alfalfa, wild hay, wheat, rye, mixed clover and timothy, barley, and potatoes are the most important crops. Cattle and hogs are raised on most of the farms.

Systematic crop rotation is not practiced, though many farmers have a more or less indefinite plan of cropping. No commercial fertilizer is used. Barnyard manure is produced in considerable quantities and applied mainly to corn and oats land.

The farm improvements are exceptionally good. The buildings are kept well painted and the land is all fenced and cross-fenced. Modern labor-saving machinery is in common use.

Farm laborers are scarce and command high wages.

The soils of Madison County are all derived from transported materials and are of glacial, loessial, or alluvial origin. They have been grouped into 12 distinct series, respresented by 23 soil types.

The Marshall silt loam, the most extensive and important soil of the loessial uplands, is developed over the greater part of the southwestern half of the county. It is highly productive and well adapted to all crops common to the region.

The Knox silt loam is productive but is not as strong as the Marshall silt loam. It is especially adapted to alfalfa on account of its high lime content.

The Shelby soils are derived largely from the Kansan drift sheet. They are usually characterized by a fairly stiff compact sandy clay subsoil.

The Valentine soils represent wind-blown materials from the surrounding types. They are all of a sandy nature and are for the most part better adapted to grazing than to grain farming, because of their tendency to drift when the protective covering of grasses is removed.

The Scott silt loam occurs in small basinlike depressions throughout the loessial uplands. It is poorly drained and is seldom used for crop production.

The Gannett loamy sand occupies shallow poorly drained depressions throughout the areas of Valentine soils. The bodies are usually small and used exclusively as pasture and hay land.

The Judson silt loam represents colluvial deposits accumulated at the foot of slopes. It is of small extent in this county.

The Waukesha soils are not extensive. They occur in bodies of varying size upon the terraces throughout the county. The soils are highly productive, ranking with the Marshall silt loam in this respect.

The O'Neill soils are sandy throughout the 3-foot section. They occur upon terraces in close association with the Waukesha soils. They are considered inferior on account of their sandy nature and lower content of organic matter.

The Wabash silt loam occurs extensively in the bottoms throughout the loessial upland division of the county. It is also developed along the North Fork of Elkhorn River in the northeastern part of the county. The soil is exceptionally well drained, considering its low position, and is nearly all farmed.

The Cass soils are developed chiefly along the Elkhorn River. They occupy first bottoms or flood plains. They are sandy and somewhat inferior to the Wabash silt loam, but they are considered excellent soils for general farming in this county.

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