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UNITED STATES DEPARTMENT OF AGRICULTURE

Soil Survey

of

Loup County, Nebraska

By

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Nebraska Soil Survey, in Charge

and

F. A. HAYES
United States Department of Agriculture

Bureau of Chemistry and Soils

In cooperation with the
University of Nebraska State Soil Survey
Department of the Conservation and Survey Division

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SOIL SURVEY OF LOUP COUNTY, NEBRASKA

By BASIL ABASKIN, Nebraska Soil Survey, in Charge, and F. A. HAYES,
United States Department of Agriculture

COUNTY SURVEYED

Loup County is in north-central Nebraska (fig. 1). Taylor, the county seat, is about 155 miles northwest of Lincoln. The county is almost square, each boundary being about 24 miles long. It comprises 576 square miles, or 368,640 acres.

The county is in the Great Plains physiographic province, mostly within the vast sand-hill section of Nebraska, although the southern part includes the eroded northern edge and scattered outlying remnants of the loess section.

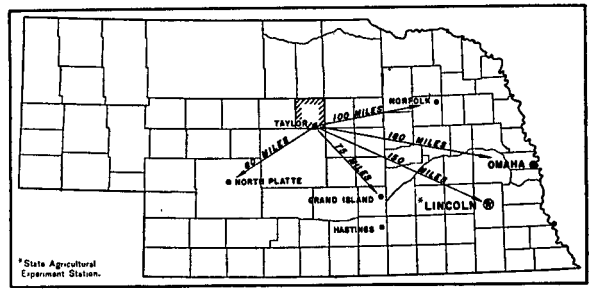

FIGURE 1.—Sketch map showing location of Loup County, Nebr.

The relief in the sandy areas has been produced largely by wind, and a typical sand-hill topography prevails. Over most of the county, incoherent sand has been piled into irregularly distributed dunes and ridges, from 10 to 80 feet high. Most of the dunes are covered with grass, are fairly stable, and have well-rounded tops, although some, locally known as "choppies", are much more angular. Here the grass cover has been destroyed and the sand has been whipped into sharp-topped hills and ridges, most of which are pitted by blow-outs, especially on their north and west sides.

The generally hilly relief of the sand hills is relieved here and there by nearly level or undulating areas and by numerous small pockets and basins. It is further modified by the broad, flat-bottomed, and rather shallow valleys of North Loup and Calamus Rivers which flow southeast across the southern and central parts of the county, respectively.

The relief along the northern edge of the loess section has been produced mainly by water erosion, but it has been modified in many places by drifting sand. Most of the loess-mantled upland is in the extreme southern part of the county. Outlying areas of loess, more or less mixed with sand, are scattered throughout the sand hills in the southern half of the county, and surface wash from this material has given some of the alluvial lands a loesslike character.

Along its northern edge the main loess deposit has been deeply carved by an intricate system of tributaries leading to North Loup River. It still includes a few high flat-topped divides which rise

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from 30 to 100 feet above intervening V-shaped valleys and mark the approximate level of a former loess plain that extended northward beyond the present boundaries of the loess section. Throughout most of their area the loessial uplands have been reduced by geologic erosion to a level far below that of the old plain. Parts of them have received so much wind-blown sand that the loess remains at the surface only near the centers of enclosed valleys and pockets surrounded by higher lying sandy deposits. In some localities throughout the sand hills the loess has been blown or washed into the lower situations where it rests on gray sand.

Alluvial lands, including the terraces and bottom lands, comprise about 7 percent of the county. They occupy continuous strips, ranging from one-half mile to 2 miles in width, along North Loup and Calamus Rivers and narrow broken strips along a few short tributaries to the North Loup, and along Skull, Bloody, Gracie, and Dry Creeks which empty into the Calamus from the north.

The terraces are more extensive than the bottom lands. They occur chiefly along the rivers where they lie from 6 to 15 feet above the flood plains and are not subject to overflow from the main streams. Most of them are nearly level or very gently undulating, except those areas where the terrace material is composed largely of incoherent sand, in which the wind has produced strongly undulating or rather hummocky relief.

The bottom lands occupy the lowest positions. They occur in strips of various widths, most of them narrow, along all the larger and many of the smaller drainageways. They are nearly level but are modified in places by old and active stream channels, cut-offs, slight elevations, and shallow depressions. They are subject to overflow during flood stages of the streams.

The average elevation of the county is about 2,400 feet above sea level. The highest point is probably in the sandy uplands in the northwest part and the lowest, about 1,550 feet, is in the bed of North Loup River at the place where this stream crosses the eastern county line.

All the county, except parts of the bottom lands and a few basinlike depressions on the sandy uplands, is well drained. North Loup and Calamus Rivers and most of the creeks throughout the sand hills have from moderate to low gradients and, at places, are aggrading their channels. The rest of the drainageways have steep gradients, especially those issuing from the loessial uplands south of North Loup River. The rivers and Skull and Bloody Creeks are the only perennial streams.

Well water of excellent quality is readily obtained in all localities. Most of the upland wells in the sand hills and loess-covered areas range from 100 to 350 feet in depth. The deepest wells are on the higher loessial divides. Water in the alluvial lands is obtained at depths ranging from 30 to 100 feet.

The native vegetation consists chiefly of grasses. Grama, big bluestem, and little bluestem predominate on the loess-covered areas; needlegrass and sandgrass are the leading species on the sandy soils; and in the bottom lands sloughgrass and panic grass grow luxuriantly.

Narrow belts of native broad-leaved (deciduous) trees, chiefly willow, boxelder, elm, ash, and cottonwood, are along the rivers.

Scrub cedar grows densely in a few canyons in the southern part of the county. The trees are not of merchantable size but are of value for firewood and posts.

The first permanent settlement in the area now included in Loup County was made in 1873 in the North Loup Valley, a few miles east of the present town of Taylor. Within the next few years most of the land was included in homesteads. The county was established and organized from unorganized territory in 1883, and its boundaries have remained unchanged.

According to the Federal census the county had 1,818 inhabitants in 1930, all classed as rural. All the people are white, and 97.3 percent of them are native born. The density of the population averages 3.2 persons to the square mile. The population is densest in the larger stream valleys, on the broader and more nearly level loessial divides, and in the vicinity of Taylor. The sand hills and the rougher parts of the loess uplands are sparsely settled.

Taylor, the county seat, had a population of 272 in 1930. It is in the south-central part of the county and affords a market for a part of the surplus farm products. Almeria and Valleyview afford local markets for farm supplies and produce.

The public-road system is fairly well developed, except in the rougher and more sandy parts where construction and maintenance of roads are expensive. United States Highway No. 83 crosses the central part in a general north-south direction passing through Taylor, and a State highway extends east from Taylor. These roads are surfaced with gravel, and the county roads are of earth construction. Most of those in the loess-covered uplands follow section lines and are kept in good repair, but those in the sand hills receive little attention. Most of them are trails which follow the valleys and have gates on all property lines.

Telephones and rural mail routes reach nearly all sections, and the public-school system is well developed. Surplus farm products, mainly livestock, are shipped to outside markets, chiefly Omaha.

CLIMATE

The climate of Loup County is of the midlatitude continental type. It is characterized by a wide range in temperature and precipitation between winter and summer, but is well suited for producing feed and vegetable crops and for raising livestock. The spring season is cool with much rainy weather which favors the rapid growth of pasture grasses and facilitates storage of soil moisture for farm crops.

The summers are long, with warm days and nights, which are especially favorable for the growth of corn. The autumns are long and temperate with only occasional periods of rainy weather, giving the farmers ample time to harvest the corn crop. Low temperatures prevail during the winter and are usually accompanied by snow which moistens the surface of the ground and helps to prevent drifting of the soils.

The precipitation varies greatly from year to year. About 74 percent of it falls from April to September, inclusive, or during the principal part of the growing season. It comes chiefly as heavy thundershowers. Snow falls mainly during the period from December to March, inclusive. It varies annually from a few inches

to several feet, but averages less than 16 percent of the mean annual precipitation.

In average years there is sufficient moisture for successful farming on the finer textured soils, without rigid adherence to dry-farming methods. Drought is almost unknown during April, May, and June. In July the rainfall is less favorably distributed, and during August and September long droughts sometimes occur, causing reduced yields of grain and hay. Total crop failures, however, are rare.

No Weather Bureau station is maintained in Loup County, but, according to the records of the station at Purdum, about 50 miles northwest of Taylor, the average date of the last killing frost is May 8 and that of the first is September 30. This gives an average frost-free period of 145 days which is ample for the maturing of all the crops commonly grown. During the 20 years,[1] from 1898 to 1914, there were five times in which killing frosts occurred 10 or more days earlier in the fall than the average date and four times in which they were 10 or more days later in the spring. Killing frost has been recorded at Purdum as late as May 27 and as early as September 12.

From about October 1 to April 1 the prevailing wind is from the northwest, and during the rest of the year it is from a southerly direction. Strong winds are common, but tornadoes are rare. Table 1, compiled from the records of the Weather Bureau station at Pur-

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Purdum, Blaine County, Nebr.*

[Elevation, 2,600 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1931)	Total amount for the wettest year (1915)	Snow, average depth
	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*	*Inches*
December	24.7	74	−27	0.91	0.78	1.35	6.2
January	21.8	67	−35	.59	.37	1.55	5.0
February	25.8	70	−34	.83	.83	2.22	6.8
Winter	24.1	74	−35	2.33	1.98	5.12	18.0
March	35.6	89	−18	1.25	2.60	3.31	9.8
April	47.2	98	4	2.37	1.23	6.04	5.4
May	57.1	98	16	3.22	1.05	3.37	1.3
Spring	46.6	98	−18	6.84	4.88	12.72	16.5
June	67.2	106	33	3.26	1.50	4.72	0
July	73.4	108	39	3.25	1.88	2.98	0
August	71.7	106	37	3.14	1.91	2.36	0
Summer	70.8	108	33	9.65	5.29	10.06	0
September	62.6	102	21	1.70	.80	5.83	(1)
October	50.4	96	2	1.52	.34	2.00	3.5
November	36.9	81	−16	.73	1.12	.23	5.1
Fall	50.0	102	−16	3.95	2.26	8.06	8.6
Year	47.9	108	−35	22.77	14.41	35.96	43.1

[1] Trace.

[1] REED, W. G. FROST AND THE GROWING SEASON. U. S. Dept. Agr., Atlas of American Agriculture, pt. 2, Climate, sec. 1, p. 9 (Advance sheets no. 2), illus. 1918.

dum in Blaine County, gives the more important climatic data which are representative of climatic conditions in Loup County.

AGRICULTURE

The first white men to enter the area now included in Loup County were roving trappers and hunters who subsisted mainly on wild game, fish, and fruit. They were followed by cattlemen who were attracted to the section by the luxuriant grass cover and the abundant water supply. The cattle range was practically unlimited until about 1873 when settlers from the Eastern States began to homestead the land, forcing the cattlemen to move their herds farther west.

The first settlers located mainly in the valleys of North Loup and Calamus Rivers, where water was readily obtainable and where the relief favored easy tillage. By 1890 most of the land, even throughout the sand hills, was homesteaded. The early settlers came largely from farming sections in more eastern States and were not familiar with the climatic and soil conditions here. Much of the land in the sand-hill section was placed under cultivation. This resulted throughout the more sandy areas in almost total crop failures and in temporary ruin of the land for grazing. There was little or no market for the crops, and transportation facilities were poor. In addition the settlers were handicapped by a succession of exceptionally dry years which culminated in the severe droughts of the early nineties. Many of the farmers became so impoverished that they were forced to leave the county. By 1900, the population had decreased more than 20 percent from that recorded in 1890, and most of the sand-hill land was again acquired by cattlemen who operated within fenced ranches.

Under the present agricultural system the alluvial lands and the nearly level loessial uplands are used for producing grain and tame hay and to a small extent for dairying. The sand hills and the rougher parts of the eroded loess hills are not suited for cultivated crops and are devoted to grazing and wild hay, in connection with cattle raising which is the principal source of income.

Corn has occupied most of the cultivated land since farming began. The corn acreage, however, has always been exceeded by the area devoted to pasture and since about 1909 by that used for wild hay. In most years oats have ranked next to corn among the grain crops, largely because they are needed for livestock feed. The acreage in rye has greatly increased since early settlement, especially on the more sandy soils. Wheat is grown on only a few farms, and nearly all of it is sold for cash. No grain crop is grown so extensively in Loup County as in counties where the land is less sandy.

According to the Federal census, crops were harvested on 55,907 acres, or on only about 15 percent of the area of the county, in 1929. This included 22,272 acres on which wild hay was cut. Most of the rest of the land is devoted to grazing.

Most of the farms and ranches range in size from 320 to 1,000 acres, but there are several small holdings. The average size of the 317 farms, which included 67.2 percent of the county in 1930, was 781 acres.

Farms in the river valleys and throughout the loessial uplands are generally better improved than in the more sandy sections. Most of the houses are one-story wooden structures, which generally are kept in good repair. A few sod houses of the pioneer settlers remain in the sand hills. Most of the barns and other outbuildings are large enough to store the crops, except hay which is stacked in the field. The Nebraska agricultural statistics for 1930 report 40 farmhouses with modern heating plants, 47 with running water, 44 equipped with electricity, and 101 with radios. The tillable land is fenced and cross fenced. In the rougher and more sandy sections few of the ranches are cross fenced, but all are enclosed with barbed wire.

The work animals on the farms are heavy draft horses and mules, but saddle horses of lighter breeds are kept on all the cattle ranches. Some farmers use tractors and trucks for the heavier farm work. There were 17 tractors, 42 gas engines, 31 trucks, 299 automobiles, 3 grain threshers, and 1 combine on the farms in 1930. Modern labor-saving machinery is in general use, and the more expensive equipment is kept under shelter.

Farm labor during the last few years has been plentiful and unusually cheap. Monthly wages range from $15 to $20 with board and lodging. Day labor is plentiful at $1. Most farmers do their own work except during the hay-harvesting season, when much help is hired.

The Federal census reports owners and part owners on 55.6 percent, tenants on 42.9 percent, and managers on 1.5 percent of the farms in 1935. Tenancy has greatly increased since 1890, when only 12.9 percent of the farms were operated by tenants.

According to the Nebraska agricultural statistics, 54 percent of the acreage occupied by tenants was rented for cash and the remainder for a share of the crops in 1930. Under the cash system the tenant pays from $2 to $5 an acre for the better grade of farming land and $100 to $150 a section (640 acres) for pasture. Under the share system the tenant generally receives two-thirds of the grain and one-half of the hay, and he furnishes all labor, seed, and machinery.

The Federal census gives the average acre value of the land and buildings as $8.13 in 1935. The selling price of individual farms and ranches ranges widely, depending on the character of the soil, relief, drainage, improvements, and location with respect to markets. The highest priced land is in the North Loup Valley in the vicinity of Taylor.

Livestock raising is the most important occupation. The value of all domestic animals, chickens, and bees on farms on April 1, 1930, was $876,198, whereas the value of all crops and forest products for home use and sale was $435,678. Cattle represent about 72 percent of the value of livestock; horses, mules, and burros about 14 percent; and hogs about 10.5 percent. The remaining 3.5 percent represents the value of chickens, sheep, goats, and bees.

Table 2, compiled from the Federal census reports, gives the number and value of all domestic animals and poultry in 1900, 1910, 1920, 1930, and 1935.

TABLE 2.—*Number and value of livestock in Loup County, Nebr., in stated years*

Livestock	1900		1910		1920		1930		1935	
	No.	*Value*	*No.*	*Value*	*No.*[1]	*Value*	*No.*[2]	*Value*	*No.*[3]	*Value*[4]
Cattle	9,067	----	11,242	$249,949	12,771	$589,810	12,460	$632,620	12,022	----
Swine	6,020	----	6,960	64,589	6,946	122,441	6,878	92,056	2,216	----
Horses	2,300	----	3,354	296,895	3,441	167,394	2,697	106,434	313	----
Mules	120	----	266	23,080	417	31,834	292	15,236	129	----
Sheep	1,208	----	221	1,470	212	2,678	1,171	8,301	959	----
All poultry	[5]16,772	$3,753	19,084	9,540	27,832	18,912	[5]26,773	20,347	20,547	----

[1] Number on farms and ranges only.
[2] Number on farms and ranges only as of Apr. 1.
[3] Number on farms and ranges only as of Jan. 1. Greatly reduced because of shortage in feed crops due to drought.
[4] Not available.
[5] Chickens only.

More cattle are raised than all other livestock. Most of the cattle are grade animals, but the herds are usually headed by purebred Hereford or Shorthorn bulls. Some cattle are purchased for summer grazing, but most of them are raised within the county. After coming off summer range, most of the cattle are shipped to Omaha as stockers or feeders.

Dairying is of minor importance, and no farm is devoted exclusively to this pursuit. From four to eight milk cows, mainly of beef breeds, are kept on most farms. The greater part of the surplus dairy products, mainly cream, is sold at cream stations in Taylor and to a cooperative creamery in Burwell, Garfield County. The value of dairy products, excluding those used for home consumption, was $91,485 in 1929.

Hog raising is important on the finer textured soils in the southeastern and south-central parts of the county where corn and alfalfa can be grown, but only a few hogs are raised in the sand hills. All the hogs are of good breeding, and there are several purebred herds. Duroc-Jersey, Poland China, Spotted Poland China, and Hampshire are the leading breeds.

There are a few flocks of sheep, but sheep raising is comparatively unimportant. Several farmers ship in from 100 to 300 sheep annually and graze them in the rougher parts of the loessial uplands during the summer.

Draft horses are raised on nearly all farms, and much improvement has been made in them through the introduction of purebred Percheron stallions. Horses are an important source of income on some ranches in the sand hills. Mules are raised on many farms, and during recent years the demand for these animals has exceeded that for horses.

Poultry and poultry products are produced on every farm, and they are either sold or are exchanged for farm supplies. As the demand for poultry products is good, poultry raising receives considerable attention. Leghorn, Rhode Island Red, and Plymouth Rock are the leading breeds of chickens. In addition to chickens, many farmers raise turkeys, ducks, geese, and guinea fowls.

By far the greater part of the county retains its native grass cover and is used for pasture and hay land. According to the Federal census, only about 34,000 acres, or slightly more than 9 percent

of the land, was used for the production of grain, tame-hay, and forage crops in 1929. Table 3, compiled from the census reports, gives the acreage of the principal crops in 1889, 1899, 1909, 1919, 1929, and 1934.

TABLE 3.—*Acreage of the leading crops in Loup County, Nebr., in stated years*

Crop	1889	1899	1909	1919	1929	[1] 1934
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Corn [2]	11,893	11,619	17,788	16,400	18,432	265
Oats	1,599	824	4,239	3,720	4,246	133
Wheat	1,107	8,297	1,581	2,268	433	36
Rye	445	223	290	4,282	1,184	643
Barley	46	221	44	195	214	-------
Potatoes	265	139	317	126	175	60
All hay	8,097	6,926	26,091	31,060	27,283	20,458
Wild hay	-------	6,066	22,910	26,215	22,272	[3] 18,559
Alfalfa	-------	199	2,261	2,796	3,796	1,823
Clover	-------	2	20	56	219	66
Timothy and timothy and clover mixed	-------	-------	193	38	220	10
Other tame grasses	-------	643	669	1,503	525	-------
Grains and legumes cut green	-------	16	38	452	231	-------

[1] Acreage and production greatly reduced by drought.
[2] Harvested for grain only.
[3] Includes a few acres in tame grasses.

Average crop yields over long periods are fairly uniform, but the yields vary considerably from year to year, depending on the amount and distribution of the precipitation.

Table 4, compiled from the Nebraska agricultural statistics, shows the average acre yields of the leading crops during the 10-year period, 1920 to 1929, inclusive, and the approximate percentage of the land devoted to each crop in 1929.

TABLE 4.—*Average acre yield of the more important crops in Loup County, Nebr., during the 10-year period 1920 to 1929, inclusive, and the approximate percentage of the area of the county occupied by each crop in 1929*

Crop	Average acre yield	Area occupied by by crop	Crop	Average acre yield	Area occupied by crop
	Bushels	*Percent*		*Tons*	*Percent*
Corn	22.2	5.40	Wild hay	0.8	7.00
Oats	25.0	1.50	All tame hay	1.9	1.50
Spring wheat	10.7	.04	Alfalfa	2.1	.90
Winter wheat	13.3	.06	Sweetclover	1.8	.10
Barley	20.5	.05	All other cultivated crops	----------	1.17
Rye	10.3	.50			
Potatoes	74.5	.08			

Corn, the leading cultivated crop, is planted in May, generally with a corn lister. It is cultivated three or four times during the season. The last cultivation is given in July, after which the crop receives no further attention until harvest. Corn matures in September or early in October, depending on the season. The greater part of it is husked from the standing stalks, after which cattle and horses are pastured in the fields during the winter. Corn usually follows small grains or alfalfa in the rotations, although on many farms it is grown on the same land a number of years in succession. The seed used is from corn which has been grown

in the locality for many years and is known to have become adapted to local climatic and soil conditions.

The Kherson and Fulghum varieties of oats are the ones most extensively grown. This crop furnishes feed for work animals, colts, and calves, and it is of value as a step in the rotation between corn and alfalfa. The land to be used for oats is generally plowed and harrowed, and the seed is planted with a press drill in April. Oats mature in July and are cut with a header and stacked for threshing. The straw, which has a higher feeding value than that of most small-grain crops, is fed to horses and cattle. A few farmers import seed from other sections, but the common custom is to clean sufficient seed from the previous crop.

Wheat is of minor importance. Both winter and spring varieties are grown. This crop is sown chiefly on fine-textured soils of the uplands and terraces.

Rye is grown mainly for late fall pasture. When grown for grain it is seeded and harvested like oats, but the seed is planted in the fall instead of the spring. The grain is fed chiefly to hogs.

The acreage devoted to barley is small. This crop, although nearly as valuable as corn and more valuable than oats in a feeding ration, is poorly suited to sandy soils. The land to be used for barley is prepared early in the spring. The seed is planted and the crop harvested in the same manner as for oats. Most of the barley is of the smooth-bearded varieties.

Wild hay is an important crop, as large areas in the sand hills, rougher parts of the loess uplands, and poorly drained bottom lands are unsuited to the production of grain and tame hay. The principal hay grasses in the sand hills are sandgrass, *Stipa*, or needlegrass, and bunch grass. On the fine-textured soils of the uplands, grama, buffalo grass, big bluestem, and little bluestem predominate. The soils of the bottom lands are covered for the most part with a luxuriant growth of coarse water-loving grasses and sedges which produce the highest yields of hay. The upland hay, however, is of finer texture and has a higher feeding value than that from the bottom lands. Hay is stacked in the field and is hauled to the feed lots as needed, or it is baled for sale.

Alfalfa ranks first in acreage among the tame-hay crops. The area devoted to it has fluctuated only slightly during recent years. The main consideration in obtaining a stand of alfalfa is thorough preparation of the seedbed. The seed generally is broadcast on plowed, disked, and harrowed stubble land early in the spring. Occasionally it is planted with a nurse crop of oats, barley, or rye. A stand of alfalfa is allowed to remain as long as the yield is satisfactory. This crop does well on all the finer textured well-drained soils but is rather poorly adapted to incoherent sandy soils. Ordinarily it is cut three times during the growing season. The hay is stacked in the field and hauled to the feed lots as needed, and most of it is fed to cattle and hogs. Many farmers run hogs in the alfalfa fields during the summer. Cattle, however, are seldom allowed to graze on green alfalfa on account of the danger of bloating.

Mixed stands of timothy and clover are grown to some extent on the bottom lands, where the uncertain drainage conditions prohibit the growing of grain or other tame-hay crops. On some farms,

clover and timothy have been sown among the native grasses in the bottom lands in order to increase the quantity and improve the quality of the hay.

Of the minor crops, potatoes, millet, and Sudan grass are the most important. They occupy only a few fields and are fed to livestock on the farms where produced.

There are several fruit orchards on the farms. Most of the trees are in poor condition, as little attention is given to pruning and spraying. The largest orchards are on the terraces. They consist chiefly of apple, cherry, plum, and pear trees. According to the 1930 census report there were, in 1929, 2,212 apple trees, 329 cherry trees, and 220 plum and prune trees. Wild plums and grapes, which grow along the larger streams and canyons, are abundant during favorable seasons.

No definite system of crop rotation is used, although most farmers change their crops with sufficient regularity to prevent the soil from becoming impoverished. Considerable alfalfa is grown. When this crop is plowed under, the land generally is used for corn 2 years, oats 1 year, then rye or wheat, and back to corn. On tenant farms the rotation is governed more by the demand and price for the grain than by the requirements of the soil.

No commercial fertilizer is used. Some farmers apply barnyard manure to the more eroded soils of the loessial areas, but the supply is seldom sufficient for more than a small part of the farm.

SOIL-SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field.

The soils are examined systematically in many locations. Test pits are dug, borings are made, and exposures, such as those in road or railroad cuts, are studied. Each excavation exposes a series of distinct soil layers, or horizons, called, collectively, the soil profile. Each horizon of the soil, as well as the parent material beneath the soil, is studied in detail; and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The reaction of the soil [2] and its content of lime and salts are determined by simple tests. The drainage, both internal and external, and other external features, such as the relief, or lay of the land, are taken into consideration, and the interrelation of soils and vegetation are studied.

The soils are classified according to their characteristics, both internal and external, special emphasis being given to those features influencing the adaptation of the land for the growing of crop plants, grasses, and trees. On the basis of these characteristics, soils are grouped into mapping units. The three principal ones are: (1) Series, (2) type, and (3) phase. There are areas of land, such as riverwash or dune sand, which have no true soil; and these are called (4) miscellaneous land types.

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[2] The reaction of the soil is its degree of acidity or alkalinity expressed mathematically as the "pH value." A pH value of 7 indicates precise neutrality, higher values alkalinity, and lower values acidity.

The most important of these groups is the series which includes soils having the same genetic horizons, similar in their important characteristics and arrangement in the soil profile, and developed from a particular type of parent material. Thus the series includes soils having essentially the same color, structure, and other important internal characteristics, and the same natural drainage conditions and range in relief. The texture of the upper part of the soil, including that commonly plowed, may vary within a series. The soil series are given names of places or geographic features near which they were first found. Thus Norfolk, Hagerstown, Barnes, Miami, Houston, and Mohave are names of important soil series.

Within a soil series are one or more soil types, defined according to the texture of the upper part of the soil. Thus the class name of the soil texture, such as sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam, and clay, is added to the series name to give the complete name of the soil type. For example, Thurman loamy fine sand and Thurman fine sandy loam are soil types within the Thurman series. Except for the texture of the surface soil, these soil types have approximately the same internal and external characteristics. The soil type is the principal unit of mapping and because of its specific character is generally the soil unit to which agronomic data are definitely related.

A phase of a soil type is a subgroup of soils within the type, which differs from the type in some minor soil characteristic that may, nevertheless, have important practical significance. Differences in relief, stoniness, and the degree of accelerated erosion are frequently shown as phases. For example, within the normal range of relief for a soil type, there may be parts which are adapted to the use of machinery and the growth of cultivated crops and other parts which are not. Even though there may be no important differences in the soil itself or in its capability for the growth of native vegetation throughout the range in relief, there may be important differences in respect to the growth of cultivated crops. In such instances the more sloping parts of the soil type may be segregated on the map as a sloping or hilly phase. Similarly, soils having differences in stoniness may be mapped as phases, even though these differences are not reflected in the character of the soil or in the growth of native plants.

The soil surveyor makes a map of the county or area, showing the location of each of the soil types, phases, complexes, and miscellaneous land types, in relation to roads, houses, streams, lakes, section and township lines, and other cultural and natural features of the landscape.

SOILS AND CROPS

The soils of Loup County, as a whole, are better suited for native hay and pasture than for cultivated crops. As previously mentioned, the county is almost entirely within the sand-hill section of Nebraska. It includes areas chiefly in stream valleys, protected situations throughout the sand hills, and on the loessial uplands in the extreme southern part, where cultivation does not result in disastrous wind erosion. Elsewhere the soils are so sandy and un-

stable that the land is temporarily ruined when the grass cover is destroyed.

Except on sand hills and ridges, steep loessial slopes, and recently deposited stream sediments where soil development has scarcely started, the soils have accumulated enough organic matter to darken their surface layers considerably. The intensity of the darkness and the depth to which it extends depend in any given locality partly on the moisture conditions and partly on the length of time the soils have lain in their present position undisturbed by destructive erosion. The topsoils are ordinarily darker and deeper on the more nearly level areas throughout the uplands and on the terraces and bottom lands than they are in rolling situations or on slopes. They average thicker, in areas of similar relief, on silty than on sandy soil material.

All the darker soils, except some which are poorly drained, are suited for cultivated crops. They are friable throughout and are well supplied with nitrogen. The organic matter, which accounts for the dark color, tends to give even the more sandy soils sufficient coherence, or body, to prevent destructive wind erosion if the soil is carefully managed. Most of the darker soils are farmed. The finer textured ones are used for all crops commonly grown. The more sandy ones are used mainly for corn, and to some extent for sweetclover and rye. In general they are unable to hold enough moisture in the upper soil layers for satisfactory yields of wheat and oats.

This county is within the limy soil section of the United States. Few of the soils are actually deficient in lime, so far as crops and native vegetation are concerned. Most of the sandy ones, however, have lost the greater part of this material and will not effervesce when acid is applied. All the silty soils on the uplands and most of those on the terraces contain an abundance of lime within easy reach of crop roots. In the more eroded situations the silty soils of the uplands are limy in the topmost part of the surface soil. The soils of the bottom lands are prevailingly limy, and most of them have very dark surface layers. These soils under good drainage would produce higher yields of corn and alfalfa than any other soil in the county, but under natural conditions most of the land occupied by them is poorly drained and is used chiefly for wild hay.

The greater part of the county, including the sand hills and severely eroded areas of the loessial uplands, is in cattle ranches or in farms on which cattle raising is the chief occupation.

Although most of the land suitable for cultivation is farmed, the acreage is insufficient to supply enough feed for all the livestock, and the greater part of the cattle are shipped to market immediately after coming off summer range in the fall. Some of the younger cattle are carried through the winter on native hay, supplemented occasionally by a small quantity of grain and alfalfa, but most of the last two crops are needed for work animals, milk cows, hogs, and calves. Some of the farms on the deep fine-textured soils of the terraces and more nearly level parts of the loessial uplands produce enough corn and alfalfa to fatten a few cattle.

In this report the individual soils of the county are grouped on the basis of their natural characteristics, with special emphasis on

their stability and drainage conditions, which largely determine their productivity and crop adaptations. The three broad groups are: (1) Well-drained stable soils of the uplands and terraces; (2) poorly drained soils of the basins and bottom lands; and (3) excessively drained unstable soils of the uplands and terraces. These groups correspond rather closely to the use being made of the soils under the present farming system. The soils included in the first group are used mainly for grain, tame hay, and forage crops; those in the second group for the production of native hay; and those in the third group for pasture. This grouping is based not only on the stability and drainage of the soils, but also on soil characteristics, relief, or lay of the land, and the character of the materials from which the soils have developed. None of the groups is confined to any particular part of the county, although some soils in each group are so situated.

In the following pages, the various soils in the different groups are described, and their crop adaptations are discussed; the accompanying soil map shows their distribution; and table 5 gives their acreage and proportionate extent.

TABLE 5.—*Acreage and proportionate extent of the soils mapped in Loup County, Nebr.*

Type of soil	Acres	Per-cent	Type of soil	Acres	Per-cent
Holdrege very fine sandy loam	2,304	0.6	Cass fine sandy loam	896	0.2
Marshall very fine sandy loam, sandy-substratum phase	5,056	1.4	Sarpy sand	256	.1
Thurman fine sandy loam	768	.2	Gannett loamy sand	256	.1
Thurman loamy fine sand	4,416	1.2	Colby silt loam	576	.2
Anselmo loamy fine sand	1,216	.3	Colby very fine sandy loam	2,880	.8
Hall silt loam	1,536	.4	Rough broken land (Colby soil material)	4,608	1.3
Hall very fine sandy loam	5,632	1.5	Sparta sand	17,088	4.6
Waukesha very fine sandy loam	3,072	.8	Valentine fine sand	103,616	28.1
Waukesha fine sandy loam	768	.2	Dune sand	196,800	53.4
O'Neill fine sandy loam	1,408	.4			
O'Neill loamy fine sand	7,104	1.9	Total	368,640	
Cass loamy fine sand	8,384	2.3			

WELL-DRAINED STABLE SOILS OF THE UPLANDS AND TERRACES

This group occupies only 8.9 percent of the land area of the county, but it comprises the greater part of the cultivated land. It includes the Holdrege, Marshall, Hall, Waukesha, Anselmo, Thurman, and O'Neill soils.

The soils of the first four series have developed largely from loess and are composed mostly of silt, although some of them are moderately sandy in the lower part of the profile. Anselmo loamy fine sand has developed from silt-sand mixtures, and the Thurman and O'Neill soils are formed mainly from sand. All soils of the group except the Anselmo, which is somewhat light, have accumulated an abundance of organic matter and have thick dark topsoils. None of them is deficient in lime, so far as crop needs are concerned, but only the Holdrege and Hall soils have an abundance of this material. The Hall, Waukesha, and O'Neill soils are on terraces, and the other soils are on the uplands.

Areas occupied by these soils have very gently undulating or slightly rolling relief. They are well drained but are not subject

to destructive erosion. None of the soils is droughty, but the sandy Thurman and O'Neill soils are unable to hold as much moisture as the more silty soils.

The greater part of each soil belonging to this group is under cultivation. Corn, because of its wide adaptation to different soil and moisture conditions and because of its large yields and high feeding value, is the leading crop on all of them. Oats, wheat, and barley are grown mainly on the silty soils and most of the sweet-clover and rye on the sandy soils. Most of the alfalfa is grown on the Hall and Waukesha soils, but some is grown on the Holdrege and Marshall soils. This crop does well so long as its roots can obtain moisture from deep soil layers to supplement that furnished by the precipitation. When the supply of moisture in the subsoil is exhausted, alfalfa suffers from drought, and yields decline, especially throughout the uplands.

Holdrege very fine sandy loam.—Holdrege very fine sandy loam is one of the most productive soils on the uplands of the county, but it is not extensive. It occupies some of the highest and least eroded areas on broad nearly level or gently rolling divides and on gradual slopes throughout the silty uplands in the southern part. The largest area, which comprises about 400 acres, is 3 miles southwest of Taylor. The soil has developed from a light-gray limy silt which once covered a much larger part of the county. The slightly sandy character of the surface layer is chiefly the result of wind-blown material from the more sandy soils of the section. This soil is not subject to destructive erosion except around the margins of some areas, where the land slopes rather steeply to drainageways.

The topsoil, which ranges from 10 to 15 inches in thickness, consists of very dark grayish-brown mellow heavy very fine sandy loam or fine-textured loam and contains a large quantity of organic matter. The upper part of the subsoil, to an average depth of 2 feet, is light-brown heavy yet friable silt loam. The next, or third, layer is transitional. It is composed of floury light grayish-brown silt containing only faint traces of organic matter. None of these layers contains much lime. The fourth layer resembles the third in texture and friability, but it contains an abundance of lime, the greater part of which is in finely divided form. This layer is characteristic of most well-developed soils throughout the central and western parts of the United States. It is generally somewhat lighter in color than any other layer and, on account of its high content of lime, is known as the "lime zone", or "lime horizon." It ranges from 12 to 14 inches in thickness in Holdrege very fine sandy loam of this county. Beneath the layer of greatest lime enrichment is the light grayish-yellow silty and limy loess from which the soil has developed. The loess is well supplied with lime but does not contain so much of this material as does the lime horizon.

This soil is remarkably uniform throughout most of the areas, but a few minor variations are worthy of mention. In places around the shoulders of divides, run-off is rapid, sheet erosion is active, the dark topsoil is thin or in places absent, and light-colored material may be exposed at the surface. Such areas, where of sufficient size to warrant mapping, are shown on the map as Colby soils, but the smaller patches are included with Holdrege very fine

sandy loam. In a few places, the light-brown upper subsoil layer is very poorly developed or is entirely lacking, and the dark topsoil may rest on the soft light-colored transitional layer overlying the lime horizon, or may be directly on this horizon. The texture of the topsoil varies somewhat from place to place. It is slightly coarser in areas adjacent to the sandy soils and approaches a silt loam in areas where it has not been greatly modified by wind-blown sand.

Holdrege very fine sandy loam is probably as strong and fertile as any upland soil in the Mississippi Valley. Practically all of it in this county is under cultivation, and corn and oats are the leading crops. Some alfalfa, wheat, rye, and sweetclover are grown in a few widely scattered fields. Although very fertile, this soil does not return as high yields as most of the soils in eastern Nebraska and Iowa where the rainfall is greater. In seasons of heavy rainfall, however, yields of corn and alfalfa are nearly doubled.

The average yield of corn over a period of years is about 25 bushels an acre, and oats yield about the same as corn. Rye and wheat yield about 13 bushels, and alfalfa produces from 2 to 2½ tons of hay. The latter crop is cut three times during the summer season.

Cattle raising is not practiced extensively, as this soil is too valuable to be used as grazing land. A few farmers fatten cattle purchased from ranchers in the sand hills. The animals to be fattened are fed corn and alfalfa for 60 to 90 days and are then shipped to the Omaha market. Hogs are raised on nearly every farm and many farmers have large herds.

Marshall very fine sandy loam, sandy-substratum phase.—Marshall very fine sandy loam, sandy-substratum phase, occurs in scattered small areas on gentle slopes around the northern edge of the loessial uplands and in valleys and pockets throughout the sand hills in the southern half of the county. The largest area, comprising about 160 acres, is in the south-central part of Madison Square Precinct.

This soil has developed on a thin layer of loess that rests, at a depth ranging from 24 to 40 inches, on material composed mainly or entirely of sand. The relief is nearly level or gently undulating. In most places surface drainage channels are not well developed, but the underlying sand carries away all surplus moisture and the soil is everywhere well drained. The loessial material above the sand has a high water-holding capacity, and the soil is not droughty. It is not able to hold as much moisture as the Holdrege soils which are developed on a much thicker loessial deposit.

The topsoil, which is about 10 inches thick, consists of very dark grayish-brown mellow very fine sandy loam and has an abundance of organic matter. It contains some fine sand and medium sand and sufficient silt to prevent destructive wind erosion, even during prolonged periods of dry, windy weather. The subsoil, which is brown in the upper part and light grayish brown in the lower, consists of loesslike silt with only a small admixture of the finer grades of sand. It averages about 15 inches thick. The upper part of the rest of the soil mass is composed of loose very fine sandy loam, but the material becomes coarser and less coherent with depth

and in most places is almost pure fine sand or medium sand below a depth of 3 feet.

The soil is everywhere low in lime, as compared with the Holdrege soils, but it does not seem to be deficient in this material so far as crop needs are concerned.

Practically all of this phase of Marshall very fine sandy loam is under cultivation and is used for the same crops as are grown on Holdrege very fine sandy loam. The Marshall soil is not quite so retentive of moisture as the Holdrege, but much of it, especially in the depressed areas throughout the sand hills, receives considerable moisture through seepage from higher levels. In the depressed areas crop yields are higher than those obtained from any other soil on the uplands. Elsewhere crop yields on this soil average about the same as, or slightly lower than, those obtained on Holdrege very fine sandy loam.

Included with this soil on the soil map are numerous small areas in which the topsoil consists of fine sandy loam rather than very fine sandy loam. A large proportion of this soil occurs in depressed flats in the sand hills. The largest bodies are in the northeastern part of Kent Precinct. Nearly all of this coarser soil is used for cultivated crops, of which corn is the most important. Alfalfa, rye, and sweetclover are grown also. Yields in most places are about the same as, or slightly lower than, those on the finer soil.

Thurman fine sandy loam.—Thurman fine sandy loam covers a few small areas throughout the uplands in the southern part of the county where it occurs in close association with the Valentine and Anselmo soils. Most of it is in Madison Square Precinct. This soil differs from the Valentine soil mainly in the darker color of its surface layer. It is much more sandy than any Holdrege or Marshall soil mapped in this county.

The topsoil is very dark grayish-brown mellow fine sandy loam about 14 inches thick. It has a high content of organic matter. The subsoil is composed of medium sand or fine sand which is looser than the material above and allows rapid percolation of water. It is brown in the upper part where stained by organic material from the topsoil but rapidly becomes lighter colored with depth. It is light brown at a depth of about 36 inches beneath the surface of the ground. No layer contains much lime, but the soil is not deficient in this material, so far as producing crops is concerned.

The relief ranges from nearly level to gently undulating. Surface channels are not established, because the porous sand absorbs the moisture. Owing to its high content of organic matter, the topsoil is fairly stable and retains moisture well. The soil does not have as high water-holding capacity as more silty soils, but in this section it is able, during most years, to hold the greater part of the comparatively small amount of precipitation received until the absorbed moisture can be drawn off by crops.

Practically all the land is under cultivation. Corn is the chief crop, and some oats, rye, barley, and alfalfa are grown. The soil is not well suited to most small grains or alfalfa on account of the loose sandy character of the seedbed, which favors soil blowing, with consequent injury to the young plants during dry, windy weather.

Yields of crops are less uniform than on the finer textured soils. During seasons of normal or heavy precipitation the sand allows some loss of water through downward seepage, and crop yields, although favorable, are not so high as they are on more silty soils. In dry years this soil returns as high yields of corn as any other upland soil, regardless of texture.

Thurman loamy fine sand.—Thurman loamy fine sand occupies small areas throughout the sandy uplands in the southern part of the county. Most of it is within or adjacent to areas of Valentine soils from which it differs chiefly in having a darker topsoil. The largest area, comprising about 200 acres, is in Madison Square Precinct.

This soil contains a larger proportion of sand than Thurman fine sandy loam and is less coherent. The organic matter, although plentiful in the upper part of the soil profile, decreases rapidly with depth and is scarcely noticeable below a depth of 14 inches. The topsoil, which ranges in thickness from 10 to 14 inches, is very dark brown loamy fine sand. The subsoil is composed of light-brown incoherent fine sand and medium sand. The soil throughout is low but not deficient in lime.

The relief and the drainage conditions are about the same as those of Thurman fine sandy loam. The topsoil retains moisture fairly well, owing to its high content of organic matter. Under cultivation, however, it is rather unstable and is poorly suited to most shallow-rooted crops. Corn, because of its large and coarse root system, is not greatly injured by the shifting sands and is the chief crop on this soil. It yields about 10 bushels an acre during seasons of normal precipitation. Some rye is grown for late fall pasture. This crop does well, provided it stools sufficiently to cover the ground before soil drifting becomes severe.

About 20 percent of the area occupied by this soil retains its native cover of grasses and is used for pasture and hay land.

Anselmo loamy fine sand.—Anselmo loamy fine sand covers small areas of various sizes and shapes throughout the sandy uplands, mainly in Madison Square and Strohl Precincts. The largest area, about 120 acres, is 9 miles southwest of Taylor.

This soil is similar to Valentine fine sand, but it contains a larger proportion of silt which gives it greater stability and moisture-retaining capacity. The relief ranges from nearly level to rolling, but the land does not have the hummocky appearance characteristic of most Valentine soils. Drainage channels are not developed because the soil is sufficiently porous to absorb rapidly the surplus moisture, and the land is everywhere well drained.

The topsoil, to an average depth of 16 inches, consists largely of sand, but it contains sufficient silt and organic matter to give it a loamy texture and darker color than the rest of the profile. The content of organic matter, however, is too low to make the topsoil as dark as that of the Thurman soils. In most places the color of this layer does not differ greatly from that of the corresponding layer in areas of Valentine fine sand. The upper layer of the subsoil, which ranges in thickness from 8 to 14 inches, is light-brown sand containing a small quantity of silt. The lower layer, to a depth of

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about 40 inches, is very light brown sand containing an abundance of silt and clay. This layer is more coherent than any other layer of the soil profile. It rests on loose grayish-brown sand similar to that beneath the Valentine and Thurman soils. This soil is not noticeably calcareous except in a few places.

Included with this soil in mapping are a few small areas of Anselmo fine sandy loam. These are chiefly along the southern county line in sec. 35, T. 21 N., R. 20 W., and secs. 31, 32, and 33, T. 21 N., R. 19 W. In them the topsoil layer contains a larger proportion of silt and is a little more stable than the corresponding layer in Anselmo loamy fine sand. Otherwise, the two soils are identical in profile features, and both have about the same types of relief and drainage.

Most of Anselmo loamy fine sand is under cultivation, and corn is the main crop. Some rye and sweetclover are grown for pasture. The soil, although much lighter in color than any of the Thurman soils, is, owing to the higher content of silt in its subsoil, about equal to Thurman loamy fine sand in productivity.

Hall silt loam.—Hall silt loam is on stream terraces composed largely of silt. It occupies a few areas south of North Loup River in Kent and Taylor Precincts.

This soil has developed from fine-textured material carried to its present position by streams from the loessial uplands. Later entrenchment of the stream channels left the deposits from 10 to 25 feet above the present bottom lands, and prolonged weathering under conditions favorable for the accumulation of organic matter and deep soil development has produced the present soil.

The topsoil is very dark grayish-brown friable silt loam about 14 inches thick. The upper subsoil layer, to a depth ranging from 12 to 18 inches, is dark grayish-brown silt loam of slightly greater compaction than the topsoil. The lower part of the subsoil is grayish-brown or light grayish-brown limy silt to a depth of 5 feet. This layer is the lime horizon and contains numerous seams, specks, splotches, and fine winding threads of white lime. The parent material, or substratum, is light grayish-brown or grayish-yellow loose floury silt. It is well supplied with lime but does not have such an abundance of this material as does the lime horizon.

The terraces on which this soil occurs are nearly level or very gently undulating, with a gentle slope down the valley and toward the channel of North Loup River. Both surface and internal drainage are adequate. The soil is not subject to destructive wind or water erosion.

Hall silt loam is one of the most productive soils in the county. Its high content of organic matter and its silty character tend to make it very retentive of moisture. The soil is naturally strong and fertile and will withstand severe cropping, even under poor management, for several years. Nearly all the land is under cultivation. Any crop common to the section may be grown, but most of the soil is used for corn, oats, and alfalfa, ranking in acreage in the order named. In seasons of normal precipitation, corn and oats yield about 30 bushels and alfalfa about 2.5 tons of hay an acre.

Hall very fine sandy loam.—Hall very fine sandy loam resembles Hall silt loam except that its topsoil is a little more sandy and looser. The topsoil contains an abundance of organic matter, is friable throughout, and is very dark. It rests on a slightly lighter colored and heavier but friable upper subsoil layer which overlies the lime horizon, a loose floury and highly calcareous silt.

This soil is somewhat more extensive than Hall silt loam. It occurs on nearly level or very gently undulating stream terraces, generally in close association with Hall silt loam. All the land is well drained.

This soil is as productive and as well adapted to all crops common to the section as is Hall silt loam. In fact, the farmers regard the two soils with equal favor for the production of grain and alfalfa. Nearly all of Hall very fine sandy loam is under cultivation.

Waukesha very fine sandy loam.—This soil is on terraces along North Loup River and its tributaries, where it has developed from silty material deposited by the streams. The deposits are less limy than those on which the Hall soils have formed. The largest area, comprising about 930 acres, is in the eastern part of Madison Square Precinct about 4 miles south of Almeria.

The 8- to 12-inch topsoil consists of very dark grayish-brown loose and friable very fine sandy loam which has a large content of well-decayed organic matter. The subsoil, which extends to an average depth of 30 inches, is silty. It is very dark grayish brown in the upper part and brown in the lower part. The material composing it is slightly heavier than that of the topsoil, but it remains very friable. In some places there are a few light-gray splotches and rusty-brown stains. The subsoil rests on light-brown loose silt loam or very fine sandy loam. The soil throughout contains little lime but is not deficient in this material for the production of crops.

Around the outer margins of this soil, where it borders silty areas of the uplands, are narrow strips in which the topsoil contains a larger proportion of silt than is typical. These strips are of such small extent that they are included with Waukesha very fine sandy loam on the soil map.

The relief is almost level or gently undulating, and drainage is everywhere good. Even the more nearly level areas have sufficient slope to carry off the surplus water.

Waukesha very fine sandy loam is one of the best farming soils in the county and is equal to Hall silt loam for the production of grain and tame hay. The soil is highly retentive of moisture and, although rather low in lime, is not deficient in this material. It is well adapted to the crops common to this section, and practically all of the land is under cultivation. Corn, oats, and alfalfa are the chief crops. In seasons of normal precipitation corn and oats yield about 30 bushels and alfalfa 2 to 2½ tons of hay an acre.

Waukesha fine sandy loam.—This soil is on stream terraces and is closely associated with Waukesha very fine sandy loam, from which it differs only in containing a slightly larger proportion of sand. It occupies a few areas in the southern part of Strohl Precinct and in Madison Square Precinct.

The topsoil consists of very dark grayish-brown mellow fine sandy loam. It is underlain by brown slightly heavier but friable silt loam

or very fine sandy loam, which gradually becomes coarser and lighter colored with depth, giving way, in most places at a depth of 3 feet, to light grayish-brown fine sandy loam. The soil throughout is low in lime.

Practically all of this soil is under cultivation. It is used for the same crops as are grown on the other silty soils of the terraces, and it has about the same productivity. Its higher content of sand makes it a little less retentive of moisture than the more silty soils of the terraces. None of these soils, however, receives more moisture than it can hold.

O'Neill fine sandy loam.—O'Neill fine sandy loam covers small scattered areas on sandy terraces along the main streams. The largest area, comprising about 300 acres, is on the north side of North Loup River in Sawyer Precinct.

The topsoil is dark grayish-brown or very dark grayish-brown loose fine sandy loam, rich in organic matter, ranging from 10 to 18 inches in thickness. Owing to a higher content of humus, the upper part, to a depth of about 8 inches, is considerably darker than the lower part. The subsoil is light-brown or light grayish-brown incoherent sand containing little or no organic matter. It rests on stream sediments which are similar to it in color but generally slightly coarser in texture. The soil has been thoroughly leached of lime.

The relief is nearly level or gently undulating, with a slight slope toward the streams. Drainage channels are not well established, because the porous soil material absorbs practically all of the precipitation. The organic matter in the topsoil is highly retentive of moisture, but the subsoil has rather low water-holding capacity, compared with the corresponding layer in less sandy soils. The soil, however, is not droughty.

Practically all of the land is under cultivation. About 75 percent of it is used for corn and most of the remainder for alfalfa or rye. Rye is grown chiefly for late fall and early spring pasture. Alfalfa, in places where the roots are able to reach the underlying water table, seems to do as well as on the best silty soils, but over most of O'Neill fine sandy loam yields of this crop are low because of insufficient moisture. The average yield of corn is about 17.5 bushels, rye about 9 bushels, and alfalfa 1.3 tons of hay an acre.

O'Neill loamy fine sand.—This soil occupies small areas and narrow strips on the sandy terraces along Calamus and North Loup Rivers and some of their tributaries. The largest development is a long narrow strip on the north side of North Loup River in Sawyer and Strohl Precincts. The soil differs from O'Neill fine sandy loam in that it has a sandier and looser topsoil. It is also more extensive than that soil.

The 8- to 14-inch topsoil is rather incoherent grayish-brown or dark grayish-brown loamy fine sand. The upper part contains more organic matter and is slightly darker than the lower part, but it does not contain sufficient organic matter to prevent soil blowing when the native sod is destroyed. The subsoil is composed of light-brown or light grayish-brown incoherent sand. Pebbles are scattered throughout the soil mass and are numerous in places in the lower part. Neither the topsoil nor subsoil is limy.

The relief in general is nearly level or slightly undulating, but here and there hummocks have been formed by the wind. Drainage channels are not established. The porous soil rapidly absorbs the surplus water and insures good internal drainage. The soil, as a whole, is somewhat droughty for farm crops on account of its high content of sand.

About 70 percent of this soil is under cultivation, and the rest is used for native pasture or hay land. The wild grasses are chiefly big bluestem, *Stipa*, sandgrass, and buffalo grass. Of the cultivated crops, corn, rye, and alfalfa are the most important. The average yield of corn is about 10 bushels, rye 5 bushels, and alfalfa 0.6 ton of hay an acre.

POORLY DRAINED SOILS OF THE BASINS AND BOTTOM LANDS

This group includes the Cass and Sarpy soils of the bottom lands and the Gannett soils of the wet swales and pockets in the sand hills. The soils have developed from sand, under the influence of a high water table and poor internal drainage. During wet seasons the ground water rises to or near the surface, thereby producing small patches of marshy land in the lower situations. Most of the Cass and Sarpy soils are subject to occasional overflow from the streams. The soils of this group occupy 2.7 percent of the land area of the county.

The abundant moisture has promoted a luxuriant grass growth and rapid decay of vegetation. All soils of the group, except the Sarpy, which is developed on the most recently deposited stream sediments, have very dark or almost black topsoils owing to their large content of well-decayed organic matter. The soils are moderately limy from a point near the surface downward.

Because of poor drainage, most of the area occupied by these soils is used for wild hay. The native grasses will in nearly all places produce from one-half to three-fourths ton of hay an acre. In a few fields where timothy and clover seed has been sown among the wild grasses, hay yields exceed 1 ton an acre during favorable years. Hay from the native grasses of the bottom lands is much coarser and has a lower value for feeding than hay from the better drained upland and terrace soils, but the high yield tends to offset the inferior quality. When the hay contains a large proportion of timothy and clover, that from the poorly drained soils is as nutritious, ton for ton, as any native hay in the county.

In a few places where drainage is adequate, these soils are used for the production of corn and alfalfa, giving as high or higher yields of these crops than are obtained on the uplands and terraces. Only a few areas are used for small grains. These crops grow well where the soil is not too wet for cultivation, but they mature late, usually return low yields, and tend to produce a rank growth of vegetation with weak stems which break and fall during windy weather.

Cass loamy fine sand.—Cass loamy fine sand is the most extensive soil of this group. It occurs in small bodies and narrow strips on the more sandy parts of the flood plains along North Loup and Calamus Rivers and the larger creeks throughout the sandy uplands. The largest area, comprising about 1,700 acres, is along Gracie Creek in Gracie Precinct.

The topsoil, which ranges from about 8 to 12 inches in thickness, is very dark grayish-brown loamy fine sand. It contains a large proportion of well-decomposed organic matter which accounts for its dark color and loamy texture. The content of organic material, however, is not sufficient to prevent soil blowing during prolonged droughts if the native vegetation is destroyed. The subsoil is light grayish-brown incoherent sand which continues below a depth of 3 feet. It is deficient in organic matter. The soil is moderately limy, especially in the subsoil.

Cass loamy fine sand has developed from sandy sediments deposited by the streams during periods of high water. It is not old enough to have acquired definite layers or horizons of true soil character, although the upper layers of the sedimentary deposits have been darkened by organic accumulations.

The relief is nearly level, modified in places by depressions, dry channels, and slight elevations. Drainage is variable. The soil lies from 3 to 6 feet above the streams and is subject to overflow. Small areas along Calamus River remain in a marshy condition most of the year.

This soil is not well suited for crops on account of its uncertain drainage, and only about 10 percent of it is tilled. The greater part of the remainder retains its native grass cover and is used for the production of hay. Corn and alfalfa, the leading cultivated crops, are grown on the higher and better drained land. Here corn yields about 20 bushels and alfalfa about 2 tons of hay an acre. The soil is seldom used for small grains because of the difficulty in obtaining a firm seedbed. During dry years the sandy topsoil is subject to considerable drifting which would injure the root systems of small grains.

Native grasses, including big bluestem, sloughgrass, canary grass, and pony grass, grow luxuriantly on this soil, yielding three-fourths of a ton of hay an acre during most years.

Cass fine sandy loam.—Cass fine sandy loam occupies a few small bodies, most of which are within larger areas of Cass loamy fine sand on the sandy bottom lands of North Loup River and Bloody and Gracie Creeks. The largest development, comprising about 170 acres, is on the south side of the river, about 2 miles east of Taylor.

This soil is similar to Cass loamy fine sand except for a higher proportion of fine-textured particles in its surface layer, greater stability, and slightly lower position. The topsoil, which averages about 12 inches thick, is friable very dark grayish-brown fine sandy loam. It contains an abundance of well-decomposed organic matter. The subsoil is incoherent light grayish-brown sand similar to that in Cass loamy fine sand, but it is more poorly drained. In some places it is almost continually saturated with water.

Nearly all of the soil is used for wild-hay land. The native vegetation consists largely of sandgrass, needlegrass, sloughgrass, and bluestem, and these grasses yield about 1 ton of hay to the acre.

Sarpy sand.—Sarpy sand occupies a few small bodies on the bottom lands of North Loup River.

This soil is light grayish-brown sand from the surface downward. The 2- or 3-inch surface layer is slightly darkened by organic matter, but the amount of this material is not enough to prevent the soil

from drifting during dry, windy weather. The sand, below a depth of 8 or 10 inches, in most places is splotched with rust-colored stains, indicating poor drainage.

The soil is developing on very recently deposited sandy alluvium. It is not old enough to have acquired a dark-colored topsoil through the growth and decay of vegetation. In some places it resembles riverwash, but it is more stable and not so greatly influenced by each slight rise of the stream. The relief is nearly level. The soil lies from 2 to 3 feet above the stream channel, and the lower part is almost continually saturated.

Nearly all of Sarpy sand is used for pasture or hay land. It supports a fairly dense growth of water-loving grasses but, on account of its small extent, is of little agricultural importance.

Gannett loamy sand.—Gannett loamy sand occurs in several small basinlike depressions in the sand hills. The depressions are most numerous in the northern part of Strohl Precinct and in Gracie Precinct. Most of them are only a few square rods in size.

The 10-inch topsoil is dark-brown or very dark grayish-brown loose loamy sand. Its color and structure vary with its content of organic matter. In a few places the topsoil contains so much organic matter in various stages of decay that it is almost black, spongy, and noticeably light in weight. The subsoil consists largely of grayish-brown or light grayish-brown incoherent sand containing rusty-brown splotches, spots, and streaks caused by poor drainage. In most places, generally at a depth ranging from 2 to 4 feet, is a layer of light grayish-green or grayish-yellow sticky sandy clay from 2 to 4 inches thick. Below a depth of 4 feet the material is incoherent sand similar to that underlying Valentine fine sand and dune sand, and below a depth of 2 feet the soil is limy.

Most areas of this soil have no surface drainage outlets, and the moisture which collects in them through seepage from higher land and precipitation is forced to seek outlet by downward percolation. Marshes and temporary lakes occupy some of the basins.

Owing to its poor drainage and small extent, Gannett loamy sand is of little agricultural importance. All the land is used for the production of native hay or pasture, for which it is well suited.

EXCESSIVELY DRAINED UNSTABLE SOILS OF THE UPLANDS AND TERRACES

The members of this group cover 88.4 percent of the county and furnish most of the pasture, on which cattle raising so largely depends. They include the Colby, Valentine, and Sparta soils, and the land types—dune sand and rough broken land—which are classed with this group because they are used almost exclusively for grazing.

These soils are so subject to severe wind or water erosion when cultivated or lose so much precipitation through run-off or downward percolation that they cannot, except locally, be used profitably for tilled crops under the present farming system. They all, however, include a few cultivated fields. Small areas of some of them are fairly well suited to corn and rye, provided they are carefully managed and the precipitation is favorable.

The Colby soils and rough broken land are underlain by limy silt which is highly retentive of moisture, but they are on steep slopes where surface run-off is excessive and erosion is severe. They differ

mainly in the extent to which erosion has progressed. Rough broken land has the more pronounced relief. The rest of the group includes soils and soil-forming materials that consist largely or entirely of incoherent sand and contain little lime.

All these soils are deficient in organic matter and are light colored from the surface downward. The Colby soils, Valentine fine sand, and Sparta sand, however, have accumulated sufficient decayed grass to make their topsoils slightly darker than the rest of the profile. Sparta sand is on nearly level or slightly undulating and extremely sandy stream benches, Valentine fine sand is on rolling or hummocky uplands and terraces, and dune sand is in the hilly uplands.

About 80 percent of the area occupied by the soils of this group is used for pasture and most of the remainder for the production of native hay.

Colby silt loam.—Colby silt loam occupies small bodies and narrow strips on valley slopes of the loessial uplands in Kent, Taylor, and Madison Square Precincts. The relief nearly everywhere is steeply sloping, run-off is rapid, and erosion has prevented the development of much topsoil. In many places the light-colored loess is exposed.

Where present the topsoil in general is dark grayish-brown friable silt loam to a depth ranging from 5 to 7 inches. It contains a moderate supply of organic matter which decreases rapidly with depth and is practically absent below a depth of 14 inches. The rest of the soil mass is light grayish-brown or grayish-yellow floury silt and is very limy. It is essentially the loess deposit from which the soil is developing.

Owing to its steeply sloping relief, this soil is not well suited to the production of grain or tame hay. A few small fields under careful management are cultivated, but nearly all of the soil remains in its virgin state and is used for pasture land. It is covered with a good growth of little bluestem, grama, and porcupine grass, which will support from 20 to 25 cattle on each quarter section (160 acres) during the summer grazing season.

Were it not for its unfavorable relief and the danger of erosion when the grass cover is destroyed, Colby silt loam would be a fairly productive farming soil. It has high water-holding capacity and, although rather low in organic matter and consequently in nitrogen, would be well suited to corn and alfalfa in the few localities where water loss through run-off is not excessive. Larger returns, however, are obtained when the soil is used for pasture than could be obtained from cultivated crops.

Colby very fine sandy loam.—Colby very fine sandy loam occupies small bodies and narrow strips throughout the loessial uplands in the extreme southern part of the county. It differs from Colby silt loam only in having more and in places a little coarser sand in its surface layer. The soil has developed from light-gray limy floury silt similar to that underlying Colby silt loam, but it is generally adjacent to or within short distances of more sandy soils and has received sufficient wind-blown sand to give its surface layer a very fine sandy loam or fine sandy loam texture. Otherwise the two soils are almost identical. Both are steeply sloping and severely

eroded, with thin topsoils overlying the parent loess. In spots, Colby very fine sandy loam has not developed a topsoil on account of erosion, and the unweathered or only slightly modified limy loess is exposed.

Nearly all of this soil is included in pasture. A few fields of the less steeply sloping areas are used for growing corn, alfalfa, and sweetclover, but the total cultivated acreage is very small. The soil has about the same value for grazing as has Colby silt loam.

Rough broken land (Colby soil material).—Rough broken land (Colby soil material) occupies a few areas of various sizes though generally small, on the loessial uplands in the southeastern and southern parts of the county. The areas are on the severely eroded loessial uplands where the surface layer of the Colby soils is unusually thin or absent and where geologic erosion has produced an extremely rough and rugged relief. Much of the land occupies steep, almost precipitous, valley sides and narrow tortuous divides.

All this land is unsuited for cultivation. It supports a fairly good growth of little bluestem, big bluestem, and grama and is used almost exclusively for grazing land. The native grasses will support from 20 to 25 head of cattle on each quarter section during the summer grazing season, May to October, inclusive.

Sparta sand.—Sparta sand is the most extensive terrace soil in this county. It occupies fairly continuous strips, from one-fourth mile to 2 miles wide, and disconnected bodies of various sizes on the sandy terraces along the rivers and along Skull and Bloody Creeks. The largest areas are in Bloody, Little York, and Strohl Precincts.

The 6- to 10-inch topsoil is incoherent sand which contains sufficient organic matter to give it a brown color but not enough to prevent the sand from blowing when cultivated. The rest of the profile differs from the topsoil only in that it is slightly lighter colored. It contains faint traces of organic matter to a depth of about 14 inches, below which the material is light grayish-brown almost pure fine sand or medium sand. No part of the soil mass contains lime.

This soil has developed from sandy stream deposits made prior to the deposition of the sands on which the Sarpy soils are forming, but drought and subjection to more or less constant wind erosion has prevented the accumulation of much organic matter.

Areas of this soil lie from 10 to 15 feet above the present bottom lands, and all are well drained. Surface drainage channels are not developed because the porous sand rapidly absorbs all moisture. The relief in general is gently undulating, but it is modified to some extent by slight hummocks produced largely by the wind.

Sparta sand is poorly suited to cultivated crops on account of its instability and low content of organic matter. Most of it is used for grazing land. It supports a rather sparse grass cover consisting chiefly of sandgrass and needlegrass, and it does not have a high value even for grazing.

Valentine fine sand.—Valentine fine sand is extensive, covering 103,616 acres, or 28.1 percent of the land area of the county. It occupies irregularly shaped areas, largely in dry sandy valleys and flats throughout the sand hills, where it is closely associated with dune sand.

The 6- to 12-inch topsoil consists of incoherent grayish-brown sand. The upper part, to a depth of about 4 inches, is generally somewhat darker than the lower part, owing to a small content of organic matter. The rest of the material is light grayish-brown almost pure sand, which extends to a depth below 4 feet. The sand is composed chiefly of old quartz particles of fine and medium grades. Neither the topsoil nor the subsoil is limy.

The relief of this soil ranges from almost level to strongly rolling, but in most places it is hummocky. Most of the more nearly level areas are modified here and there by low rounded knolls and ridges. This soil differs from dune sand, which it closely resembles, in having less relief.

The color and depth of the topsoil varies somewhat with differences in the relief. In the shallow depressions where conditions have been most favorable for plant growth and decay this layer is a little darker and deeper than on the more nearly level areas. On the crests of the low knolls and ridges the organic matter has been largely removed by the wind, leaving the topsoil shallow and prevailingly light in color.

Surface drainage channels are not established. All surplus moisture is rapidly absorbed, and no water is lost through run-off.

This soil is very unstable when the native-grass cover is destroyed, and it is of little value for the production of tame hay and grain. Probably not over 10 percent of it, most of which is used for cornland, is under cultivation.

The soil supports a fairly heavy cover of grass—chiefly sandgrass and needlegrass—and nearly all of it is used for pasture land. Some hay is cut from areas where moisture conditions are most favorable. The native grasses will support from 70 to 80 head of cattle on each square mile during the summer grazing season or when cut for hay will yield a little more than one-fourth of a ton an acre.

Included with Valentine fine sand in mapping are a few small bodies of Valentine loamy fine sand. They are in nearly all precincts, but few of them occupy more than 8 or 10 acres, and their combined area probably does not exceed 640 acres. These bodies are in slight depressions where conditions have been favorable for the more rapid growth and decay of grasses than on the higher lying Valentine fine sand. As a result, the topsoil is slightly darker and more loamy. The included soil also is used mainly for pasture land.

Dune sand.—Dune sand consists of hilly areas of wind-blown sand. It covers 196,800 acres, or 53.4 percent of the land area of the county. The largest and most uniform areas are in Gracie, Bloody, Sawyer, Strohl, and Little York Precincts.

This material has made little or no progress toward the development of soil, but it supports a fair grass cover and is valuable for grazing land. It consists of gray incoherent fine sand or medium sand to a depth exceeding 10 feet. The 2- or 3-inch surface layer may be slightly browner than the rest of the material, owing to a small content of organic matter. The sand is derived from weathered soft sandstone and has been deposited in its present position by wind. Any silt or clay which it may have contained originally has long since been blown away. The sand has been thoroughly leached of its lime.

Dune sand is almost identical with Valentine fine sand, but it has much more broken relief. In most places it has been whipped by the wind into hills and ridges from 40 to 80 feet high, with intervening valleys, pockets, and swales, some of which are occupied by the Valentine soil. Old and recent blow-outs are of common occurrence, especially on the north and northwest sides of the hills.

Dune sand is of no value for cultivation. Small patches are annually broken and cultivated, but removal of the native grasses ruins the land, not only where the vegetation is destroyed but also for several rods to the leeward. At present most of the dune sand in this county is fairly well sodded, and only a small part of it is subject to active wind erosion. The native vegetation includes many valuable pasture, hay, and sand-binding grasses, of which little bluestem, blow-out grass, sandreed grass, *Redfieldia*, and needlegrass are most common. In the spring and summer these grasses will maintain from 70 to 80 head of cattle on each square mile, but in the winter they cannot be depended on for pasture. When cut for hay they yield about one-third of a ton an acre in average years.

CLASSIFICATION OF SOILS ACCORDING TO PRODUCTIVITY

The soils of Loup County are classified in table 6 according to their estimated ability to produce the more important crops of this section. This classification compares the inherent productivity of each soil for each leading crop in the county to a standard, namely 100, which is the rating given to a soil that is inherently the most

TABLE 6.—*Classification of soil types in Loup County, Nebr., according to productivity*[1]

Soil type[2]	Crop productivity index[3] for—									Principal crops or type of farming
	Corn	Oats	Wheat	Rye	Barley	Alfalfa	Sweetclover	Wild hay	Pasture	
Hall silt loam	60	60	60	60	55	55	65	70	35	General farming.
Hall very fine sandy loam.	60	60	60	60	55	55	65	70	35	Do.
Waukesha very fine sandy loam.	60	60	60	60	55	55	65	70	35	Do.
Waukesha fine sandy loam.	60	50	50	55	50	55	60	70	30	Do.
Cass fine sandy loam (well drained).	50	35	35	35	35	50	75	80	40	Corn and alfalfa.
Holdrege very fine sandy loam.	50	50	50	50	45	30	65	70	35	General farming.
Marshall very fine sandy loam, sandy-substratum phase.	50	50	50	50	45	30	65	70	35	Do.
Cass loamy fine sand (well drained).	40	30	30	35	30	45	70	75	36	Corn, rye, and sweetclover.
O'Neill fine sandy loam.	35	30	30	35	30	30	50	50	30	General farming.

[1] This table has been prepared jointly by officials of the following organizations: Soil Survey Division, Bureau of Chemistry and Soils, U. S. Department of Agriculture; Land Use Planning Section, U. S. Resettlement Administration; and the Conservation and Survey Division and Agricultural College, University of Nebraska.

[2] Soils are listed in the approximate order of their general productivity, the most productive first.

[3] Soil types inherently most productive for the specified crop in the United States are given the index 100. Only those inherently most productive soil types of significant acreage in the more widely known crop regions are given this standard rating. The other indexes give the approximate production in percent of the standard.

NOTE.—No ratings on grain and tame-hay crops are given to soils that are definitely unsuited for cultivation, although some areas of these soils are farmed.

TABLE 6.—*Classification of soil types in Loup County, Nebr., according to productivity*—Continued

Soil type	Crop productivity index for—									Principal crops or type of farming
	Corn	Oats	Wheat	Rye	Barley	Alfalfa	Sweetclover	Wild hay	Pasture	
Thurman fine sandy loam.	30	25	25	30	25	20	40	60	30	General farming.
Colby very fine sandy loam.	25	20	20	20	15	15	30	40	28	Pasture.
Colby silt loam	25	20	20	20	15	15	30	40	28	Do.
O'Neill loamy fine sand.	20	15	15	20	15	15	35	55	26	Corn, rye, and alfalfa.
Thurman loamy fine sand.	20	15	15	20	15	15	35	55	26	Corn, rye, and sweetclover.
Anselmo loamy fine sand.	20	15	15	20	15	15	35	55	26	Do.
Cass fine sandy loam (poorly drained).	------	------	------	------	------	------	------	100	45	Pasture and wild hay.
Gannett loamy sand	------	------	------	------	------	------	------	105	45	Do.
Cass loamy fine sand (poorly drained).	------	------	------	------	------	------	------	80	40	Do.
Sarpy sand	------	------	------	------	------	------	------	50	23	Do.
Sparta sand	------	------	------	------	------	------	------	40	25	Do.
Rough broken land (Colby soil material).	------	------	------	------	------	------	------	------	26	Pasture.
Valentine fine sand	------	------	------	------	------	------	------	40	20	Pasture and wild hay.
Dune sand	------	------	------	------	------	------	------	30	20	Do.

productive in the United States for the crop under consideration and which occupies sufficient acreage to warrant classing it as the standard soil for that crop. The rating, 100, is called the base index and is the standard with which the productivity of all other soils for a particular crop is compared. Thus a soil estimated to be half as productive of a given crop as the one having the base index rating, receives an index of 50. A few unusually productive soils of small total acreage may have an index above 100 for a specified crop.

Inherent productivity indexes show the natural ability of the soil to maintain production at or near the level existing when the soil has become adjusted to tillage. These indexes are established under the assumption that the best cropping and soil-management practices are followed, excepting those that would materially modify the soil, such as the use of commercial fertilizers, residues, and manures from crops not grown on the soil, terraces, irrigation, and artificial drainage.

In table 6 the soils are listed in the order of their general productivity which is determined chiefly by their ability to produce the more important staple crops. No attempt is made to group the soils best suited for particular crops, and no consideration is given to differences in the quality of the crops.

As the soils in Loup County do not receive lime or commercial fertilizers, no rating is given to indicate their response to these materials.

The factors influencing the productivity of the soils are mainly climate, soil characteristics, and surface configuration. Since long-time yields[3] furnish the best available summation of the factors

[3] Data on long-time yields for specific soils were collected by the field parties during and subsequent to the soil survey. In addition free use was made of unpublished estimates on average annual crop yields for the period 1923 to 1932, inclusive, supplied by the Bureau of Agricultural Economics, U. S. Department of Agriculture, and the Nebraska Department of Agriculture, cooperating.

contributing to soil productivity, they were among the data used in determining the inherent productivity indexes given in the table.

The rather low indexes given to most of the soils in Loup County do not necessarily indicate that these soils are not well suited for the crops grown on them. Some of the soils are among the strongest and most productive in the general region. Few of them give as high yields of any particular crop as are obtained on the ideal, or standard, soil for that crop, but this, in most instances, is due mainly to less favorable moisture conditions and surface features, or both, than occur in the area occupied by the standard soil. The majority of the soils contain enough plant nutrients to insure higher yields if moisture were more abundant.

In rating the soils on the bottom lands or flood plains, two index ratings are given, one applying to the better drained areas and the other to poorly drained areas. The soil map does not distinguish between these areas except in localities where drainage is so poor that a marshy condition prevails a part of each year. Here, the conventional marsh symbol is used. Elsewhere on the bottom lands, the poorly drained tracts, although numerous, occupy such small patches and narrow strips that they cannot be indicated legibly on a map of the scale used in this survey.

Streams occasionally overflow small tracts on the flood plains, but no special consideration is given to these tracts because overflow is of little importance in the agriculture of the county.

The table here presented is not based on enough of the factors which influence land use to warrant interpreting the ratings directly into specific land values. It is based on essentially permanent factors relating to the inherent productivity of the soils, and no consideration has been given transitory economic factors. In some instances the information on which the ratings are based is not so complete as desired, and further study may suggest changes.

The following tabulation gives the more important crops of the county and the acre yield that has been set up as a standard of 100 for each crop. These yields when applied to the inherently most productive soils of significant acreage in the United States are accompanied by a product of satisfactory quality and are obtained without the use of amendments that would materially modify the soil.

	Bushels
Corn (grain)	50
Oats	50
Wheat (all kinds)	25
Rye	25
Barley	40
	Pounds
Alfalfa	9,000
Sweetclover	4,000
Wild hay	2,000
	Cow acre-days [4] *per year*
Pasture	100

[4] "Cow acre-days" is a term used to express the carrying capacity of pasture lands. It is the numerical equivalent of the number of animal units supported by 1 acre during a given number of days.

MORPHOLOGY AND GENESIS OF SOILS

Most of the soils in Loup County are immature. All this county, except about 20 square miles of loess-mantled uplands and terraces in the southern part, is in the sand-hill section of Nebraska. Here the soils, where they have attained sufficient development to be regarded as true soils, consist mainly of gray quartzitic sand of fine or medium grades. The more extensive soils are composed almost entirely of this material. The sand is extremely resistant to weathering and over most of its area is so unstable that much of the weathered material is removed by wind before it has been influenced to a noticeable extent by soil-forming agencies. The greater part of the sand has accumulated little organic matter, and nearly all of it is low in lime.

In the parts of the county mantled by loess the soils have not been affected injuriously by wind, but throughout much of their area they occupy steep valley slopes and rough broken land. Here, rapid run-off of water has discouraged a heavy covering of vegetation, has removed the organic matter and other products of soil development almost as fast as they have formed, and has kept the unweathered loessial material on or near the surface of the ground.

All the soils have developed under a grass vegetation. The luxuriance of the grass growth and the amount of organic matter returned to and retained by the soil when the grasses decay vary widely in different localities, according to deficiencies in the supply of moisture and the severity of wind or water erosion. Throughout the sand hills the vegetation includes tall grasses, chiefly *Stipa comata* (Trin. and Rupr.), *Calamovilfa longifolia* (Hook), *Andropogon furcatus* (Muhl.), and *A. scoparius* (Michx.). These grasses have large root systems, but, except in moist situations, their growth is sparse, their roots decay slowly, and most of the decomposed vegetal material is removed from the rather unstable sands during periods of dry, windy weather. In the loess-covered areas short grasses, mainly *Bouteloua curtipéndula* (Michx.), Torr., *B. grácilis* (H. B. K.) Lag., and *Buchloë dactyloídes* (Nutt.) Engelm., are most common. These have shorter but much denser root systems than the species of tall grasses growing on sand. Their roots form a turf 6 or 8 inches thick and on decaying leave more organic matter in the surface soil than is left in the sandy lands by the sparser growing tall grasses. In many places it is probable that much of the organic matter is removed by erosion.

As a result of their low supply of organic matter, the more extensive soils in both the sand and loess-mantled parts of the county are light in color. Light-colored soils occur even on the terraces and bottom lands, especially in situations where the soils are subjected to considerable disturbance by wind or are developing from very recently deposited sand sediments. The soils have dark surface layers where moisture conditions have favored rapid growth and decay of vegetation and wherever the parent soil material has lain in its present position undisturbed by destructive erosion for considerable time. Soils that have dark surface layers occupy most of the terraces and bottom lands, the more nearly level divides and

more gradual slopes in the loessial uplands, and the sand hills wherever the soils have been protected from severe wind erosion during their development. The darkest soils are on the flood plains along streams and in pockets and swales in the sand hills where they have developed under conditions of abundant soil moisture, an unusually rank growth of grass, and rapid decay of vegetation. In these places many of the topsoils contain organic matter in excess of 4 percent. Some of them are almost black. In a few marshy areas throughout the sand hills the surface soil layers consist mainly of organic remains, are light in weight, and resemble muck. The subsoils in poorly drained areas are light colored, as a rule, and contain rusty-brown spots, splotches, and streaks. Most of those of soils in wet pockets throughout the sand hills have a 2- to 4-inch gleilike layer of pale bluish-green sticky sandy clay which is probably the result of the high water table, anaerobic conditions, and excessive leaching.

The mean annual precipitation of about 23 inches is insufficient to penetrate the well-drained finer textured soils to a greater depth than about 4 feet. Therefore the readily soluble salts, chiefly lime carbonate, have accumulated at about this depth, forming a layer with a higher content of lime than occurs in any other part of the soil profile or in the underlying parent material. This layer, commonly known as the lime horizon, is not present in all sandy soils, most of which are very low in lime, nor is it present in soils derived from loess which rest on sand within a depth of 4 feet. The latter soils, because of their comparatively low resistance to percolation by water, have sufficiently increased the efficiency of the carbonate leaching process to prevent the development of lime horizons. Even many of the sandier soils contain traces of disseminated lime in their lower layers, and in most of the poorly drained areas carbonates distributed in this form are abundant.

Although most of the soils, including all the more extensive ones, are immature, a few have reached a stage of development that may be regarded as normal, or mature, for this climatic and botanic region. These soils occur chiefly on the silty terraces and the nearly level or very gently sloping parts of the loessial uplands. All are well drained, but none is severely eroded. Following is a description of a profile of Hall silt loam, examined on a well-drained smooth loessial terrace in the southeastern part of the county:

A$_1$. 0 to ¾ inch, dark grayish-brown single-grained silt loam which is mulchlike when dry.

A$_2$. ¾ inch to 4 inches, very dark grayish-brown laminated silt loam thoroughly matted with roots of grama grass.

A$_3$. 4 to 20 inches, very dark grayish-brown silt loam with a mealy or poorly defined fine-granular structure.

B. 20 to 40 inches, grayish-brown silt loam which is somewhat more compact than that in the A horizon. This material breaks into clods of irregular sizes and shapes.

C. 40 inches +. The upper part of this horizon consists of the lime horizon which is light grayish-brown friable massive to cloddy silt loam containing an abundance of lime carbonate. Most of the lime is thoroughly mixed with the mineral material, but some is concentrated in the numerous seams and cracks and in filmlike coatings on the surfaces of clods. There are only a few hard lime concretions. The lime horizon is underlain by almost white floury loess which, although calcareous, contains no concentration of carbonates.

The transition in color and texture between contacting horizons is gradual. The topsoil is well supplied with organic matter but has been leached of its readily soluble lime. Below a depth of 20 inches, the organic material occurs chiefly as a filmlike coating on the surfaces of soil particles. The film becomes thinner downward and disappears at a depth of about 30 inches. All horizons of the solum show evidence of having been worked over by worms and insects. The entire subsoil has an indistinct prismatic cleavage so characteristic of normally developed Chernozems in the loess section of the United States.

The profiles of the Hall and Holdrege soils in this county are similar. There are, however, slight differences in the texture and thickness of the several layers. The profiles of the Marshall and Waukesha soils also resemble the one described in most respects, but in this county the Marshall and Waukesha soils contain more sand and are more deeply and thoroughly leached of readily soluble salts than the Holdrege and Hall soils. The lime horizon, so characteristic of the Holdrege and Hall soils, is absent in the Marshall and Waukesha soils.

The rest of the soils are relatively immature. Some of them have acquired deep dark topsoils, but none has all the layers common to normally developed soils in this section.

Table 7 gives the results of mechanical analyses of samples of several soils in this county.

TABLE 7.—*Mechanical analyses of several soils in Loup County, Nebr.*

Soil type and sample no.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Holdrege very fine sandy loam:	*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
379001	0–13	0.0	0.3	0.6	4.4	39.0	32.3	23.3
379002	14–30	.0	.0	.0	.7	27.6	50.0	21.6
379003	31–42	.0	.0	.3	.6	26.3	52.6	20.2
379004	43–58+	.0	.2	.1	.6	27.8	51.0	20.3
Valentine fine sand:								
379022	0– 8	.0	1.1	5.5	39.5	40.8	7.1	6.1
379023	9–60+	.0	.7	3.4	33.9	49.5	4.5	8.0
O'Neill fine sandy loam:								
379035	0–18	.0	.6	3.5	32.0	40.8	15.7	7.4
379036	19–58+	.1	.3	2.1	27.8	41.3	19.6	8.8
O'Neill loamy fine sand:								
379037	0–14	.1	.9	5.5	39.3	32.9	12.6	8.6
379038	15–56+	.0	.6	4.8	36.6	39.4	10.8	7.9
Marshall very fine sandy loam, sandy-substratum phase:								
379024	0– 6	.2	.9	2.1	15.6	32.1	34.2	15.0
379025	7–16	.0	.2	.3	2.1	28.4	41.9	27.1
379026	17–34	.0	.0	.2	1.8	37.3	39.0	21.7
379027	35–60+	.1	.1	.1	.9	35.8	44.8	18.2

SUMMARY

Loup County is in north-central Nebraska. Most of it is in the sand-hill section of the State, but a few square miles in the southern part are occupied by the northern fringe and scattered outlying areas of the loess section.

The relief ranges from nearly level to hilly. The relief in the sand hills has been produced largely by wind, and the typical sand-hill topography prevails. Nearly level strips of alluvial land are along all the drainageways. Small areas of slight relief are on high

tablelands of the loess section and in numerous pockets and swales throughout the sand hills. Elsewhere the surface of the land has been greatly roughened by wind or geologic water erosion.

The county is drained by North Loup and Calamus Rivers which flow southeast across the southern and central parts, respectively. These streams have low gradients and are filling their channels at places. In the sand hills, tributary drainage to the trunk streams is poorly established because most of the surplus moisture escapes downward through the loose porous sands. All the smaller streams in the loess-covered parts of the county have steep gradients and are deeply entrenched.

Well water of excellent quality is readily obtainable in all parts of the county, at depths ranging from 30 to 350 feet.

Native forest grows in narrow belts along North Loup River and its tributaries. It consists of scrub elm, ash, boxelder, cottonwood, and willow and is of value mainly for posts and firewood.

The climate is characterized by high summer and moderate to low winter temperatures. The mean annual precipitation is about 23 inches, and the mean annual temperature is about 48° F. The average frost-free season is 145 days.

The agriculture consists chiefly of livestock raising. The soils on the more nearly level areas of the loessial uplands in the southern part of the county and most of those on both the sandy and silty terraces along the rivers are under cultivation. They are well suited for the crops commonly grown in the section. Most of the darker and more stable soils in protected situations throughout the sand hills are cultivated also. Most of the land remains with its native covering of grasses and is used for grazing land or for the production of wild hay, in connection with cattle raising.

Corn is the most important cultivated crop, mainly because it is needed for feed, but partly because of its wide adaptation to different soil and moisture conditions. Oats, alfalfa, rye, and wheat are grown chiefly on the finer textured soils. The bottom lands are too poorly drained in most places for cultivated crops and are used mainly for native-hay land.

The farms, as a rule, are well improved, and modern labor-saving machinery is in general use.

The soils and land types have been placed, mainly on the basis of their stability and drainage conditions, in three broad groups, as follows: (1) Well-drained stable soils of the uplands and terraces, (2) poorly drained soils of the basins and bottom lands, and (3) excessively drained unstable soils of the uplands and terraces.

The soils of the first group are used mainly for grain and tame-hay crops. They include the Holdrege, Marshall, Hall, Waukesha, Anselmo, Thurman, and O'Neill soils. The more silty members are the more productive, but in average years all soils of the group return good yields of most crops commonly grown in the section. The Anselmo, Thurman, and O'Neill soils are a little unstable during dry, windy weather and for this reason are not so well suited for small grains as are the more silty soils. They are used chiefly for corn, alfalfa, and sweetclover.

The soils of the second group are used mainly for the production of native hay. They include the Cass and Sarpy soils of the bottom

lands and the Gannett soils of wet swales and pockets in the sand hills. All these soils are subject to complete or partial inundation during seasons of heavy precipitation. They consist mainly of sand from the surface downward. Some corn and alfalfa are grown on the better drained land where more nearly uniform and usually higher yields of these crops can be obtained than on any of the soils throughout the uplands.

The soils of the third group occupy nearly nine-tenths of the land area of the county. They include the Colby, Valentine, and Sparta soils and all the areas classed as dune sand and rough broken land. These soils and land types are subject to such severe wind or water erosion when cultivated or lose so much of the precipitation through run-off or downward percolation that they cannot, except in a few small areas, be cultivated under the present system of farming. They are used almost exclusively for grazing land. They furnish most of the pasture on which cattle raising, the chief source of income, so largely depends.

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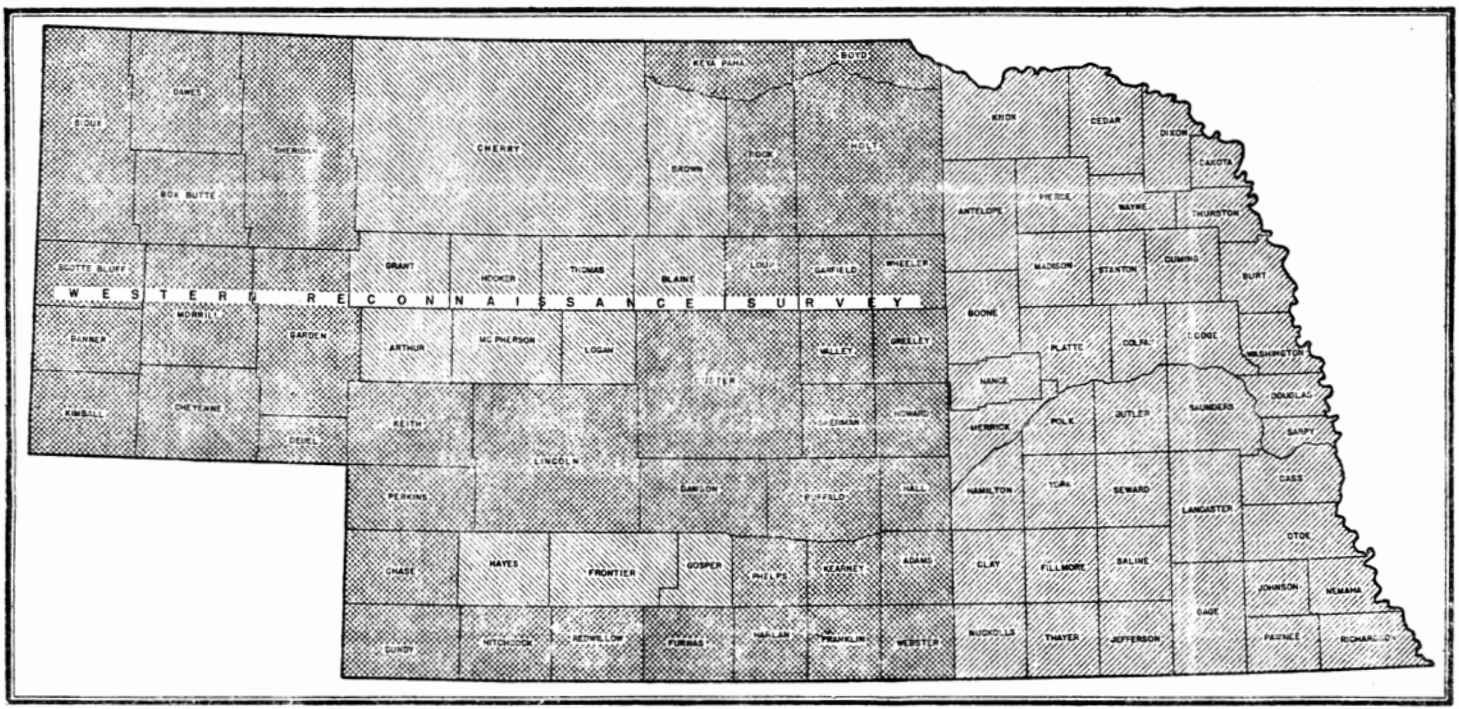

Areas surveyed in Nebraska shown by shading. Detailed surveys shown by northeast-southwest hatching; reconnaissance surveys shown by northwest-southeast hatching; crosshatching indicates areas covered in both ways.

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