

SOIL SURVEY OF OTOE COUNTY, NEBRASKA.

By WILLIAM G. SMITH, of the U. S. Department of Agriculture, and L. T. SKINNER, of the Nebraska Soil Survey.

DESCRIPTION OF THE AREA.

Otoe County is located in the southeastern group of counties in Nebraska. It is bounded on the north by Cass County, on the east by the Missouri River, the main channel of which is also the State line, on the south by Nemaha and Johnson Counties, and on the west by Lancaster County. It measures 18 miles north and south, the northern boundary being 32 miles long and the southern boundary 40 miles. The survey contains 606 square miles, or 387,840 acres.

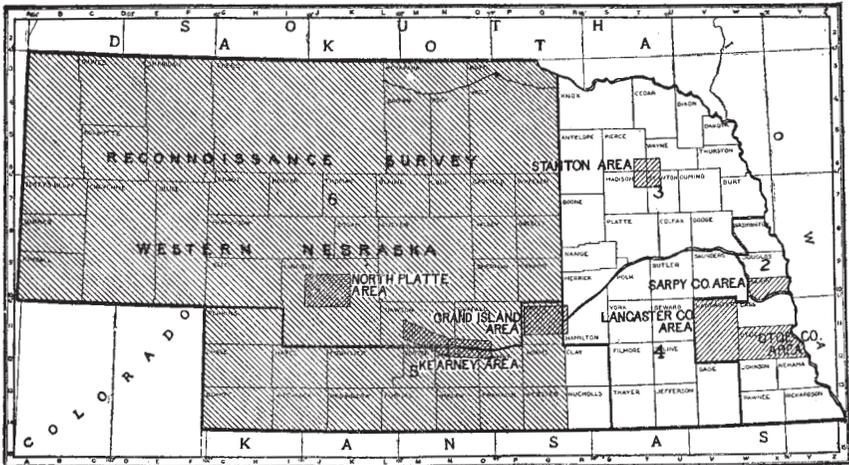


FIG. 51.—Sketch map showing areas surveyed in Nebraska.

From a physiographic standpoint the area included within the county boundaries is essentially a plain sloping from west to east. Its existing surface is rolling to undulating in the western part of the county and hilly in the eastern part. The hilliness is merely the result of dissection. The streams of the interior of the county are all tributaries of the Missouri River, which flows along its eastern boundary. They are not only larger, but increase in number and in depth to which they have cut their valleys as the Missouri River is

approached. In the western part of the county the valleys are shallow, usually taking the form of upland prairie sags. In the eastern part they are deep and narrow.

A prominent feature of the eastern part of the county is the flood plain of the Missouri River. It lies about 908 feet above sea level at the southern boundary of the county and reaches an elevation of 928 feet at the northern line. The greater part of the upland includes elevations from about 1,000 feet on the east, rising progressively westward to about 1,400 feet above sea level. With a few minor exceptions the bluffs overlooking the Missouri River bottom are very steep, rising from 100 to 200 feet in height. A zone extending from 3 to 6 miles west from the face of the bluffs includes some of the county's deepest valleys, which also have very steep sides; while in the same direction beyond this zone, the valleys become progressively shallower, with sides less steep.

The county has many major and minor streams, each fed by many tributaries, so that practically every section of land is reached. Along the Little Nemaha River and its larger branches are some of the widest bottom lands in the county, ranging from one-half mile to $1\frac{1}{2}$ miles in width. The numerous other drainage ways of the county have bottoms varying in width from less than one-eighth mile to about one-half mile. Only a very small part of the Missouri River bottom land lies within Otoe County. The river flows quite close to the bluffs on the east of the county, leaving most of the bottom land on the east side of the river in Iowa and Missouri.

The principal drainage of Otoe County is toward the east and southeast. The Little Nemaha River with its many tributaries drains practically all of the western five-sixths of the county. The eastern part, including most of the loessial region, is drained by numerous small streams flowing east and northeast into the Missouri River.

Otoe County was organized in 1854 from part of Pierce County. The present boundaries were fixed by the second Nebraska Legislature in 1856. Nebraska City, the county seat, was the first permanent settlement and trading center of importance of the region, being one of the gateways of the overland travel westward. It was a noted Missouri River landing in 1856 and later, though at present there is little river traffic of consequence. From 1854 on settlement continued steadily, land being taken up under the preemption act in 160-acre tracts. The first settlers selected sites on or near the larger streams, where wood and water were easily obtainable. Soon settlement extended onto the uplands, the question of water supply being solved by deep wells, and that of wood supply by purchase or by drawing on early forest plantings.

Agricultural development began almost with settlement, and rapidly expanded. Some ranching was practiced in the early days

in the western part of the county, but this form of husbandry has been abandoned, the lands being now too high-priced for any but the more intensive uses.

The census of 1910 reported a population of 19,233 for the county, as compared with 22,288 in 1900 and 25,403 in 1890. Nebraska City is the county seat, with 5,488 inhabitants. Palmyra, Syracuse, and Unadilla are other important towns.

The Chicago, Burlington & Quincy and the Missouri Pacific Railroads traverse the county. The former has a branch from Nebraska City westward through Dunbar, Syracuse, Unadilla, and Palmyra, and thence to Lincoln. A branch south and one east connects with the trunk line from Omaha to Kansas City and other points. The Missouri Pacific has a main line running from Omaha through Wyoming, Nebraska City, and Paul to St. Louis, and a branch from Omaha passing north and south through the county, touching at Berlin, Dunbar, Lorton, and Talmage. Another branch crosses the southwest corner through Douglas and Burr, forming a junction with the Omaha branch at Talmage.

Public highways, many of which are in fairly good condition for travel, are, with few exceptions, located on section lines. As a whole, the transportation facilities of Otoe County are fairly good.

CLIMATE.¹

Otoe County is located in that portion of Nebraska favored, as a rule, with sufficient rainfall to insure continued development of the extensive farming interests found here. The mean annual precipitation, as shown by the records of the stations at Syracuse and Turlington, centrally located in Otoe County, is 29.47 inches. About three-fourths of this comes during the growing months, April to September, inclusive. There are seasons when the crops suffer for want of rain, but on the whole the rainfall is sufficient, and so distributed that most of it can with proper cultural methods be conserved for crop use.

Most of the rainfall in the summer months occurs in storms accompanied by thunder and lightning, and often with heavy rainfall for a short time. Somewhat more than half the rainfall of May, June, and July occurs in rains of 1 inch or more in 24 hours. In most years at least a part of the region is visited by a storm with a rainfall of 2 or 3 inches in 24 hours. The rainfall in May and June is usually well distributed, and drought periods are almost unknown. In July the distribution is not quite so satisfactory. On the average

¹ Data taken from the United States Weather Bureau summary, section 37, southern Nebraska.

rain falls about every fourth day during the three months, May, June, and July.

The average snowfall is about 23 inches. There is usually very little snow before November, while ordinarily April is the last month during which snow falls in the spring. Snow remains on the ground but a few days at a time after each storm, the ground being bare more than half of the time, even during the months of heaviest snowfall, from December to March, inclusive.

The roads during the mild winters are usually muddy from melting snow, very little sleighing being possible. The alternate freezing and thawing is not without advantage to the farmer, as this has a tendency to improve the physical condition of the soil.

The mean annual temperature is 50.6° F. December, January, and February are the coldest months, ranging in monthly averages from 27.3° for December to 23.3° for February, while June, July, and August are the hottest months, ranging in monthly averages from 71.1° to 76°, July having the highest mean. The average range of mean temperature from the warmest to the coldest month is 52.7° F. The highest temperatures usually occur a few times during July, August, and the first 10 days in September, reaching as high as 108° for July. The lowest temperatures occur during December, January, and February, ranging from -16° to -29° F.

The average date of last killing frost in the spring is April 21, and that of the first in the fall is October 7. This gives an average growing season of 168 days. The latest date of killing frost in the spring so far recorded is May 20, while the earliest in the fall is September 13. There is thus a minimum growing season of 115 days.

During the months from May to November, inclusive, the prevailing wind is from the south and southeast, while from December to the following April, inclusive, it blows from the north and northwest. The average wind velocity is not definitely known. At Lincoln, in Lancaster County, it is 11 miles per hour. During storms wind velocities of 30 to 50 miles per hour are likely to occur, and velocities as high as 70 to 80 miles have been recorded for short periods of time.

The average relative humidity for the year is about 70 per cent. The humidity is higher in the morning than in the afternoon. In the afternoons of spring and summer the lowest humidity occurs, sometimes as low as 20 per cent.

The sky is relatively free of clouds; from 175 to 185 clear days may be expected, from 81 to 86 cloudy, and the rest of the year partly cloudy.

The following table is compiled from the records of the Weather Bureau stations at Syracuse and Turlington, Nebr. The figures given above for relative humidity are taken from the records of the Lincoln Station.

*Normal monthly, seasonal, and annual temperature and precipitation at
Syracuse and Turlington, Nebr.*

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.
	° F.	° F.	° F.	Inches.	Inches.	Inches.
December.....	27.3	72	-16	0.82	T.	2.74
January.....	24.3	65	-26	0.77	1.09	1.45
February.....	23.3	79	-29	0.98	0.31	0.12
Winter.....	25.0	79	-29	2.57	1.40	4.31
March.....	37.3	91	-10	1.42	1.24	0.76
April.....	51.7	98	16	2.52	0.93	1.69
May.....	61.7	100	25	4.77	2.87	6.39
Spring.....	50.2	100	-10	8.71	5.04	8.84
June.....	71.1	102	41	4.57	4.00	7.97
July.....	76.0	108	45	3.93	3.17	9.01
August.....	74.7	105	44	3.43	2.83	4.73
Summer.....	73.9	108	41	11.93	10.00	21.71
September.....	67.2	102	27	2.84	2.47	4.31
October.....	54.6	94	8	2.44	1.28	3.58
November.....	38.5	78	-10	0.88	1.23	2.92
Fall.....	53.4	102	-10	6.26	4.98	10.81
Year.....	50.6	108	-29	29.47	21.42	45.67

AGRICULTURE.

Corn and flax were the main money crops of the county until 1870, when the latter crop was abandoned, as it was found to exhaust the land. Spring wheat next received attention. What were then known as the "tea" and "grass" varieties were grown to a considerable extent by 1888. Winter-wheat production received its greatest impetus when the State experiment station demonstrated the value of certain varieties imported from Russia and Turkey, a variety known as "Turkey Red" now being commonly grown throughout the county. Corn has always ranked first. Some ranching was practiced in the early days, but as the land was taken up and settled more intensive farming became the rule with a gradual decline in the ranching industry.

There are 2,298 farms in the county, embracing approximately 97.2 per cent of the total land area, of which 92 per cent is improved. The average farm contains 164.1 acres, of which 151 acres are

improved. Farms vary in size from 3 acres to 1,000, the greater number being from 50 to 500 acres in extent, and over half are from 100 to 250 acres, making between three and four farms to the section of land.

Nearly half, or 49.8 per cent, of the farms are operated by the owners, 49.5 per cent by tenants, and 0.7 per cent by managers. In the last decade the number of farms operated by owners has decreased, 53.8 per cent falling in this class in 1900, while the number of farms operated by tenants has increased accordingly.

Farm property in the county, according to the Thirteenth Census, was valued at \$40,249,560, of which land represents \$31,707,711; buildings, \$4,147,485; implements and machinery, \$921,801; and domestic animals, \$3,472,563. The large increase as compared with 1900 is due to advance in land values, although material increase in other groups is uniformly shown. The value per farm is given as \$17,515, of which \$15,603 represents land and buildings. The average value per acre for the whole county is given as \$84.10, more than double that of the 1900 census, which was \$37 an acre. Much of the improved farm land is valued at \$100 to \$150 or more an acre.

All except 27 of the farms of the county report live stock of various kinds. There are 34,669 head of cattle, valued at \$886,578; 14,013 horses, worth \$1,567,799; 2,807 mules, at \$404,957; 61,266 hogs, valued at \$502,277; and 2,619 sheep, worth \$11,872. There are also a few goats, asses, and burros, representing less than 1 per cent of the whole.

Corn is the principal crop of the county, the census of 1910 reporting 137,596 acres, on which 3,308,389 bushels were grown, an average of 24 bushels to the acre. Oats ranked next with 967,840 bushels from 41,592 acres, or 23 bushels to the acre. There were 40,301 acres planted to wheat, from which 769,212 bushels were harvested; 1,512 acres in potatoes, which yielded 137,484 bushels, while the 38,400 acres cut for hay produced 61,784 tons. About 53 per cent of the acreage is in corn, 16 per cent in oats, 15.5 per cent in wheat, and 15 per cent in hay and forage, while less than 1 per cent of the acreage includes barley, rye, and potatoes. Every farm has a small patch of potatoes for home use.

The acreage in clover and timothy mixed is about equal to that in wild hay, and both together include over three-fourths of the total acreage of all classes of hay and forage. The bulk of the remaining fourth is about equally divided between timothy, clover, and alfalfa. The latter crop is of recent introduction and present indications point to a considerable increase in acreage within the next few years.

According to estimates based on reports of Otoe County tax assessors,¹ the corn crop is valued at nearly \$2,500,000; wheat at nearly

¹ Bulletin No. 23 A, Commission of Labor, Nebraska, November, 1911.

\$1,500,000; oats at nearly \$250,000, while alfalfa, clover, timothy, wild hay, and other forage crops aggregate in value nearly \$335,000. The approximate value of all field crops, according to the above authority, is \$4,431,309, exceeding in value that of live stock by nearly \$1,000,000.

Nearly every farm has its orchard of 2 to 5 acres, consisting of apples, peaches, pears, plums, and cherries. Only a rather small proportion of the orchard products finds its way to outside markets, most of the fruit being utilized for home and local use. Usually very little attention seems to be given to spraying, pruning, and cultivating the orchards, a neglect which results in uncertain yields and more or less blemished fruit. For the purpose intended, possibly the care given is sufficient.

The fact that over half (53 per cent) of the acreage in field crops is in corn is suggestive of a practice more or less common, especially with tenant farmers, of growing this crop continuously on the same land or with a small grain in some form of rotation. Any such crop practice is sure sooner or later to result in lower yields and inferior crops, even on such naturally strong and productive soils as those found in Otoe County. With liberal applications of barnyard manure such crop methods might give permanent profits, but since the field crops here produced are largely sold from the farm, the supply of manure is curtailed. The rather low average yields of corn and small grain may be taken as evidence against the existing methods.

Many farmers in Otoe County practice rotations in which clover forms a step, and these are obtaining larger yields at very little, if any, additional cost of production. A rotation admitting of wide latitude in application, and which has been found profitable, consists of corn, oats, wheat, clover, or clover and timothy mixed, each crop being grown for one or two years at the option of the owner. This system is adapted to both grain and stock farming, and where pasture is needed the clover and timothy may be left down two or more years, using it for hay or pasture as may be required. This crop sequence has been found profitable both from the viewpoint of increasing the productiveness of the soil and of affording a fairly uniform distribution of labor.

Land for corn should be plowed deep in the fall, especially where previously in clover or clover and timothy or alfalfa. It should be disked and harrowed the following spring, preparatory to planting the corn with a two-horse check-row planter, during the first three weeks in May. Thorough cultivation should follow in June and July to conserve moisture and to kill weeds. Three cultivations usually suffice before the corn grows too tall to use the ordinary two or four horse corn cultivator. When corn follows corn, some farmers use the lister, though this practice apparently does not give as satisfac-

tory results as plowing, harrowing, and check-row planting. Listing tends to promote washing and gullyng where the rows run up and down the slopes, while the other method gives a more uniform surface for the absorption of rainfall as well as allowing cultivation lengthwise and crosswise of the field, thus giving more complete surface tillage and dust-mulch cover.

The many fields of young corn noted during the progress of the soil survey showing very uneven stands suggests the need of more care in the selection of seed corn.¹ Where especially good, even stands of corn were seen they proved to be in each case the result of careful seed selection in some form.

A good practice is to select ears of seed corn in the field before October 1. In this way the securing of strains having a tendency to mature before frost time may to a degree be expected. The ears so selected should be hung up in a dry, well-ventilated place, such as a dry cellar, attic, or storeroom, where they may dry out normally, as freezing will lower the germinating power of corn that is even slightly soft.

Where the rotation detailed above is practiced yields of 25 to 35 bushels of corn per acre are commonly obtained. Some farmers report yields ranging from 40 to 70 or more bushels per acre.

Oats ordinarily follow corn in the rotation. Where the corn land has been well cultivated it may not be necessary to plow for oats, thorough disking with a four-horse disk followed by harrowing being sufficient. The harrowing may be deferred until spring, just preceding the sowing, from April 1 to 15. If smut² has been noted the previous season in the oat field the seed should be treated to prevent a recurrence of the disease. Yields reported, as a rule, are not high, ranging from 20 to 35 bushels per acre. Oats are desirable for home use in feeding work horses, and, in addition, fit nicely into the rotation.

The land to be prepared for wheat is properly that previously in oats, where the above rotation is followed. Since the oats are usually harvested by July 20, plowing or thorough disking of the oat stubble may begin early in August. If the land is somewhat weedy deep plowing is to be preferred. If the soil is not too wet, subsurface packing, followed by light harrowing, is recommended in order to pack the loose soil sufficiently to reestablish capillary connection with the subsoil. The seeding of wheat follows during the first three weeks in September. It is advisable to use a press drill of some form, as this insures the placing of the seed in close contact with the moist subsurface, insuring more even germination and larger

¹ See Press Bulletin No. 38, Nebraska Experiment Station, Sept. 7, 1912.

² See Bulletin No. 131, Nebraska Experiment Station, Aug. 30, 1912, on Control of Smuts of Nebraska Cereals.

yields, especially should the fall season prove dry. Drilled grain also better resists winter freezes.

Rolling the wheat field in the spring proves beneficial if the soil is dry and very much cracked. The Nebraska experiment station¹ reports an average increase of 5 bushels per acre from rolling under these conditions.

Wheat is harvested during the latter part of June and early in July.

Only a small acreage of spring wheat is grown in the county, as the yield per acre is only about two-thirds as much as that of winter wheat. Spring wheat fits into the above rotation where oats are not grown or where the winter wheat has been winter-killed. The preparation of the land and time of seeding the spring wheat is the same as that for oats.

Occasionally farmers follow corn with winter wheat instead of oats. This is accomplished by drilling the winter wheat in between the rows of standing corn, a narrow one-horse drill being used for this purpose.

Care in the selection of seed wheat is advisable. The light and defective grains may be largely removed by passing the seed grain through a seed grader, which by a hand-operated wind-blast arrangement separates the heavy grains from the light grains, the former being retained for field sowing. In case any trace of smut has been noted in the wheat fields all seed wheat should be treated to destroy it. The wheat yields reported in Otoe County range ordinarily from 18 to 25 bushels, while occasionally 35 to 50 bushels per acre are obtained.

In the above rotation clover follows wheat, the seeding being done late in March or early in April on the young winter-wheat fields. A sowing of about 8 pounds of clover seed per acre is recommended. If the season is not too dry the young clover thickens up rapidly in the stubble after the wheat harvest. Where timothy is desired as a mixture with the clover the timothy is seeded the previous fall, using about 6 pounds of seed per acre. This may be done by use of a grass-seed attachment to the grain drill, in order that this seeding may be accomplished without additional cost at the same time the wheat is sowed.

The use of clover in the crop rotation can not be too strongly recommended. It has been found that corn and small grain planted on land that has been in clover yield nearly double what they did before clover was grown.²

Usually the spring rainfall is sufficient to insure normal growth of all crops, but occasionally it is not. In order to offset a shortage in

¹ Press Bulletin No. 30, April, 1909.

² Bulletin No. 122, Nebraska Experiment Station.

forage and fall pasture that naturally follows in such instances, the use of so-called catch, or quick-growing forage plants, is recommended.

In the southern and in some of the eastern States, cowpeas and soy beans are used for this purpose, although these apparently are less profitable in Nebraska. The Nebraska experiment station¹ recommends for catch crops the use of millet, sorghum, and early varieties of field corn or of sweet corn.

Early Amber is regarded as the best of the sorghums for summer sowing. It requires about 80 days to mature as forage. Sown July 20, it will mature forage by October 10, or about time for frost. Sorghum may be drilled on stubble land that has been prepared by thorough disking with a heavy four-horse disk.

Common and Hungarian millets mature forage in 50 or 60 days. Any available land that is not too weedy may be prepared by thorough disking, using the drill for sowing the millet. If the land is weedy, plowing, followed by repacking of the soil, would be advisable.

Early varieties of field corn, such as Pride of the North, University No. 3 (Nebr.), or any of the early sweet corns, sown in the third week in July will yield 1 or 2 tons of cured forage per acre. If killing frosts are delayed until late in October, from 3 to 4 tons of forage may be expected. The corn is sown broadcast at the rate of 3 pecks per acre and the seed covered by plowing the land to a depth of 2 or 3 inches, following with a harrow or roller to repack the soil. After the corn comes up it may be well to harrow once to kill weeds and to provide a dust mulch.

Any of the above forage crops will furnish a fair amount of fall pasture after September 1 in favorable seasons. A mixture in common use is 3 pecks of millet and 2 pounds of rape seed per acre. If not pastured too closely, the rape will continue growing two or three weeks after the millet, affording pasture until the last of October.

Winter rye sown the last of July will make good pasture after the middle of September and until frost. A good plan is to sow half the available land with a mixture of millet and rape and the other half with winter rye. Alfalfa is a valuable market product, a fine feed on the farm, and is also a soil improver. Three to four cuttings are obtained, aggregating from 2 to 3 tons per acre. It is profitable to grow here as hay, but not for seed, the rainfall being rather too great for seed production.

Alfalfa is exceedingly delicate during the first year, weeds being one of its greatest enemies, and many failures are due to this cause, though several other factors add to the difficulty of successfully grow-

¹ Press Bulletin No. 35, 1911.

ing this legume. A seed bed prepared as for a garden is desirable for this crop. The Nebraska station¹ recommends early August seeding of alfalfa, the moisture conditions generally then being favorable. August seeding also follows nicely after any of the small-grain crops figured in the rotation discussed in the preceding pages. The grain stubble should be disked closely after the binder, if the soil is dry, or, if fairly moist, it may be plowed and later thoroughly packed with disk or subsurface packer. The harrow should be used at intervals until time of seeding the alfalfa, in order to destroy weeds and provide the desired seed bed.

If doubt is entertained as to the soil being inoculated for alfalfa, soil from an old alfalfa field that is free from weeds should be secured and sown at the rate of a few hundred pounds per acre prior to the last harrowing of the seed bed.

A sowing of 15 to 20 pounds of good seed per acre is advised for this locality. Where the quality of the seed is in doubt it should be tested. Dodder is the most common impurity found in alfalfa seed.

Under ordinary conditions the profitable life of an alfalfa field is limited to 6 or 7 years. Disking or rolling with a spike-toothed roller when the soil is dry and cracked tends to lengthen the life of an alfalfa field. The breaking of the soil crust, the killing of weeds, and the increased tendency of the alfalfa plants to stool are some of the beneficial results that follow this treatment. A well-drained soil is necessary for alfalfa. Low, poorly drained soils usually do not maintain profitable yields.

Investigations conducted in Nebraska show that the cost of producing corn, wheat, and oats is approximately \$12 per acre for each of these crops. This is the approximate cost, regardless of whether a large or small yield per acre is secured. At the ruling prices for these crops, profitable returns require a yield of not less than from 20 to 30 bushels of corn, 15 to 20 bushels of wheat, and 20 to 30 bushels of oats per acre.

The Nebraska experiment station² records that in one investigation 31 farmers reported average yields of 34.5 bushels of corn per acre on land before seeding to clover and alfalfa, and 68.2 bushels of corn per acre on the same land after the clover or alfalfa was plowed under and the land again planted to corn. This is significant as emphasizing clearly the necessity of giving leguminous crops a prominent place in the crop rotation.

The cost of producing alfalfa, clover, and wild hay ranges from \$3 to a little over \$5 per ton each, and at the usual prices obtained for these crops a fair profit is assured.

¹ Bulletin No. 120, May, 1911.

² Bulletin No. 122, Nebraska Experiment Station.

The following table shows some of the data included in the above discussion:

Cost of growing principal crops in Nebraska.¹

Crop.	Cost per acre.	Yield per acre.	Cost per bushel or ton
Corn.....	\$11.627	39.3 bushels...	29.6 cents per bushel.
Wheat.....	12.188	22.2 bushels.....	55.9 cents per bushel.
Oats.....	11.385	35 bushels.....	32.5 cents per bushel.
Wild hay.....	6.722	1.25 tons.....	\$5.37 per ton.
Clover.....	8.538	2.04 tons.....	\$4.18 per ton.
Alfalfa.....	10.33	3.33 tons.....	\$3.13 per ton.

¹ Bulletin No. 122, Nebraska Experiment Station.

Farm labor costs from \$25 to \$35 per month and day labor from \$2.50 to \$3.50 during harvest, board being furnished by the employer in all cases.

SOILS.

The soils of Otoe County are nearly all dark in color and are mainly silt loams in texture. They may be divided into two broad groups, namely, upland and bottom-land soils. The upland group includes extensive developments of the Knox silt loam, the Marshall silt loam, and the Shelby loam soil types. The bottom land includes extensive areas of the Wabash silt loam throughout the county, while in the Missouri River bottom relatively small areas of Wabash silty clay loam and Sarpy very fine sandy loam are found.

The geological formations of the county and their relation to the soil types of the survey are interesting and economically important. Part of the upland soils of the county are derived from a loessial deposit, varying in depth from less than 3 to more than 20 feet, and the Knox silt loam is developed on this type. It occurs over a belt of country 3 to 6 miles wide and stretching north and south across the eastern end of the county. Its eastern boundary is the western boundary of the Missouri River flood plain. Its western boundary lies 3 to 6 miles west of this. It includes about one-sixth of the area of the county. In this type the loess is recognized by its silty texture, by its yellowish-brown to light-brown color beneath a dark surface soil, by its peculiar rounded, though often abrupt, topography, by the peculiar manner in which the material stands in almost perpendicular walls when eroded, and by the uniformity of the entire subsurface section, both in color and texture. Small areas of loess, usually too small to map, occur in other parts of the county, as on many hills lying on the till or glacial drift deposits the fine-textured till closely resembles the loess. The loess is said to be well supplied with such elements as phosphates, potash, and other minerals

essential to plant growth, and the subsoil when exposed for a time weathers quickly into a productive soil. Its peculiar vertical structure also readily admits water by percolation, lessening thereby the surface run-off, and making the Knox silt loam soil, derived from the thicker deposit of the loess, more drought resistant than the Marshall silt loam.

The loess of the zone along the eastern border of the county is regarded as a deposit of wind-blown material, derived in part from dust picked up from drying mud and silt flats of the Missouri River and in part from the glacial drift. The silty material west of this zone may possibly be due in part to deposition of dust, as noted above, and also to the reworking of the surface material, principally by the wind, and to weathering. The upland soils, however, of the western five-sixths of the county, although very silty, show more or less strong characteristics of glacial origin.¹

Underlying the loessial covering above noted, in the eastern part of the county, and exposed extensively in the western portion of the county, occur the sheets of glacial drift; this consists of two main sheets separated by a subordinate sheet. The lower sheet, known as the Aftonian, is composed mainly of yellow sand and gravel; it is slightly exposed on some of the valley slopes in the western part of the county. The upper sheet, however, is the one that gives the main character to the Shelby loam and possibly to a considerable extent influences the Marshall silt loam. This material forms what is known as the Kansan drift. One phase of the Kansan drift makes it difficult of separation from the loess, in that much of its subsurface material has the yellow to brown color and silty texture so similar to the true loess. The Kansan drift has more clay and sand but less silt than the loess. The presence of small pebbles or bowlders affords some guide in distinguishing it from the loess. Then, too, the horizontal layers and more compact structure of the subsoil material evidence its having been deposited by glaciers.

The Shelby loam, which is derived mainly from the Kansan and Aftonian drift sheets, occupies the steeper slopes where bowlders and smaller gravel exist. This type occurs to some extent also on some of the valley slopes within the deeper loessial zone, classified as Knox silt loam, where the underlying boulder till is exposed.

Underlying the loess and glacial drift at various depths massive rock strata of great thickness, consisting of alternate beds of limestone and shale, are found. These formations are known as the Pennsylvanian division of the Carboniferous system.

Exposures of limestone and shale appear in some of the stream valleys of the county. In the middle and western parts of the

¹ This view is held by Dr. G. E. Condra, geographer, and Prof. E. H. Barbour, geologist, of the University of Nebraska.

county, where in a few cases the mantle of glacial drift is relatively thin, ranging from 5 to 10 feet, the limestone is seen in old quarries.

The alluvium along the tributary streams within the upland area of the county is a dark-colored silt loam, and has been mapped as the Wabash silt loam. The great width of some of the larger of these stream bottoms, together with the considerable depth of the flood-plain material, indicates a long period of development.

The valley bottoms are now widening and elevating through the deposition of overflow waters carrying silt and clay derived from the upland material.

All the streams of the county except the small creeks and the smaller hollows have well-developed flood plains varying in width, with the size of the stream, from a few hundred feet to more than a mile. The streams wind through these plains in well-defined, sharply cut, but very crooked channels. The flood plains are often overflowed, though a straightening of the channels of the streams would doubtless decrease the duration of each overflow.

The Missouri River alluvium is, as a whole, coarser and more subject to change by river erosion. The lighter textured types, at depths varying from a few inches to 2 or 3 feet, rest on a bed of sand brought from upstream sources, while with those of heavier texture the sand is found at a greater depth, but overlain with fine-textured deposits derived by wash from the nearby uplands. The sand bed represents the bars and sand flats formed in the older channels of the river. As the channel changed its course those areas were built up to higher levels by deposits of finer-textured material during successive floods that moved slowly over the flood plain. An 8 or 10 foot vertical section of the Missouri River alluvium shows alternate thin layers of varying texture, each layer marking more or less clearly a period of overflow.

The Wabash silt loam and Wabash silty clay loam soil types occur in small areas in the Missouri River bottom, where the underlying sand bed lies as a rule at considerable depths. The Sarpy very fine sandy loam is found wholly within the Missouri River bottom, where the sand bed is not far from the surface.

The greater part of the surface of the Missouri River bottom is elevated from 8 to 15 feet above the normal flow of the river. The lower levels are more or less subject to overflow; the higher lands rarely, if at all. Sand bars and sand flats now forming in the Missouri River are included under the type name of Riverwash.

The erosion of the Missouri River against its west bank about 3 miles south of Nebraska City, and also near Barney, is assuming serious proportions; several sections of valuable land have recently been carved away, and the process is still continuing. The sand bed underlying the alluvium is being worn away even during normal flow

of the river, resulting in an undermining of the overlying alluvium, which breaks off and falls in large masses into the river.

The following table gives the names and extent of the soil types of the county:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Marshall silt loam.....	170,880	44.1	Sarpy very fine sandy loam...	2,880	0.7
Wabash silt loam.....	52,096	30.4	Riverwash.....	2,880	.7
Colluvial phase.....	65,920		Wabash silty clay loam.....	2,688	.7
Shelby loam.....	47,296	12.2			
Knox silt loam.....	43,200	11.2	Total.....	387,840

KNOX SILT LOAM.

The surface soil of the Knox silt loam consists of a medium-brown to dark-brown, friable and open silt loam from 10 to 15 inches deep. The subsoil is a yellowish-brown to buff-colored silt loam of rather vertical and open structure, favoring the ready downward percolation of rain water and yet sufficiently retentive to hold a good supply for crop use. The type is easily tilled and shows no noticeable tendency to form clods.

According to the Nebraska experiment station¹ the loess soils of the State are well supplied with lime and potash, and contain a fair amount of phosphates, but are as a whole somewhat deficient in nitrogen. Thus the application of barnyard manure and the growing of leguminous crops in the rotation are to be recommended, even though this soil is productive under natural conditions. Fresh exposures at great depths, after a comparatively short time, weather into a productive soil. The lime is often seen as small, white nodular concretions, or as white stains on vertical subsoil sections.

The Knox silt loam includes the upland of the eastern one-sixth of Otoe County, consisting of a zone from 3 to 6 miles wide east and west and extending clear across the county north and south, parallel to the face of the Missouri River bluffs, as previously stated.

The surface of the type is much broken by stream valleys, which give it a rolling to hilly topography. These hills usually are rather smooth, except in the vicinity of the bluffs, and are readily cultivated over all or the greater part of their slopes. Washing and gullying seem not to be a serious feature of the type here. Some evidence of washing is seen, but this is easily stopped by placing some obstruction, such as brush or straw, in the gullies when they first form. Also a grass cover for such areas is effective in preventing further erosion.

¹ Bulletin No. 111, Nebraska Experiment Station.

The soil material of the Knox silt loam is derived from weathering of the deeper massive deposit of loess found throughout the eastern upland section of the county.

Originally much of the valley slopes was more or less covered with forest growth. Most of this is now cleared and farmed, only the steeper slopes being in forest. The more common trees are bur oak, red and white elm, ash, hickory, silver maple, box elder, black locust, black walnut, cottonwood, and hackberry. Less common, but of frequent occurrence, are black cherry, basswood, red oak, scarlet oak, honey locust, mulberry, hop hornbeam, redbud, and wild plum. Of the shrubs and smaller trees sumac, elder, hazel, "wahoo," viburnum, dogwood, and hawthorn are the most common.

Many of these trees supply material useful on the farm, such as fence posts, firewood, and occasionally lumber. Hedge plantings along public highways and subdivision land lines also exist. These include the Osage orange and many of the common trees noted above, which from trimming and thinnings give additional material useful on the farm.

The type, according to local estimate, outranks somewhat the other upland soils of the county in crop production. In seasons of normal rainfall the difference in crop yields is not so apparent, but under droughty conditions or excessive rainfall, the type produces good crops when the other upland soils show a considerable decline in yields. The peculiar columnar and open structure of the subsoil evidently affords both a means of drainage and a better reservoir for soil water, which probably accounts for the more constant yields even under the adverse climatic conditions that sometimes occur.

The type is also well adapted to tree fruits, such as apples, plums, and cherries, and to various kinds of small fruits. Potatoes, melons, cantaloupes, and other truck crops also do well, though grown only for home use.

The Knox silt loam, under existing climatic conditions, is apparently a type that would readily lend itself to a system of smaller farms with intensive methods in which fruits and truck crops would constitute the important money crops.

Corn, oats, wheat, clover, timothy, and alfalfa are grown, with corn and wheat as the leading money crops. Live stock is found on nearly every farm, but not in great numbers. Some mule and horse colts are raised from mares used as work horses.

The tenant farmers, as well as several owner farmers, grow corn, small grain, and a few hogs as money products, but the best yields can not be maintained under such a system. The yields are better where clover and alfalfa are included in the crop rotation.

By the more successful farmers, some variation of the crop rotation discussed in the chapter on agriculture is followed. This includes

corn for one or two years, followed by oats, wheat, clover, or clover and timothy, in the order named, each for one or two years. Under this system corn yields from 35 to 80 bushels per acre, oats from 20 to 30 bushels, wheat from 20 to 50 bushels, and clover and timothy hay from 1 to 2 tons per acre. Oats apparently are not well adapted to the soil here, but they fit nicely in the rotation system, and also afford a desirable feed for the work stock.

Alfalfa is well adapted to this soil, yielding from 2 to 4 tons per acre in three to five cuttings. The acreage is not as yet large, but the indications are that it will be greatly extended within the next few years. The profitable life of an alfalfa field on this soil is five to seven years.

Practically all of the type not retained in forest or pasture is in cultivation. The greater part of this soil is in well-cultivated farms, improved with fine houses and barns, and an adequate equipment of farm machinery and work teams.

This type includes some of the highest-priced lands in the county, ranging from \$100 to \$200 an acre.

MARSHALL SILT LOAM.

The surface soil of the Marshall silt loam consists of a dark-brown silt loam, from 10 to 20 inches deep, underlain by a yellowish-brown or brownish-yellow clay loam, slightly mottled with gray. Generally the surface soil is friable and easily tilled under normal moisture conditions. If plowed or worked when very wet, clods are formed that require considerable time to weather into a friable condition. Occasional small areas occur in fields having a rather sticky, plastic character when wet, and when very dry the soil here breaks up into hard lumps. These spots are locally known as "gumbo."

The subsoil is a silty clay loam in texture, possessing a rather more compact structure than the surface soil. There are local areas where it is quite compact and clayey rather near the surface, giving rise to a hardpan. This feature disappears to some extent where deep plowing is occasionally practiced and where organic matter in the form of barnyard manure is applied, or when leguminous crops are grown and plowed under.

The lime content of both surface soil and subsoil usually seems high. This tends to give the type a more friable character and favors the growth of leguminous and other field crops. The dark color of the surface soil would seem to indicate a high organic content.

The type includes about two-thirds of the upland of the western five-sixths of Otoe County, the remaining upland in this section being included in the Shelby loam, a type of distinctly glacial-drift origin.

The surface of the Marshall silt loam varies from gently rolling to fairly hilly. Nearly all of it, however, admits of cultivation, so far as the surface features are concerned. The extensive natural drainage system that characterizes the county is present on this type also, the drainage being very good. Scarcely a section of land is without some drainage channel or draw that leads to some of the major channels. The slopes are generally of easy gradient, and surface washing and gullying is not serious, though some evidence of washing is seen. A grass cover is effective in preventing gullying, and this precautionary measure is more or less employed by the farmers.

The type as found in this county is similar to the soil as developed in other areas of the Mississippi Valley. The surface soil is high in silt, and while the subsoil contains considerable clay its content of silt is also large. Because of this high percentage of silt, its color, and the similarity of the material in many respects to the definitely identified loess along the Missouri and Mississippi Rivers, this type formerly was considered as being possibly of loessial origin. The soil survey has not, however, undertaken in any case to determine the origin of this material. At the present time, therefore, the bureau does not undertake to commit itself unqualifiedly to the statement that the Marshall silt loam is in all cases derived from loess. As here mapped, it is both drift and loess. Yet the soils mapped as Marshall silt loam, whatever may be their origin, are sufficiently similar to be placed in the same type.

The stony and gravelly till may, in some local areas, be found within the 3-foot section, but where this material occurred near enough to the surface to have any marked effect on the soil and where such areas were large enough to recognize and map separately they were classified as the Shelby loam.

The native vegetation found on the small areas of the type still in native sod consists of the usual prairie grasses and a number of wild legumes.

The Marshall silt loam is considered a productive soil, making fair crops even where corn and small grain are given a preponderance over clover or alfalfa in the rotation. Where clover is used corn, wheat, oats, timothy, millet, rye, sorghum, and other forage crops produce much better. Potatoes are not extensively grown, about half an acre per farm for home use being usual. Small truck gardens produce well, and should the market demand for truck crops become more urgent, the soil would undoubtedly be found capable of producing them profitably. Orchards of from 2 to 5 acres are to be seen on nearly every farm, but the little care given results in uncertain yields, with more or less blemished fruit. With better market conditions the orchards would doubtless be given more attention.

The type is within the region known as the upland corn belt of the Mississippi Valley. Corn is at present the leading money crop, with wheat next in order.

Some farmers are giving more attention to crop rotations including clover as well as extending the acreage of alfalfa. These crops have a twofold value, viz, increasing the productive capacity of the soil and furnishing valuable forage. It has been found that by including them in the rotation the subsequent yields of corn and wheat may be nearly doubled.

Under present conditions the yields of corn range from 20 to 70 bushels and of wheat from 10 to 45 bushels per acre. The yield of oats is rather low. As a rule clover, alfalfa, and other forage crops yield well.

The higher yields obtained by some farmers may safely be ascribed to good methods, such as deep plowing and thorough harrowing, and to including clover and alfalfa in their crop rotation. The more thorough preparation of the seed bed among other advantages enables the soil to conserve a greater part of the rainfall for the use of crops.

With a subsoil more compact than that of the Knox silt loam the absorption of rain water is not so complete, and a curtailment of yields sometimes results in dry seasons. Loss from this cause may, in a large measure, be obviated by the methods just stated.

The greater part of the Marshall silt loam is in cultivation, three or four farms per section of land being the rule. Good farmhouses, barns, silos, tool and machinery sheds, and a good equipment of farm machinery and work stock are to be found on most of the farms.

The Marshall silt loam ranges in price from \$90 to \$150 an acre. The type ranks high in productiveness, next to the Knox silt loam.

SHELBY LOAM.

The typical Shelby loam has a brown to dark-brown surface soil, from 10 to 20 inches deep, having the characteristics of a silty loam, but containing a relatively high content of fine sand mixed with small, fine, and coarse gravel and boulders in varying quantities. The subsoil consists of a gray to yellow, compact clay with admixtures of fine sand, small pebbles, gravel, and boulders.

The surface soil is ordinarily rather more open in structure than that of Marshall silt loam. Because of the variable content of gravel and boulders, the type includes some marked local variations, too small to indicate separately on a map of the scale used in the soil survey. In the main, however, the dark silt loam with a moderate admixture of fine sand, pebbles, gravel, and boulders prevails over possibly four-fifths of the type as mapped. In many cases farmers have removed the larger boulders, leaving the type similar to the

Marshall silt loam, so far as superficial appearance and cultural operations are concerned. Small exposures of heavy boulder clay are found in the type, which are locally known as "gumbo."

The textural composition of the subsoil is rather more variable than that of the surface material. Usually, however, it is as described above. Cultivation is comparatively easy where the bowlders have been removed from the surface.

The lime content, like that of the other upland types, is uniformly high, lime concretions and lime stains being noticeable in many of the soil sections seen. This, together with the admixture of fine sand and pebbles, gives to the surface soil a structure favorable to absorption of rain water and ease of tillage. The type is said to be more drought resistant than the Marshall silt loam.

The Shelby loam is found in small areas occupying the valley slopes of the western five-sixths of the county and associated with its related upland type, the Marshall silt loam. Some small areas are also found within the Knox silt loam zone on the valley slopes in the northern part of the county. The greatest development, however, is found in the western part of the county along the Little Nemaha River and its many tributary valleys.

The topography is rolling to rather steep and broken, the latter feature rendering the type suitable mainly for forestry, orchards, and pasture, while the less hilly portions can be used for crops. The natural drainage is good.

The Shelby loam is derived from the weathering of the Kansan glacial drift sheet. The bowlders include granite, gneiss, trap, Dakota sandstone, Sioux quartzite, and limestone. The glacial drift material itself owes its origin largely to the trituration of the limestone and shale of the underlying Pennsylvanian formation by the glacial ice field. The bowlders were probably largely covered by the finer material of the till. Subsequently, the streams in forming the present drainage channels have exposed the underlying till and left the bowlders now found on the surface. The loessial character of the fine-earth portion of some of the type suggests modification of the type by wind action.

The native vegetation of the Shelby loam includes the usual prairie grasses and some thirty or more species of leguminous plants, possibly two-thirds of which are indigenous to this type. Among the more important may be mentioned the wild licorice, the beggar tick, the partridge pea or wild senna, the white thimbleweed, and the wild indigo. Some of the more stony slopes are in forest, consisting largely of oak. Here the boulder till seemed to be resting largely on a substratum of Dakota sandstone, or Aftonian sand.

The Shelby loam produces good yields of the staple crops, such as corn, wheat, oats, clover, and timothy, alfalfa, millet, and the

sorghums. The cultivable portion of the type can be farmed along lines similar to those outlined for other upland types.

Deep plowing is advisable to insure a more ready absorption of rain water and the prevention of washing and gullying that results from shallow plowing. The use of the lister for corn is not advised as it tends to promote erosion of the soil and loss of rain water that should be retained for crop use. Some of the slopes have more or less seepage water at or near the surface. Such areas where not too wet are well adapted to tree fruits, and considered almost equal to the Knox silt loam for this purpose. Corn on this type yields from 25 to 60 bushels to the acre, wheat from 20 to 35 bushels, oats from 15 to 35 bushels, clover from 1 to 2 tons, and alfalfa from 2 to 3 tons.

Land values are somewhat lower than for the other upland types, ranging from \$25 to \$75 an acre, depending upon location and improvements.

The following table gives the results of mechanical analyses of samples of soil and subsoil of this type:

Mechanical analyses of Shelby loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
370809.....	Soil.....	1.0	3.9	5.8	11.6	7.6	47.8	21.4
370810.....	Subsoil.....	.8	3.9	4.7	9.5	7.7	38.4	34.9

WABASH SILT LOAM.

The Wabash silt loam is the most extensive bottom-land soil of the county. The surface soil consists of a dark-brown to black silt loam, from 10 to 20 inches deep, underlain by a dark-gray to gray silt loam, usually much more compact than the surface soil. The latter varies more or less and includes areas with a considerable content of very fine sand, and others in local depressions, found chiefly between the stream channels and valley slopes, having a darker and heavier silt loam soil. The lighter-textured and higher-lying phases of the type are usually found adjacent to the stream channels. Mainly, however, the surface soil is as first described.

The Wabash silt loam is found extensively throughout the county and includes all of the bottom land within the uplands. Areas of the type are thus found in nearly every section of land in the county.

Some of the major stream valleys, such as that of the Little Nemaha River and its larger tributaries, include areas of the type, one-half mile to 1½ miles in width, while the many minor valleys and draws are from one-eighth to one-fourth mile wide. In the wider valleys the alluvial material is often from 10 to 30 feet thick.

The surface of the type is rather level, with occasional slight elevations and depressions. The higher elevations are commonly found near the stream channels and the lower levels at the foot of the valley slopes.

The flow of the streams is fairly rapid, the fall being from 5 to 15 feet to the mile. The channels are crooked, narrow, and deeply eroded, in some cases from 10 to 20 feet below the general level of the alluvial plain. During excessive rainfall these streams often overflow their banks, causing considerable injury to crops. Straightening some of these channels and removing the drift-wood obstructions will lessen danger from this source. Ditches and canals extended through the depressions with outlets in the stream lower down its course would insure more rapid and complete relief from excess water. When the streams are at normal flow, the natural drainage of the type is good.

The type is of alluvial origin and composed of material derived from the adjoining silt loam uplands. Each overflow adds productive sediments to the type, though the distribution of weed seeds by this means is sometimes a serious disadvantage.

Wabash silt loam, colluvial phase.—Many of the narrow drainage ways and all of the draws contain a soil having both alluvial and colluvial characteristics. The soil of colluvial origin seems to predominate, and such areas have been indicated on the map as a colluvial phase of the Wabash silt loam. A narrow strip of colluvial material borders much of the true bottom land, but the scale of the map used is too small to admit mapping separately many of these minor variations.

Much of the colluvial phase is wet with seepage water, and this gives the phase a bottom-land character, as far as native vegetation and crop adaptation are concerned. In some cases the seepage water is so abundant that both the colluvial phase and true bottom land are excessively wet, resulting in the development of rather swampy conditions. A line of tile or ditch near the foot of the valley slopes is usually sufficient to carry off such excess water.

The native vegetation of the Wabash silt loam includes various lowland grasses, herbaceous plants, and trees. The latter commonly include willow, box elder, walnut, ash, and cottonwood. The trees are usually found near the streams.

Corn and wheat are the crops commonly grown on the type. Corn is not so liable to injury from overflow where surface drainage is such as to favor rapid removal of the excess water, and early fall seeding of wheat makes for early maturity and harvesting before any late June overflow. Oats and spring wheat do not as a rule do so well on this type, lodging and fungus diseases being troublesome. Clover and timothy give good results as a rule. On some of the

higher levels comparatively free from overflow alfalfa yields well, though the acreage at present is small. On the higher levels truck crops do well also.

Corn yields from 30 to 80 bushels, wheat from 20 to 30 bushels per acre, and clover and timothy and wild hay from 1 to 2 or more tons per acre. The low, poorly drained areas are usually left in native grass, which is cut for hay. These areas also furnish pasturage.

In case of serious injury or destruction of the regular spring crops by overflow the land may be utilized for the remainder of the season in growing some of the catch crops, including millet, early corn, sorghum, rye, and rape.

In order better to control weeds and to maintain the conditions in the soil necessary to high yields, some careful and systematic crop rotation, such as outlined in the chapter on agriculture in this report, may be used to advantage. Deep plowing and thorough cultivation of such crops as corn are essential to the destruction of weeds, the latter being rather troublesome on the type. The conserving of soil moisture in the subsoil is also necessary, as these soils are often more susceptible to drought than some of the upland soils.

Over half of the type is in cultivation, while the remainder is wild hay or pasture land. Many of the farms are well improved and adequately equipped.

Owing to the varying conditions as to overflow and drainage land values vary widely, from \$25 to \$100 or more an acre. The price also depends upon other local conditions.

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

Mechanical analyses of Wabash silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
370813.....	Soil.....	0.1	0.2	0.3	0.5	3.1	77.6	18.1
370814.....	Subsoil.....	.0	.2	.2	.5	1.7	67.5	29.9

WABASH SILTY CLAY LOAM.

The surface soil of the Wabash silty clay loam consists of a dark-brown or dark-gray to black silty clay loam from 6 to 8 inches deep, underlain by a dark-gray to mottled light-gray clay subsoil rather more compact in structure than the surface soil. In deeper strata the subsoil may show more or less admixture of fine sand.

Local variations occur throughout the type, consisting of depressions having a quite clayey character, which are locally known as "gumbo."

The Wabash silty clay loam occurs in small scattered bodies in the Missouri River bottom, the area aggregating over 4 square miles.

The surface of the type is rather level as a whole, with occasional depressed areas, some of which are somewhat swampy. Surface ditching can be used to advantage on much of the type to insure better drainage.

The type owes its origin to silting up of old, abandoned channels of the Missouri River. Some of the lower depressions are now filling with silt and clay received from backwater and depositions from general overflows.

The lower swampy depressions support a growth of swamp grass, herbaceous shrubs, cottonwood, and willow, and are best adapted for pasture.

The higher areas in the northeastern and southwestern parts of the county, lying 8 to 15 feet above the normal flow of the Missouri River, are utilized to advantage for corn, wheat, clover, and timothy, and to some extent for alfalfa. Corn is the crop most commonly grown on the type, the yield ranging from 30 to 60 bushels per acre.

Where deep plowing with thorough disking and harrowing is practiced on the higher levels, with clover used in the crop rotation, the tilth is much improved, making possible the growing of nearly all the principal field crops common to the county. The matter of good tilth or the maintenance of an open, friable structure in the surface soil is perhaps a little more difficult than in the case of the more silty soils.

The crop rotation and soil management noted for the types previously described may in the main be followed with advantage on the Wabash silty clay loam also.

The land values of this type range from about \$25 to \$75 an acre.

SARPY VERY FINE SANDY LOAM.

The Sarpy very fine sandy loam consists of a brown to light-brown very fine to fine sandy loam, from 8 to 15 inches deep, underlain by a subsoil of fine sandy loam similar in color to the soil and becoming more open and sandy with depth. Both soil and subsoil include thin layers of varying textures and when these occur at the surface they give rise to local variations according as the heavier or lighter layers predominate.

The type is not very extensive, aggregating about 5 square miles. It is found in the Missouri River bottoms. The topography is level to moderately undulating, with occasional low, sandy ridges. The elevation of the type above normal flow of the Missouri River varies from 8 to 15 feet. Natural drainage is good.

The Sarpy very fine sandy loam owes its origin to deposition of alluvial material from successive overflows of the Missouri River.

This alluvium in a vertical section shows a structure made up of alternate layers of varying thickness and texture, each layer representing more or less definitely a period or stage of overflow and ranging from sand to silt or clay, as the case may be. The upper surface 10 to 20 inches may itself include several of these layers of varying textures. Most of the type now lies above overflow, while some of the lower levels are subject to overflow and to change in textural character. In places the river is encroaching on the type, converting it again into silt and sand flats, or to the stage denoted as Riverwash.

The lower levels support a native growth of swamp grass, willow, and cottonwood. Such areas are well suited to pasturage. Much of the type is in cultivation, producing corn, wheat, clover, and wild hay. Truck crops, such as Irish potatoes, sweet potatoes, melons, and cabbage, are also produced on the type. Corn is the principal crop, yielding from 30 to 60 bushels to the acre. The field crops and cultural methods suggested for the other bottom-land soils may be used to advantage on this type. The growing of clover and the occasional plowing under of the clover sod would add to the organic content of the soil, improve its physical condition, and thus do much to improve its productiveness. Liberal applications of barnyard manure are advisable, especially where truck crops are grown. Deep plowing and thorough cultivation are necessary for the best results with such crops as corn.

Land of this type of soil is valued at \$25 to \$80 an acre.

RIVERWASH.

The area of Riverwash in Otoe County is not extensive, only 4.5 square miles being shown. It has no agricultural value at present. The term is used to include mud, silty flats, and sand bars in the Missouri River but little elevated above the normal flow. Any material rise of the river covers the type and reassorts its material, changing the location more or less with each overflow.

SUMMARY.

Otoe County is one of the leading agricultural counties of the eastern part of Nebraska. It contains approximately 606 square miles, or 387,840 acres.

The upland ranges in elevation from 1,000 feet above sea level on the east, rising progressively to about 1,400 feet on the west. Stream valleys ramify the county throughout, giving the surface a rolling to hilly topography. The hills, however, are rather smooth and, as a rule, easily cultivated. The drainage is mainly east and southeast, into the Missouri River.

The annual precipitation is approximately 30 inches, about three-fourths of which falls with greater or less uniformity during the growing months, from April to September, inclusive, droughts being rather uncommon.

Three or four farms are found, as a rule, on each section of land. The farms are usually well improved and good farming practice prevails.

Agriculture in the county dates from 1856. The system followed is general farming combined with some live-stock raising. Corn, wheat, oats, clover, timothy, alfalfa, and wild hay represent the greater part of the crop value in the order named. Truck crops, orchard fruits, small fruits, and poultry are not produced, except to meet the domestic needs and the demands of the local markets.

Nearly half the farms in the county are operated by tenants. These and some of the farms operated by owners are given largely to growing corn and small grain. Clover is not used sufficiently in the crop rotation, and the average yields are low. The consistent use of clover in the rotation would nearly double present yields.

Drainage, protection from overflow, conservation of soil moisture by deep plowing and surface cultivation, control of washing and gullying are handled with greater or less success by the farmers. More attention should be given to the control of plant diseases and to the selection of seed.

Seven soil types, including Riverwash, were mapped in the county, representing five different series. These may be divided into two broad groups, the upland and alluvial, or bottom-land soils. Practically all are deep, well-drained soils, suited to a wide range of crops.

The Knox silt loam is considered one of the best of the upland soil types. It is extensive in area and well suited to practically all the general farm crops grown in the county, as well as to orchard fruits, small fruits, and vegetables, although the latter are grown mainly for home use. It is regarded as more drought resistant than the other types, and crops are also less likely to show decreased yields in seasons of protracted rainfall.

The Marshall silt loam is about equal in productiveness to the Knox silt loam, and has the same crop adaptation, although the more compact subsoil makes this type less drought resistant than the Knox silt loam.

The Shelby loam, owing to its high content of gravel, pebbles, and small boulders, is not so well suited to field crops as the Knox or Marshall silt loams. The less stony phases can be used for the ordinary farm crops, while those having a greater stone content can be used for fruits or pasture or left in forest.

The bottom-land soils are all more or less subject to overflow. Though usually valuable and productive, overflow makes crops more

or less uncertain. In some cases drainage is necessary or would add materially to crop yields. The Wabash and Sarpy soils are included in this group.

The Wabash silt loam is the dominant soil of the alluvial group. It is extensively developed in the stream bottoms throughout the county. It is well suited to all field crops, especially to corn, and to some extent to truck crops.

The Wabash silty clay loam is developed to a small extent in the Missouri River bottom. It also is well suited to corn and other field crops and to pasture.

The Sarpy very fine sandy loam is developed to a small extent in the Missouri River bottom. It is well adapted to corn and other field crops, as well as truck crops.

Riverwash includes the silt flats and sand bars of the Missouri River, and at present has no agricultural value.

The average price of farm land in Otoe County has more than doubled during the last 10 years. The better improved farms now have a value of \$100 to \$200 an acre. The more stony lands and those more or less subject to overflow are much cheaper, and from \$25 to \$75 an acre is asked for some of these soils.

Accessibility Statement

The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at (800) 457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at <http://offices.sc.egov.usda.gov/locator/app>.

The USDA Target Center can convert USDA information and documents into alternative formats, including Braille, large print, video description, diskette, and audiotape. For more information, visit the TARGET Center's Web site (<http://www.targetcenter.dm.usda.gov/>) or call (202) 720-2600 (Voice/TTY).

Nondiscrimination Policy

The U.S. Department of Agriculture (USDA) prohibits discrimination against its customers, employees, and applicants for employment on the basis of race, color, national origin, age, disability, sex, gender identity, religion, reprisal, and where applicable, political beliefs, marital status, familial or parental status, sexual orientation, whether all or part of an individual's income is derived from any public assistance program, or protected genetic information. The Department prohibits discrimination in employment or in any program or activity conducted or funded by the Department. (Not all prohibited bases apply to all programs and/or employment activities.)

To File an Employment Complaint

If you wish to file an employment complaint, you must contact your agency's EEO Counselor (http://directives.sc.egov.usda.gov/33081_wba) within 45 days of the date of the alleged discriminatory act, event, or personnel action. Additional information can be found online at http://www.ascr.usda.gov/complaint_filing_file.html.

To File a Program Complaint

If you wish to file a Civil Rights program complaint of discrimination, complete the USDA Program Discrimination Complaint Form, found online at http://www.ascr.usda.gov/complaint_filing_cust.html or at any USDA office, or call (866) 632-9992 to request the form. You may also write a letter containing all of the information requested in the form. Send your completed complaint form or letter by mail to

U.S. Department of Agriculture; Director, Office of Adjudication; 1400 Independence Avenue, S.W.; Washington, D.C. 20250-9419; by fax to (202) 690-7442; or by email to program.intake@usda.gov.

Persons with Disabilities

If you are deaf, are hard of hearing, or have speech disabilities and you wish to file either an EEO or program complaint, please contact USDA through the Federal Relay Service at (800) 877-8339 or (800) 845-6136 (in Spanish).

If you have other disabilities and wish to file a program complaint, please see the contact information above. If you require alternative means of communication for program information (e.g., Braille, large print, audiotape, etc.), please contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).