U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE IOWA AGRICULTURAL EXPERIMENT STATION
C. F. CURTIS, DIRECTOR; W. H. STEVENSON, IN CHARGE SOIL SURVEY,
P. E. BROWN, ASSOCIATE IN CHARGE.

SOIL SURVEY OF BUENA VISTA COUNTY, IOWA.

BY

L. VINCENT DAVIS, OF THE U. S. DEPARTMENT OF AGRICULTURE, IN CHARGE, AND H. W. WARNER, OF THE IOWA AGRICULTURAL EXPERIMENT STATION.

THOMAS D. RICE, INSPECTOR, NORTHERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1917.]

WASHINGTON:
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1919.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., October 15, 1918.

SIR: In the extension of the soil survey in the State of Iowa, a survey was made of Buena Vista County during the field season of 1917. This work was done in cooperation with the State of Iowa, and the selection of the area was made after conference with State officials.

I have the honor to transmit herewith the manuscript and map covering this work, and to recommend their publication as advance sheets of Field Operations of the Bureau of Soils for 1917, as authorized by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

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FIG. 1. Sketch map showing location of the Buena Vista County area, Iowa. 5

MAP.

Soil map, Buena Vista County sheet, Iowa.

SOIL SURVEY OF BUENA VISTA COUNTY, IOWA.

By L. VINCENT DAVIS, of the U. S. Department of Agriculture, In Charge, and H. W. WARNER, of the Iowa Agricultural Experiment Station.—Area Inspected by THOMAS D. RICE.

DESCRIPTION OF THE AREA.

Buena Vista County lies in the northwestern part of Iowa. It is in the third tier of counties south of the Minnesota State line, and on the west two counties lie between it and the Sioux River which forms the South Dakota State line. It is almost a square in outline, containing 16 townships, and has an area of 571 square miles or 365,440 acres.

Buena Vista County consists of a plateau, practically without dissection except in narrow belts along the largest streams. The broken topography occurs along most of the slopes leading to the Little Sioux Valley and along the tributaries of the Little Sioux River and Brooke Creek, and is particularly well developed in Brooke Township. In the broken areas the slopes are steep and the small drainage ways are inclined to be V-shaped gulches. In the remainder of the well-drained portion of the county where the topography mainly is gently rolling, the slopes are gentle and the streams are separated by long, low ridges, sometimes so flat that they barely form a watershed.

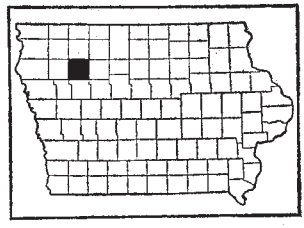


FIG. 1.—Sketch map showing location of the Buena Vista County area, Iowa.

Over the larger part of the county there are almost no stream valleys; the surface is morainic and differs radically from the erosional topography just described. In place of regular watersheds there is a confusion of irregular mounds, ranging from hills or kames to low swells. The slopes of the small mounds are usually gentle, but those of the larger are frequently quite abrupt. Nearly all, but especially the larger, have a trend northwest and southeast. Before artificial drainage was established there existed in this morainic area depressions without any natural outlet and long, winding prairie sloughs ranging from less than 1 acre to hundreds of acres in extent. These were sloughs or ponds during the greater part or all of the year,

depending on the depth and the amount of evaporation. Some of the sloughs converge to form Coon River, which assumes the form of a natural stream a few miles before crossing the southern boundary of the county. Coon River and four or five tributaries of the Missouri River entering it from the west, together with four or five small streams emptying into some sloughs, form the only natural streams in the morainic area.

Narrow strips of first-bottom land occur along the principal streams, usually beginning 2 to 4 miles from their source and continuing with gradually increasing width. In the Little Sioux River Valley there are, in addition to the first bottom, small disconnected terrace areas occurring at three different elevations. The lowest lie about 15 feet, the second from 30 to 45 feet, and the highest from 50 to 65 feet above the first bottom. The terraces occur on the concave side of the big bends of the river. Their greatest width is about five-eighths of a mile.

In elevation above sea level Buena Vista County ranges from about 1,250 to 1,525 feet. Following are the elevations of some of the principal towns:[1] Sioux Rapids, 1,276; Marathon, 1,399; Albert City, 1,325; Rembrandt, 1,333; Newell, 1,264; Storm Lake, 1,435; Alta, 1,513.

The divide between the drainage tributary to the Missouri River and that tributary to the Mississippi River crosses this county, passing through Storm Lake and Alta. From Alta the land slopes away in all directions. A narrow strip west of a line drawn from Alta to the northwest corner of the county slopes to the west. The remainder of the county north of Alta (excepting the small area north of Little Sioux River) and west of the divide has a general north slope. East of the divide the prevailing slope is to the south.

Almost all of the county east of the divide drains into the Coon River. The Little Sioux River drains the county to a distance of 2 to 4 miles on each side of it and in addition a wedge-shaped area extending from the river just west of Linn Grove almost to the city of Storm Lake. The western part of the county is drained by Maple Creek (in Cherokee County), which flows in a southerly direction and roughly parallels the west county boundary at a distance of 3 to 5 miles. A small section of country south of Storm Lake drains into Boyer River in the county to the south.

The valley of the Little Sioux River varies from one-half to 1 mile in width. It is bounded in most places by steep slopes, but in a few places the slope is very moderate. The height of the surrounding bluffs above the first bottom is 120 to 125 feet. The river is still deepening its channel and has sufficient volume and current

[1] Iowa Official Register, 1909–10. These altitudes are stated as being taken from geological and railway surveys.

for the development of water power. At Peterson, about 8 miles down the river, in Clay County, a large dam has been built for the development of electric power which is supplied to surrounding towns, including nearly all those in Buena Vista County. Water power was at one time developed for running a roller mill at Sioux Rapids, but this has since been abandoned. At Linn Grove a dam develops power for a small mill.

Brooke Creek, the principal tributary of the Little Sioux River within the county, rises just north of Storm Lake. From its source to a point about 6 miles north of Alta it formerly consisted of a series of marshes or prairie sloughs,[1] through which at present an artificial channel has been cut. From this point the creek has the appearance of a natural stream. Its valley becomes deeper and its valley slopes change from moderate to steep as it approaches the river valley. The rate of fall also greatly increases. The width of the valley, never over one-eighth mile, is less near its mouth than a short distance back. This is the case also with all the tributaries of the Little Sioux River.

The valleys of the tributaries of Maple Creek, Boyer River, and other streams are not distinctive, as the slopes rising from the first bottoms are gentle and no different from those of the small hollows. One exception to the gently sloping valley walls occurs in one of the tributaries of Boyer River which rises about one-half mile northwest of Juniata. The valley walls of this tributary are quite steep. About one-quarter mile west of the point where this stream leaves the county, another stream coming from about 5 miles northwest joins it in Sac County. The first bottom between the two is continuous, but that of the east branch, which has the steep-walled valley, is 6 to 8 feet below the level of that of the west branch. The explanation of the steep-walled valley and the lower level of the first bottom is found in the fact that within the memory of old settlers the creek known as "The Outlet" has frequently overflowed into this branch of Boyer River. The tributaries of Maple Creek, Boyer River, and Storm Lake are still cutting.

In general, the streams in the morainic part of the county, including the Coon River below the point where it loses the nature of a slough, have almost no tributaries and drain a strip of country little wider than their narrow flood plains. They have good fall and are still cutting.

The lakes of Buena Vista County are not of great importance from the standpoint of physiography. They are, in order of economic importance, Storm Lake, Pickerel Lake, and Pleasant Lake.

[1] Iowa Geological Survey, vol. 12, pp. 315–316. The author of this work believes that this is a preglacial valley in which, previously to the glacial invasion, a stream flowed in a southerly or southwesterly direction.

Buena Vista County was surveyed in 1855 [1] and the first permanent settlement was made the year following by settlers from the eastern part of the State. The land along the Little Sioux River was first settled, as the bluffs furnished protection from the wind and the timber supplied fuel. Prior to that time the Indians had lived along the river. The county was organized in 1858. Sioux Rapids was the county seat until 1878, when it was succeeded by Storm Lake. In 1859 a considerable number of Norwegians settled in the county. The Illinois Central Railroad was built in 1869 and the Chicago & North Western in 1882. Settlers came from Ohio, Indiana, and more eastern States as well as the eastern part of Iowa. The foreign nationalities represented among the early settlers were principally Danish, Norwegian, Swedish, and German.

The population of Buena Vista County in 1910 was 15,981. Storm Lake, the largest town, had a population of 2,428. The remaining 85 per cent of the county's total population is classed as rural and averages 23.7 persons per square mile. According to the State census of 1915, which gives the total population as 17,212, 44.9 per cent are native born of native parents, 37.8 per cent are native born of foreign or mixed parentage, and 17.3 per cent are foreign born. The rural population is very evenly distributed throughout the county. It is slightly less dense in the northeastern part of Brooke and the northwestern part of Lincoln Township. The numerous towns and villages include Alta, with a population of 959; Sioux Rapids, 868; Newell, 728; Marathon, 532; Linn Grove, 500; and Albert City, 261.

The county is well supplied with railroads, scarcely any farm being over 10 miles from a shipping point. All the towns are on railroads and have good communication with Chicago, Sioux City, Des Moines, St. Paul, Minneapolis, and other large cities.

The country roads are well cared for. The "county roads," which comprise the main arteries of travel, are under the supervision of the county authorities. The remainder, called "township roads," are under the supervision of the township trustees. The location and specifications of the county roads must meet the approval of the State Highway Commission. In this county the width of the road proper or crown is 26 feet for county roads and 22 feet for township roads. The county roads have all been built to a surveyed grade. Some of them have been graveled, and it is planned to gravel the remainder as soon as possible. (See Pl. I, fig. 1.) A branch of the Minneapolis & St. Louis Railroad passes through Storm Lake, Truesdale, Rembrandt, and Sioux Rapids. The Hawkeye Highway, between Dubuque and Sioux City, passes through the county along the Illinois Central Railroad.

[1] History of Western Iowa, Western Publishing Co., Sioux City, 1882, p. 440.

The county is well supplied with telephone service, practically every farm having telephone connection. Many farms are supplied with electric current from the Peterson power plant. The current is used principally for lighting purposes at present, but it is probable that in the future it will be used for power as well.

The rural schools of Buena Vista are well organized. Many independent districts still remain, but 13 consolidated schools have been established, five of which are in the country and eight in towns. The largest consolidated school in the State is located at Alta, its district comprising 51 sections.

The chief markets for the products of Buena Vista County are Sioux City, Minneapolis, and Chicago. Owing to poor railroad connections, Omaha is not an important market. Some grain goes from Sioux Rapids to cereal plants at Cedar Rapids. A large quantity goes to Minneapolis, while the bulk goes to Chicago. Sioux City and Chicago get practically all the live stock. Elevators in every town furnish a good demand for grain. The live stock is either consigned to central markets or sold to local buyers. Dairy and poultry products and vegetables are practically all sold in the various towns and consumed locally. In most of the towns there are farmers' elevators and in a few towns farmers' cooperative stores. Usually in these cases a stock company is organized among the farmers and dividends are paid from the profits of the business.

CLIMATE.

Buena Vista County has a healthful climate suited to the production of the staple farm crops, particularly corn. Total crop failures are unknown.

The mean annual precipitation is 29.8 inches. Slightly over two-thirds falls during the months from May to September, inclusive, and the rainfall is well distributed over the growing season. Destructive hail storms are rare. Droughty periods are not unknown, but usually affect only crops on soils with porous subsoils.

The summers are pleasant, without prolonged periods of intense heat. The highest recorded temperature is 104° F. The mean temperature for the summer is 70.8°.

The winters are quite cold, the temperature often being below zero continuously for a week or two at a time. The lowest recorded temperature is —36°. Practically every farm is protected by a grove on the northwest. (See Pl. I, fig. 2.)

The average growing season is 151 days in length. The latest recorded date of killing frost in the spring is May 27, and the earliest in the fall, September 12. Corn is practically the only crop whose success depends upon the length of the growing season. If all growing seasons were as long as the average the large-eared varie-

ties of corn would have sufficient time to mature, but under existing conditions a smaller, earlier maturing variety is safer. There are numerous low-lying areas which have very poor air drainage and are particularly subject to frost. In such areas it is important that early-maturing varieties of corn be grown.

The length of the grazing season is generally considered to be $5\frac{1}{2}$ to 6 months, or from the first part of May to the middle of October or the 1st of November. With protection from blizzards stock can run in the stalk fields the greater part of the winter.

The records of the Weather Bureau Station at Storm Lake show that the prevailing wind direction for May is southeast; for June to October, south; and for November to April, northwest. The records of the station at Sioux City for a period of 25 years show the average wind movement to be 12 miles per hour. The records for 8 years show the average annual percentage of sunshine to be 61.

The following table gives the normal monthly, seasonal, and annual temperature and precipitation as compiled from the records of the Weather Bureau Station at Storm Lake:

Normal monthly, seasonal, and annual temperature and precipitation at Storm Lake.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1910).	Total amount for the wettest year (1891).	Snow, average depth.
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
December	21.9	57	−27	0.82	0.20	2.28	5.2
January	17.5	58	−36	.64	.86	1.61	6.5
February	16.6	60	−34	.89	.11	1.02	6.8
Winter	18.7	60	−36	2.35	1.17	4.91	18.5
March	32.3	82	−17	1.30	.05	1.33	4.2
April	46.4	90	6	2.69	.55	2.80	2.4
May	58.5	95	22	4.51	2.77	2.88	T.
Spring	45.7	95	−17	8.50	3.37	7.01	6.6
June	68.0	97	36	4.94	2.00	14.70	0.0
July	72.8	104	45	4.21	2.61	5.23	0.0
August	71.5	97	42	3.31	2.66	3.16	0.0
Summer	70.8	104	36	12.46	7.27	23.09	0.0
September	62.6	101	22	3.22	1.56	1.70	T.
October	50.9	88	13	2.08	.44	4.36	T.
November	36.4	74	−5	1.19	.05	.72	2.4
Fall	50.0	101	−5	64.9	2.05	6.78	2.4
Year	46.3	104	−36	29.80	13.86	41.79	27.5

AGRICULTURE.

Buena Vista County has reached its present state of development in a period of 60 years. During this time agriculture has been practically the sole industry. The early crops were flax and wheat. The number of live stock kept at first was very small. It was the regular practice to grow flax for the first sod crop. Wheat was practically the only cereal, at first, but small early-maturing varieties of corn were gradually introduced and about the same time oats became of some importance. With the production of corn more live stock was raised, especially hogs.

According to the census, corn was grown on 39,248 acres in 1879, 74,982 acres in 1889, 111,458 acres in 1899, and 104,688 acres in 1909. The Iowa Census reports 123,314 acres in corn in 1914. The average yield per acre in the last four census years has ranged from 36 to 40 bushels. The census shows a steady increase in the growing of oats, from 9,458 acres in 1879 to 81,248 acres, producing 2,122,668 bushels, in 1909. With the exception that the acreage in 1899 exceeded that in 1889, wheat shows a steady reduction from 23,641 acres in 1879 to 536 acres in 1909. Hay shows a gain from 10,043 acres in 1879 to 50,353 acres in 1909, in which year there were 30,178 acres of all tame or cultivated grasses, producing 50,817 tons, and 20,175 acres of wild or prairie grasses, producing 29,396 tons. Flax occupied its maximum acreage in 1889, when it was grown on 6,217 acres. It has since been practically abandoned, only 280 bushels being produced from 48 acres, in 1909.

At present, agriculture in Buena Vista County consists mainly in the production of corn, oats, and hay and the raising and feeding of hogs, cattle, horses, and sheep. A majority of the tenants are grain farmers, while most of the resident owners are live-stock farmers. About half the farm land is used in stock farming and half in grain farming. Many farmers have a few head of stock, but could not be classed as live-stock farmers. The value of all crops grown in 1909 is given as $3,373,901, and the revenue from live stock and live-stock products as $2,381,611.

Corn occupies by far the greatest acreage of any crop. It is grown on every farm. Much of the crop, if not the greater part, is fed to stock on the farms; the remainder is sold, mainly to local buyers, at every shipping point in the county.

Oats are the second crop in point of acreage. The crop is grown on practically every farm. A small part is fed to work stock and young horses and mules. Practically all the remainder is sold to local grain buyers or consigned to commission men in the large grain centers.

Both tame and wild hay are fed to stock, and none is shipped from the county. Of the tame grasses, clover and timothy occupied 96 per cent of the total acreage in 1909.

Potatoes are the most important special crop. In 1909 there were 173,893 bushels produced on 1,858 acres. Potatoes formerly were an important crop in the vicinity of Alta, but they have since declined. In 1899 the production amounted to 211,056 bushels.

The growing of sweet corn for a canning factory is a specialized industry in the vicinity of Storm Lake. The factory contracts with local farmers for 800 to 1,200 acres of sweet corn each year. It furnishes the seed, at a charge of $2 per bushel, and pays $10 a ton for the corn in the husk. The varieties grown are the Evergreen and Country Gentleman. The canning season lasts 4 or 5 weeks and 1,500,000 No. 2 cans of corn are put up. It is reported that as a rule the Webster soils produce more and better corn than the other types in the neighborhood of the factory.

Nearly every farm has a garden and a small orchard. The gardens exclusive of potato patches average about one-fifth acre. The average size of the potato patches is 1 acre. The Early Ohio is the leading early variety and the Rural New Yorker the principal late variety. The garden vegetables include root crops, peas, and beans. The census of 1910 reports a total of 37,474 apple trees in the county, 9,552 plum trees 3,704 cherry trees, 1,241 peach trees, and 743 nut trees. Raspberries, gooseberries, blackberries, and strawberries are grown by some farmers. Some apples are grown on nearly every farm. The most common varieties are the Wealthy, Duchess, Longfield, Yellow Transparent, and Whiting No. 20. The bulk of the garden and orchard products are consumed on the farm, the surplus being sold on the local markets.

The principal live-stock industries, named in the order of their importance, are the raising of hogs, feeding of beef cattle, dairying, the raising of horses and mules, and sheep raising.

Hogs are raised more extensively than any other class of live stock. In 1914 there were 74,483 hogs on the farms. The general practice is to market hogs 10 to 12 months from farrowing time, at a weight of 225 to 275 pounds. Many farmers let the hogs clean up the corn fields. It is a common practice to confine the stock in pens during the latter part of the fattening period. Some farmers use self feeders, and a large percentage use meat meal or alfalfa to balance the ration.

Comparatively few beef cattle are raised, as the farmers depend largely on buying from the central markets of Sioux City, Omaha, and Chicago, and to a small extent from western ranges. It is a common practice to feed for short periods, from 60 to 90 days. Corn, hay, and in some cases silage are commonly fed, with concentrates added during the last three weeks of the feeding period. Silage is being fed more commonly to beef cattle every year, as the number of silos steadily increases. (See Pl. I, fig. 2.) Feeder cattle

are generally bought in the fall, put on corn during the husking period and through the winter, and disposed of on or before the first day of April. Where a farmer has as many as a carload he usually consigns them to a commission man in one of the central markets; otherwise he generally sells to a local buyer. There are fine herds of beef cattle on some farms. (See Pl. II, fig. 1.)

The value of the dairy products produced in Buena Vista County in 1909, excluding those used in the home, is given by the census as $281,069. There are only about a dozen farmers engaged in dairying exclusively. Of these about half sell milk and cream to people living in the larger towns. Most of the remainder sell cream and feed the skim milk to hogs and calves. Consequently the greater part of the dairy products come from farmers producing them as a side line. Probably about 400 farmers keep 2 to 10 cows, mostly dual-purpose, and ship some cream. Creameries are located at Storm Lake, Alta, and Albert City. Local creameries in some instances are being supplanted by cream stations, where the cream is bought for shipment to some large creamery. Cream stations are now located at practically every shipping point in the county. Where strictly dairy cows are kept the Holstein predominates, with the Guernsey next, and the Jersey third.

Poultry raising is, with one or two exceptions, carried on as a side line, though many farmers are beginning to give this industry considerable attention. Poultry products are sold to the local markets and to a few buyers who make a specialty of buying for shipment to large plants.

The average number of horses per farm in 1914 was 7.2. The total number of horses and mules in the county was 13,891, of which 407 were mules. The colts under one year numbered 1,073, or less than one per farm. This number may be taken as representing approximately the average number produced per year. The colts are generally broken and worked. What few horses are sold are usually bought one or two at a time by professional buyers. The market age is 4 to 10 years.

The census gives the value of the wool produced in 1909 as $6,281. The Iowa census gives the value of the sheep on farms in 1914 as $13,830 and their number as 3,262. Only a few farmers keep sheep. Some are raised, but the greater number are bought through the large markets, principally Sioux City and Omaha. It is a common practice among the farmers handling sheep to buy lambs of 60 to 80 pounds in weight in August. They are allowed the run in almost every part of the farm, including the corn fields, and invariably clean up the weeds. Unless the corn is down badly they do not molest the crop. The sheep later are put on a fattening ration for a period of

40 to 60 days. They are fed grain (generally corn), concentrates, silage, and hay (clover and timothy or alfalfa if available).

The topography has an important influence on agriculture in this county. In low-lying flats and "pockets" the air drainage is poor, and it is necessary to grow early-maturing and cold-resistant crops and varieties as far as possible. The poorly-drained soils are largely used for pasturage or hay production where not tiled. Farmers recognize that, though potatoes will do very well on most of the soils, they will give best results on Peat, Muck, and loamy soils. Alfalfa is seeded only on well-drained soils. The adaptation of the newly-broken sod land for flax has been recognized from the earliest history of the county.

A considerable area of poorly-drained land has been improved by tile drainage. In the Webster silty clay loam best results have been obtained by placing the drains every 2 or 3 rods.

In growing corn the land is generally plowed in the fall and left bare, though in a few instances rye is sown as a cover crop. In the spring the soil is worked up with disk and drag harrows during the latter part of April or the first part of May. Planting is generally done between May 1 and 10 with a check rower, corn being drilled only where it is to be used for silage or fodder. The field is gone over with a harrow before the corn comes up and the crop is cultivated four or five times. Harvesting begins about October 15 and generally ends by Thanksgiviing. Silage and fodder corn are generally cut between September 1 and 20. Probably 10 per cent of the crop or slightly less is cut for fodder and silage. All the corn gathered for storage is husked in the field. A practice coming into favor with a large number of farmers is to fence off small areas at a time and turn in hogs. The principal white varieties of corn grown are the Silver King and Iowa Silvermine, and of the yellow varieties, early types of Reid's Yellow Dent, Golden West, and Murdock's Early Yellow Dent. Most of the corn grown is the more or less mixed progeny of the foregoing types. The growing period necessary for the common varieties ranges from 90 to 115 days. The farmers take much pride in the quality of the corn produced, and probably the largest corn show in the State aside from the State Corn Show is held at Newell every January.

Small grain is sown on corn stubble. Though it is not always done, the best practice is to disk the land before seeding. The seed is generally broadcasted. Oats are seeded at the rate of 3 bushels per acre and wheat at the rate of $1\frac{1}{2}$ to $1\frac{3}{4}$ bushels. After seeding the land is disked and harrowed. Harvest generally takes place between July 10 and 25. The grain is cut with self-binders and shocked in the field. About 25 to 30 per cent is stacked before thrashing. Early varieties of oats are beginning to predominate. The remainder is

for the most part medium, very little late oats being grown. Kherson is the predominating variety of early oats, other varieties being Early Champion, Iowa 103, and Iowa 105. The last two have come to the front the past year and will doubtless lead hereafter. Green Russian is the principal medium-late variety.

The greater part of the wheat grown is winter wheat. Turkey Red is the most common variety of winter wheat and Marquis, of spring wheat.

Timothy and clover are most commonly seeded with oats or just after the oats have been seeded and disked and before harrowing. The rate of seeding is 6 to 14 pounds per acre of clover and 6 to 10 pounds of timothy. Occasionally 4 to 6 pounds of alsike are added. If these crops are grown separately, which is very rare, the rate of seeding is slightly heavier. About 1,000 bushels of timothy seed is produced each year in Buena Vista County. Where the crop is grown for seed it is cut, bound, and thrashed at about the same time and in about the same manner as oats. Clover seed is sometimes harvested at the second cutting, but two cuttings are not always obtained. Plenty of moisture is needed after harvest, and sometimes the crop is pastured instead of cut. The first clover crop is cut between June 25 and July 10; the second, the last week of August or the first of September. For hay, timothy is usually cut the first week in July, and for seed about the middle of July. One cutting of timothy is obtained the second year.

Alfalfa is grown only in 1 to 5 acre plots, except in Brooke Township, where it occupies a considerably larger acreage than elsewhere. Probably the most common practice is to sow alfalfa with a nurse crop of early oats, though it is frequently sown in the spring or in August without protection. Good stands are obtained both with and without a nurse crop.

Farms in Buena Vista County are well equipped. Good farm buildings and modern homes are characteristic. (See Pl. I, fig. 2.) Nearly every farm has a large barn, hog house, garage, chicken house, corn cribs, and granary, and on many there are also an ice house, milk house, silo, elevated tank, tool shop, litter carrier, and machine shed. Many farms have storage-battery lighting systems. Acetylene-light plants are quite common, and some farmers use gasoline lighting plants. Electric current for both light and power is being extended from the towns into the country. Much of the farm fencing is woven wire. The farm implements usually include a rotary harrow (4-horse), 4-section drag, gang plow, 1 or 2 row cultivators, corn planters, broadcast seeder, manure spreader, stationary gas engine, grain grader, self-binder, self-dump elevator, mower, dump rake, and buck rake. Less common implements are the hay loader, tractor (8 to 12 horsepower; one semicaterpillar

tractor in the county), corn binder, corn picker, lime spreader, ensilage cutter, and small-farm grain separator. The work horses are of good quality and of medium draft type.

The average depth of plowing is 4 to 5 inches when horses are used and 6 to 7 when tractors furnish the power. After plowing the land is disked, lap disked, and harrowed, or lap disked, cross disked, and then harrowed, depending on the length of time available. The corn is cultivated twice to a depth of about 3 inches; later cultivations are 1½ to 2 inches deep.

A definite rotation is practiced by most of the farmers of Buena Vista County, consisting of corn 1 year, oats 1 year, clover and timothy 1 year, and either returning to corn, as is done in most cases, or adding one more year of timothy and clover. If the timothy and clover is continued into the fourth year the crop is principally timothy. An exception to the common rotation is that new ground is generally kept in corn for 2 or 3 years. More of the farms are handled on the 3-crop basis of corn, oats, and timothy and clover, a small acreage of the latter often being left each year for old meadow. Pastures seldom exceed 20 acres and are seldom kept in the same place for more than 4 or 5 years.

Practically no commercial fertilizer is used in Buena Vista County. Lime is used to a small extent. All the barnyard manure is applied, either by hand or more frequently with manure spreaders, upon small-grain stubble or hay stubble before fall plowing for corn.

Farm laborers in Buena Vista County are mostly American, and the supply is scarce. Prevailing wages for single men are $35 to $50 a month, with board and washing. For married men the average agreement calls for $50 a month, with tenant house if such is available, and certain incidentals, such as fuel, milk, poultry, 200 to 300 pounds of meat, and a garden patch. Day wages range from $2 to $3.50, depending on the season. For corn plowing $2 a day is the customary wage, for haying $2.50 to $3 and for thrashing and silo filling $3 to $3.50. These rates for day wages apply to present conditions (1917), and are higher than for 3 or 4 years past.

The size of farms varies from 20 to 640 acres. The average size is 180.6 acres. The area in farms in 1909, according to the census, is 95.5 per cent of the total area of the county, while 92.6 per cent of the land in farms, or 167.3 acres per farm, was improved. The average size of farms increased 33.6 acres between 1879 and 1909.

In 1879, 80 per cent of the farms were operated by owners and 20 per cent by tenants, while in 1909, 51.2 per cent were operated by owners, 48.1 per cent by tenants, and 0.7 per cent by managers. Of the farms operated by tenants, the Iowa census of 1915 shows that practically three-fifths rent for cash, one-fifth for cash and a share of the crop, and one-fifth on shares. Cash rent for cultivated land ranges from $6 to $12 an acre, with an average of about $9. For

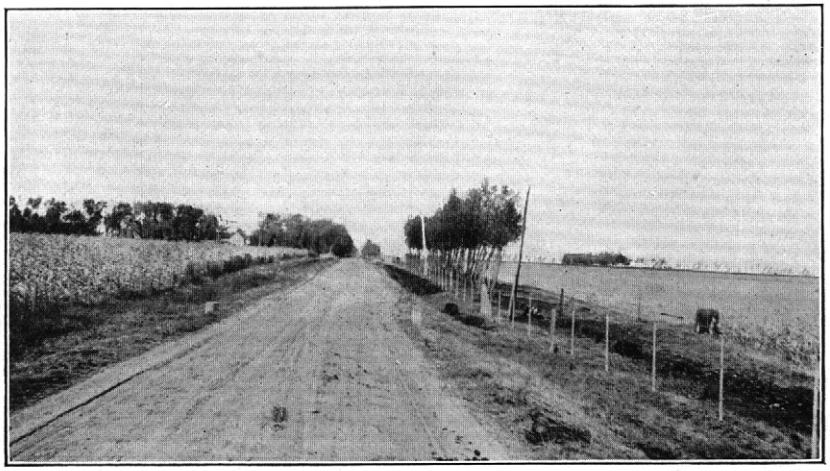


FIG. 1.—GRAVELED COUNTY ROAD.

Many miles of county road have been surfaced with gravel, and it is planned to surface all the rest.

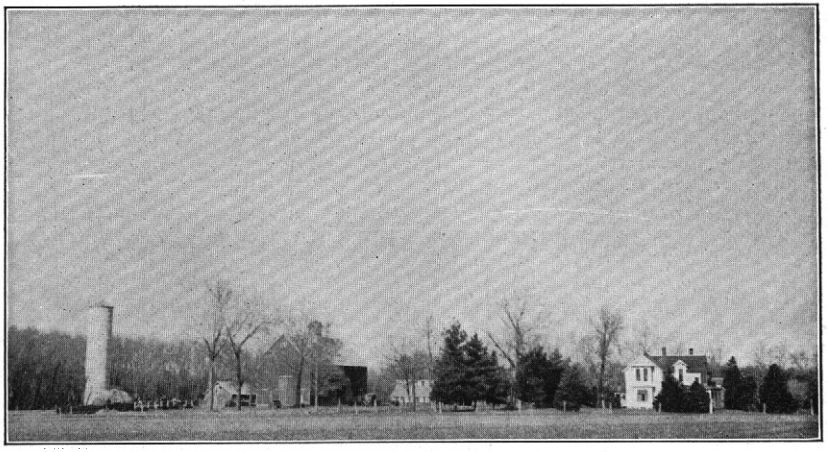


FIG. 2.—TYPICAL FARMSTEAD OF THE BETTER CLASS.

Note the tall concrete-slab silo and the planted windbreak.

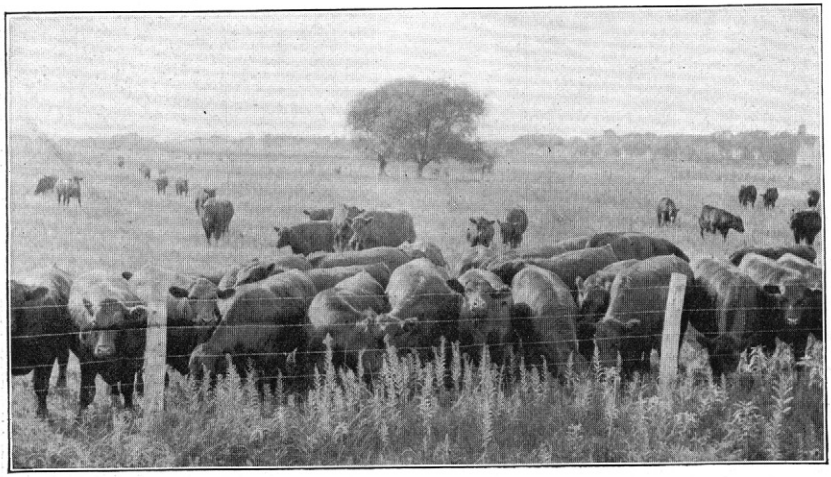


FIG. 1.—HERD OF ABERDEEN-ANGUS CATTLE IN THE VICINITY OF NEWELL.

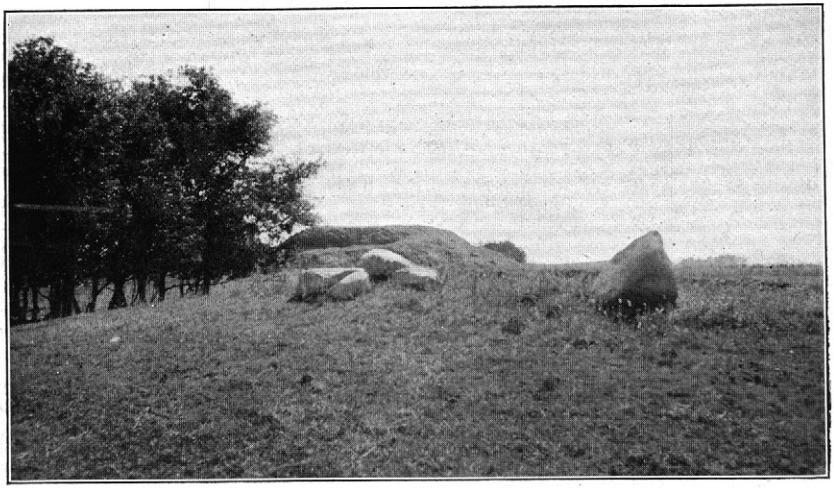


FIG. 2.—BOWLDERS IN EXPOSED GRAVEL POCKET AT CREST OF SLOPE IN CARRINGTON LOAM.

pasture the range is from $4 to $8, with an average of about $7. The terms of share rental vary with the individual contract. Where the renter furnishes everything he ordinarily gives one-third to one-half of the crop, and where the owner furnishes everything he receives four-fifths of the crop. Between these extremes there are numerous arrangements.

Land values in Buena Vista County vary according to the topography and condition of the land—whether well drained or subject to overflow—the improvements, and the location with reference to towns and transportation facilities. The range in the selling price of farm land is from $50 to $300 an acre. The price of average farm land is about $190 an acre.

SOILS.

Buena Vista County lies within that part of the United States which was invaded by Pleistocene glaciers. The ice in its movement gathered and transported a heterogeneous mixture of coarse and fine rock débris, and upon its retreat left a mass of drift consisting of clay, silt, sand, and bowlders of all sizes. Successive invasions and recessions of the ice sheets occurred during a long period of time, but not all of this region was covered by each advance. Two glaciations, the Kansan and the Wisconsin, are represented in Buena Vista County. The Wisconsin drift, left by the last great ice invasion, extends from the eastern side of the county over nearly two-thirds of its area. Its western boundary is irregular but coincides closely with the boundary between the Carrington loam derived from the Wisconsin drift, and the Carrington silt loam, largely derived from the Kansan drift or from an overlying deposit of silty material.

The Wisconsin drift is similar to the Kansan in appearance, but differs from it in being less oxidized, so that the deep-brown to faintly reddish-brown color prevailing in the latter is replaced by a pale yellowish brown in the former. It also contains more pebbles and bowlders and is much richer in limestone. Where the material has not been oxidized it is bluish drab to bluish gray or gray. The stones vary in size from the most minute pebbles to bowlders 3 to 4 feet in diameter. Of the many bowlders 1 to 1½ feet in diameter almost all are granite, but there are also gneiss, diabase, sandstone, and limestone, the latter appearing to be in the minority. The most of the stones are rounded, but some are angular. There are apparently no striations. The depth of the Wisconsin drift in this county is uncertain,[1] but is doubtless sufficient to prevent any influence on the soils by underlying formations.

[1] Geology of Cherokee and Buena Vista Counties, by T. H. MacBride, Iowa Geol. Survey, vol. 12, pp. 323–324.

The author seems to question whether the formation in the western part of the county and in the vicinity of Little Sioux River near Sioux Rapids is Early Wisconsin, Kansan, or Wisconsin. Not typical because of proximity to the boundary of the moraine.

The Kansan drift consists of a bluish clay which has become brownish or yellowish where exposed to oxidation, and which when sufficiently free from sand and gravel usually presents a peculiar jointed structure. It contains numerous pebbles, bowlders, and shale fragments distributed through the clay. In this county its depth, as judging from well borings, is 20 to 50 feet.

The soils derived from the two drift sheets do not differ in appearance. The difference in texture of the two principal soils representing these sheets is due in large part to a thin covering of silty material over the Kansan which has influenced the surface soil over extensive areas, and its absence over the Wisconsin drift.

The silty material has a wide distribution west of the county, and it is generally believed that it covers to a greater or less depth nearly all of the Kansan drift. It is very difficult to distinguish this material from the well-weathered, silty Kansan material and it is a question how much the Carrington silt loam, as mapped in this county, has been modified by this layer and how much is due to the long weathering of the Kansan drift. Numerous flat areas and island-like knolls of undoubted till origin are scattered through the western part of the county. It is probable that many good-sized areas are of purely loessial origin and might be mapped as Marshall silt loam, but their separation from the true Carrington soil would be very difficult and entirely arbitrary. The fact that a till subsoil is nearly everywhere encountered at a depth of less than 3 feet has seemed to justify the inclusion of the material with the Carrington silt loam.

In the morainic portion of the county there is some variation in the composition of the drift. In many cases pockets of sand, gravel, and bowlders occur at the top of knobs or kames and at the crest of slopes, extending almost if not quite to the surface. The exposed or nearly exposed areas of this character are generally more or less circular and only a few feet in diameter. (See Pl. II, fig. 2.) The pocket of coarse material slopes outward, and the drift becomes deeper with increased distance. In these pockets the sand and gravel are frequently stratified, as if waterlaid. The strata are frequently tilted and cross-bedded.

The lime content of the drift varies in different parts of the county. In the poorly drained areas, especially in the morainic sections of the county, the drift appears quite calcareous and frequently contains lime concretions; in the better drained situations the content of lime is variable. In some places pebbles and small bowlders are lime coated, and both they and the drift material react with hydrochloric acid, while only a rod away in any direction no calcareous reaction may be obtained. From observations made during the progress of the survey it was concluded that drift underlying the better drained soils is not highly calcareous and that areas showing a high

lime content, while numerous, are local and not representative of the general nature of the drift.

Conditions have been favorable for the rapid weathering of the glacial drift and for the accumulation of organic matter in the surface soil. Lime and other soluble constituents have not leached out, and there has been little loss of soil or organic matter through erosion. The variations in the glacial soils are due to the difference in the character of the drift and in the drainage conditions under which the soils have been formed. The Carrington soils occur in the better drained parts of the drift area and over almost all of the erosional area. In the morainic section they occupy knobs, kames, and low swells. The more poorly drained parts of the drift area are occupied by the Webster soils and Muck and Peat.

The Webster soils occur throughout the morainic area of the county, and to a small extent in the erosional section, occupying many irregular, low areas, varying from a few acres to several hundred acres in extent, where the soil has developed under poor drainage conditions. Before the introduction of artificial drainage the areas were inundated much or all of the year. In the western part of the county, in the more typical erosional section, the areas are somewhat more irregular in shape and larger, consisting of large, wide troughs. There has been a heavier growth of vegetation in the areas occupied by the Webster soils than in the better drained areas, and as a result they contain more organic matter. In many instances there has been a slight addition of soil material by the washing in of silt and clay from the higher surrounding land.

In two small peninsular areas in Storm Lake, totaling about 40 acres, the soils are derived from material deposited in or affected by the lake. The surface is 2 to 6 feet above the lake. The soil is a sandy loam to sand containing considerable gravel, and has been mapped with the Clyde series.

On the northwest side of Storm Lake an area of submerged marsh has been mapped. This area is covered with shallow water in which marsh grasses are growing. It can not be drained by ordinary means and has no agricultural value in its present condition.

In some areas which were permanently wet before the introduction of artificial drainage, water-loving flora developed to a greater extent than in other poorly drained areas which were only intermittently inundated, and organic matter accumulated much faster, especially since there were no prairie fires here such as consumed much of the organic matter in other poorly drained areas. These areas of cumulose soil are mapped as Muck or Peat, according to the proportion of organic matter present and its state of decomposition. The Webster silty clay loam, Webster silt loam, Muck, and Peat exist in all the intermediate forms between a silty clay loam and a peat,

with no sharp line of demarcation. They have of necessity been arbitrarily separated in many cases.

Alluvial soils of Buena Vista County may be divided into two general groups, namely, terrace soils and first-bottom or recent alluvial soils. The former are much less extensive and less important than the latter.

Terraces occur only in the Little Sioux Valley. The topography of Brooke Creek for a short distance back from its mouth seems to show vestiges of a terrace, now nearly removed by erosion. The terraces in this county are thought to have been formed at the time of the glacial invasion. Owing to the nature of their formation, the terrace soils are underlain with sand and gravel, and in dry periods tend to be droughty. The soils are classified with the O'Neill series.

The first-bottom soils are well distributed throughout the erosional parts of the county. In the morainic belt they occur along the Coon River below sec. 3, T. 91, R. 36, and its three or four natural tributaries from the west. The alluvial strips are proportionate in width to the streams they adjoin. The soils have been derived from alluvium deposited by the flood waters of the streams, and in texture are loams, silt loams, and silty clay loams. They are mapped with the Lamoure and Wabash series, depending upon their lime content.

The types of the Carrington series in this county are characterized by dark-brown to black surface soils, 10 to 18 inches in depth, and yellowish-brown or mottled yellowish-brown and gray subsoils. Gravel may occur in both soil and subsoil, but chiefly in the latter.

The Carrington soils occur in well-drained areas and on slopes varying from gentle to steep. In many places there are embedded gravel pockets, which lie almost if not quite at the surface. Both soil and subsoil are predominantly noncalcareous, but numerous small spots are found where the gravel is coated with lime and both the surface soil and subsoil react with hydrochloric acid.

The types included in the Webster series are characterized by black surface soils extending to a depth of 12 to 14 inches, and heavy, usually plastic, subsoils, mottled black, gray, and sometimes yellowish brown to rusty brown, with some drab. Gravel and bowlders occasionally occur on the surface and throughout the 3-foot section. Lime concretions are of frequent occurrence in the subsoil. Generally the subsoil and substrata, and not infrequently the surface soil, are calcareous and react with hydrochloric acid.

The O'Neill series includes types with dark-brown surface soils and brown to yellowish-brown subsoils, with a large proportion of sand in either the subsoil or substratum. Gravel occurs on the surface and generally throughout the 3-foot section. The O'Neill soils

occupy terraces in the valley of the Little Sioux River. They have a level to gently sloping surface, frequently traversed at right angles by draws leading to the first bottoms. Both soil and subsoil are noncalcareous.

The members of the Wabash series have black noncalcareous surface soils and subsoils, the latter usually being as heavy as or heavier than the surface soils. This series occurs in the level first bottoms. The only distinguishing characteristic between the Lamoure and Wabash soils in this county is the higher lime content of the Lamoure.

The following table gives the name and actual and relative extent of the several soils mapped in the county:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Carrington loam	168,448	48.6	O'Neill loam	1,600	0.4
Steep phase	9,216		Muck	1,216	0.3
Carrington silt loam	101,760	27.8	Lamoure silty clay loam	768	0.2
Webster silty clay loam	57,536	15.7	Peat	640	0.2
Wabash silt loam	11,328	3.1	O'Neill fine sandy loam	320	0.1
Webster silt loam	7,232	2.0	Clyde sand	64	0.1
Wabash silty clay loam	5,312	1.5	Total	365,440	.....

CARRINGTON LOAM.

The surface soil of the Carrington loam is a dark-brown to black, mellow, friable loam, 12 to 14 inches deep. Within the average farm its texture varies from a loam with so little sand as almost to constitute a silt loam to a loam so gritty as to approach a fine sandy loam. The subsoil to a depth of 36 inches is a heavy loam to light silty clay loam, yellowish brown in the upper part and becoming lighter with depth. It is in many places mottled with rusty brown and gray in the lower portions. The subsoil ranges from friable to semiplastic, the latter characteristic existing only in the heavier developments. Gravel occurs throughout the 3-foot section, generally to a greater extent in the subsoil than in the surface soil. It consists of quartz, sandstone, and granitic pebbles, and to a less extent of limestone. In many places large bowlders, mostly granite, occur on the surface. (See Pl. II, fig. 2.)

On the more gradual slopes the soil generally approaches a silt loam in texture, varying but slightly from the Carrington silt loam. On the east side of the Coon River, in the eastern parts of Lincoln and Grant and the western parts of Fairfield and Coon Townships, there are included several areas of fine sandy loam soil varying in size from a fraction of an acre to about 3 acres. In the southwest

corner of Lee Township and vicinity (just west of Rembrandt formation), the type is so closely associated with the Webster silty clay loam that it is unavoidable to include some areas of heavy loam, approaching a clay loam. In all parts of the county, especially in central Fairfield and Grant Townships, some of the boundaries drawn between the Carrington loam and Webster soils are more or less arbitrary.

The surface soil of the Carrington loam is fairly well supplied with organic matter. Neither surface soil nor subsoil is rich in lime, or gives any reaction with hydrochloric acid, except in numerous small areas where limestone fragments and lime-coated pebbles are generally found.

The Carrington loam occurs most extensively in the morainic region where it occupies all the naturally better drained areas. In addition it occurs in the region of erosional topography on one hill 2 miles south of Hanover Church and on the slopes intermediate between gentle and steep along the Little Sioux River and its tributaries, particularly Brooke Creek and the tributary just east of that stream. In the morainic region the type occupies gentle to almost steep slopes and swells, mounds, and kames. The surface drainage is good and the underdrainage is inclined to be rapid, but in most areas the soil is retentive of moisture, although in dry years a small part of its area, where the subsoil is particularly porous, is inclined to be droughty.

The Carrington loam is one of the three most important types in the county. Probably 85 to 90 per cent of it is in cultivation. The remainder is either occupied by farm buildings, windbreaks, and feed lots or temporary pasture, and could be cultivated or is so closely associated with other soil types needing artificial drainage that it is deemed best to keep it in pasture or meadow till the associated types are drained and ready for cultivation. Probably none of the type is forested naturally, except possibly a strip along the Little Sioux River and its tributaries.

Corn is the principal crop, rotated with oats and timothy and clover. Alfalfa is grown to a small extent. Hog raising, cattle feeding and raising, and dairying are carried on to an important extent. Corn yields 25 to 55 bushels per acre, with an average of 35 to 40 bushels; oats 30 to 50 bushels, timothy and clover 1 to $1\frac{1}{2}$ tons, and alfalfa, as a total of several cuttings, $2\frac{1}{2}$ to $3\frac{1}{2}$ tons.[1]

This soil is cultivated and handled under the methods prevailing throughout the county. Land to be planted in corn is fall plowed as far as possible. In preparing the land for oats, the cornstalks are cut with a disk harrow, and the seed sown broadcast, followed by

[1] Yields given in this report are based on statements of farmers, census statistics, and observations during the progress of the survey.

disking and harrowing. The only fertilizer used is barnyard manure, which is usually applied before plowing for corn.

This land sells at $140 to $250 an acre, depending on the improvements and nearness to towns.[1] Probably most of the farms are situated in part on other soils, especially in the morainic region, where they usually include some land of the Webster soils.

To improve the Carrington loam the land should be plowed to a depth of 6 or 7 inches. The greater part of the type is deficient in lime, and liming would be especially beneficial for the production of clover and alfalfa. This soil, like practically all the other types in the county, would be more productive if larger numbers of live stock were raised. The growing of an earlier maturing and slightly smaller variety of corn is desirable, as the large variety prevailingly grown at present requires a longer season than can be safely depended on.

Carrington loam, steep phase.—To a depth of 10 to 14 inches the Carrington loam, steep phase, is a dark-brown to black, friable loam. The subsoil consists of a yellowish-brown loam soon changing to a clay loam and becoming mottled with gray and rusty brown. It passes into a silty clay loam to silty clay at about 32 inches. There are numerous pebbles scattered throughout the 3-foot section, principally granite, quartzite, sandstone, and to a much lesser extent limestone. Granite and sandstone bowlders are frequently found on the surface. In some small areas particularly subject to erosion the surface soil is very thin and in some small patches has been entirely removed. No reaction was obtained with hydrochloric acid from samples of either the surface soil or subsoil, but there may be small areas which would show an alkaline reaction. It is probable, however, that any lime accumulation has been prevented by leaching.

This phase occurs on some of the upland slopes along the Little Sioux River and its tributaries and in one small isolated area along Boyer Creek. In almost all cases the slopes are too steep to cultivate, and may be termed sharply rolling to broken. (See Pl. III, fig.1.)

The run-off is everywhere ample, and in places there is severe erosion. The underdrainage in general is good, but some seepy spots exist, indicating that at these places there is an impervious layer close to the surface.

Probably less than 5 per cent of this soil is in cultivation. About half of it is forested, principally with bur oak, soft maple, elm, basswood, and red oak. On the steeper slopes bur oak predominates to the practical exclusion of the other varieties. Almost the only crop grown is corn. Most of the phase is used for pasture, for which it

[1] The selling price as stated for this and other soil types is taken from figures of actual sales, which in the case of types that do not occupy whole farms are considered in conjunction with observations in the field.

is well suited, as nearly all areas are traversed by spring-fed streams. (See Pl. III, fig. 2.)

There is probably no farm wholly on this phase, but it may be said to sell for $50 to $100 an acre.

In plowing this soil the contour lines should be followed as closely as practicable. Where the forested areas are used for pasture it is probable that the removal of a larger percentage of the trees would be profitable. Air drainage is better than in the case of any other soil in the county, and for this reason some form of orcharding might be profitably introduced. The difficulty of growing crops on account of the excessive slope may be overcome to a large extent by terracing, though in some parts of the type this would probably be impractical.

CARRINGTON SILT LOAM.

The surface soil of the Carrington silt loam is a dark-brown to black, friable silt loam extending to a depth of 12 to 16 inches, underlain by a yellowish-brown, friable silt loam which becomes lighter in color and generally slightly heavier with depth. The lower subsoil is in most places a silty clay loam, semiplastic in structure, but in some areas it is just as light textured and loose as the upper subsoil. Below 20 inches grayish mottlings generally occur. Over the greater part of the type neither surface soil nor subsoil reacts with hydrochloric acid, though the reverse is true in numerous small areas. Some gravel occurs in the 3-foot section, and some granite, sandstone, and limestone bowlders are found on the surface. Both the gravel and the bowlders are noticeably less abundant than in the case of the Carrington loam. The type is very uniform. A few gravel pockets occur, but these have no appreciable effect upon the soil.

The Carrington silt loam covers the greater part of the upland of the western part of the county and the gentler slopes near the Little Sioux Valley. In general it may be said to occupy the long, broad, gently sloping divides in the erosional region. The topography is undulating to gently rolling with no abrupt slopes. (See Pl. IV, fig. 1.) Both surface drainage and underdrainage are good, though the subsoil is sufficiently heavy to prevent droughtiness in periods of little or no precipitation.

This is one of the three most important types in the county. Probably 90 to 95 per cent of it is in cultivation, the remainder being occupied by farm buildings and feed lots, and to a lesser extent temporary pasture. The type is naturally a prairie soil, and at present the only timber consists of the artificially planted windbreaks about the farmstead, and rows of trees along farm lines. Corn, oats, timothy, and clover are the main crops. Potato growing, which has been specialized in to some extent around Alta, is largely developed on this type, although other soils of similar or lighter texture are

equally well adapted to the crop. The total acreage devoted to potato growing on this type is insignificant compared with that of the main crops.

Corn yields ordinarily 40 to 55 bushels per acre, oats 40 to 50 bushels, timothy and clover 1½ tons. As on other types, when clover predominates the yield is slightly greater, and when the timothy predominates, slightly less than the amount stated. Alfalfa yields 4 tons, in three cuttings. The Carrington silt loam is easily cultivated. It is of sufficiently light texture not to stick to cultural implements. It is handled under the agricultural methods prevailing throughout the county. The type can be improved by the same means as the Carrington loam.

This land sells for $175 to $300 an acre, depending on the improvements and the nearness to towns and shipping points.

WEBSTER SILT LOAM.

The surface soil of the Webster silt loam is a black, friable silt loam 12 to 14 inches deep. The subsoil is a black silty clay loam which gradually becomes heavier with depth and at 18 to 20 inches is a silty clay, mottled with gray and in some cases with yellowish and rusty brown. In some places small quantities of gravel occur on the surface and in the soil and subsoil. Snail shells are of frequent occurrence on the surface and in the surface soil, and lime concretions are quite common in the subsoil. The surface soil is everywhere well supplied with organic matter, and where the supply is most abundant the soil has a somewhat fluffy structure. Owing to the fact that the type is more or less intermediate between the Webster silty clay loam and Muck and is so closely associated with them, the boundary lines as drawn are in some cases arbitrary. The Webster silt loam includes some areas of Webster silty clay loam, Muck, and Carrington loam too small to be mapped separately.

The Webster silt loam occurs, with one or two exceptions, only within the region of morainic topography. It occurs in numerous more or less isolated level areas of irregular shape and varying size. Its greatest development is in the southern part of Lee Township, where in early times the larger prairie sloughs were most numerous. Before the installation of artificial drainage it is probable that water stood on the surface of the type for much of the year, but with an outlet provided for surface water and the installation of tile drains both surface and underdrainage are good. Practically all of the type has been artificially drained and the greater part is in cultivation. The uncultivated land is used for mowing land or pasture, awaiting in most cases the completion of artificial drainage systems. There has never been any forest on the type.

The common farm crops are grown, largely in connection with the Carrington or other soils. Owing to the abundance of organic matter, it is probable that corn is grown more extensively and for longer periods in succession than on most of the other soil types. Owing to the tendency of this and other low-lying types to be subjected to frost earlier in the fall than soils occupying higher and more sloping ground, corn is grown largely for silage and fodder purposes.

Corn ordinarily yields 25 to 50 bushels per acre, clover and timothy 1 to 2 tons, and oats 35 to 60 bushels. Early oats and short-strawed varieties yield best and are preferred, as the long-strawed varieties tend to lodge badly.

The selling price of land of this type ranges from $125 to $250 an acre, depending on the character of the adjoining land, the state of improvements, including drainage, and the nearness to towns and shipping points.

WEBSTER SILTY CLAY LOAM.

The surface soil of the Webster silty clay loam consists of a black silty clay loam extending to 12 or 14 inches. It is underlain by a dark-brown to black silty clay loam to silty clay, which becomes heavier and more plastic with depth. Below 18 to 20 inches the subsoil is mottled with gray, the mottling increasing with depth and generally displacing the dark brown at 26 to 30 inches. Yellowish-brown and rusty-brown mottlings frequently occur with the gray. Lime concretions are frequently found in the subsoil, and less frequently gravel and rock fragments of granite, quartz, sandstone, and limestone. Gravel and bowlders are occasionally found on the surface, but much less frequently than in the areas of Carrington loam. (See Pl. IV, fig. 2.) Generally the substratum and subsoil and frequently the surface soil are highly calcareous and react with hydrochloric acid.

In some small areas and near the margin of other areas in the morainic portion of the county and in most of the areas in the erosional part of the county the usual gray color seems displaced by a drab and the yellowish brown and rusty brown are lighter; below 24 inches the color is generally mottled yellowish brown and gray. Highly calcareous material is limited to the extreme lower subsoil or substratum.

Included with the Webster silty clay loam, particularly in the region of morainic topography, are numerous areas of Webster silt loam and Carrington loam too small to be mapped separately.

The Webster silty clay loam is distributed over practically all of the county. It occupies level to undulating, flat or depressed areas, formerly under water for a considerable part of the year, or areas of almost imperceptible slope, where the soil has developed under

poor drainage conditions. The drainage has been improved over the greater part of the type by open ditches and tile drains.

This is one of the most extensive and important soils in the county. Probably 75 per cent of it has been sufficiently reclaimed for profitable cultivation. It is naturally a prairie soil and supports practically no timber. That part of the type not in cultivation is largely in mowing land and pasture, only a very small part being used for buildings and feed lots.

Owing to its high content of organic matter, this soil is devoted to corn more constantly than most other types. Hay ranks next in importance, with oats third. Where the type is associated with a Carrington soil it is preferred for hay. The area devoted to oats is small. The short-strawed, early oat gives best results. On farms where this soil predominates the agriculture depends on the state of drainage. Where good drainage has been established, grain farming largely predominates; otherwise the land is used for live-stock farming, being kept in pasture and hay crops. The live-stock farming is most frequently cattle raising and feeding, with hog raising as a side line. Hogs can be very economically produced by allowing them to follow the cattle.

Ordinary yields on the Webster silty clay loam are: Corn 30 to 50 bushels, hay 1¼ to 2 tons, and oats 20 to 40 bushels per acre.

Owing to its heavy nature it is difficult to get soil of this type to scour from cultural implements if at all wet. If it is plowed when too wet it is apt to clod. The type is occasionally given an application of barnyard manure, though the Carrington soils are generally given preference in manuring on account of the higher organic content of the Webster soils.

Land of the Webster silty clay loam sells at $125 to $250 per acre.

The use of barnyard manure on this type has a beneficial effect in tending to lighten the surface soil. Another factor tending to produce the same result is fall plowing, which through subjecting the soil to freezing and thawing tends to pulverize and aerate it.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of the Webster silty clay loam:

Mechanical analyses of Webster silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
331817, 331819.....	Soil.....	0.1	0.9	1.2	8.9	12.1	53.4	23.7
331818, 331820.....	Subsoil.....	.1	.8	.6	4.1	10.3	59.0	25.3

CLYDE SAND.

Three small areas in the vicinity of Storm Lake are mapped as Clyde sand. The largest lies on the west side of the lake, separating the lake proper from the marsh to the west; the second largest occurs between the lake proper and a smaller marsh just west of the Casino; the smallest consists of an island about 10 rods off-shore just southwest of the city of Storm Lake. The two larger areas occupy peninsulas. The total area occupied by the type is 25 to 30 acres.

The surface soil is a brown, medium sand, mixed with some gravel, extending to a depth of 14 inches. It is tinged with gray when dry. The surface soil grades into a slightly lighter colored subsoil of the same texture.

The Clyde sand appears to have been deposited by the wave action of the lake waters. It lies 2 to 6 feet above the normal level of the lake. None of the land is in cultivation.

O'NEILL FINE SANDY LOAM.

The surface soil of the O'Neill fine sandy loam consists of 9 inches of brown fine sandy loam, grading into a yellowish-brown fine sandy loam closely approximating a sandy loam in texture. Below 16 inches the subsoil becomes more sandy and the color lighter with depth. Both surface soil and subsoil have a loose, porous structure. Neither is calcareous. The surface soil approaches a fine sand in texture in some places and a loam in others. The areas nearest the first bottom are usually the lightest in texture and those farthest removed the heaviest.

Only five areas of this type are mapped. They occupy part of the lower terrace between Sioux Rapids and the point where the Little Sioux River leaves the county. The type has a level to gently sloping surface, traversed in many places by draws. Both the surface drainage and underdrainage are thorough, and in dry periods crops may be injured, as the power of this soil to retain moisture is lower than that of the other two terrace types.

The total area of this soil is only about 200 acres. All of it is in cultivation. The common crops are grown. Corn yields ordinarily 25 to 40 bushels per acre, oats 20 to 30 bushels, and timothy and clover 1 to 1½ tons. The type is handled in practically the same way as the Carrington loam. Being looser and coarser, it can be handled under a wider range of moisture conditions.

The O'Neill fine sandy loam does not constitute all of any farm. It probably has a somewhat lower selling value than the O'Neill loam.

To improve this type contour plowing should be practiced on the slopes. Manuring will increase its power to retain moisture. The

application of lime, while likely of only temporary benefit, would probably give good results in the growing of clover and alfalfa.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the O'Neill fine sandy loam:

Mechanical analyses of O'Neill fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
331821	Soil	3.1	14.6	10.5	36.9	9.0	17.0	8.8
331822	Subsoil	3.3	14.3	11.9	46.8	9.4	7.9	6.3

O'NEILL LOAM.

The O'Neill loam is a dark-brown, moderately loose, friable loam extending to 12 or 14 inches, underlain by a brown loam which at about 18 inches gives way to a yellowish-brown fine sandy loam. At 28 to 30 inches the texture becomes a sandy loam. Gravel is scattered on the surface and throughout the 3-foot section. Neither surface soil nor subsoil is calcareous.

The O'Neill loam occurs on the terraces in the Little Sioux Valley, at all three of the different elevations at which they occur. It lies both on the level terraces and on the slopes between the terraces or between the first bottom and the terraces. A few streams and draws cross the type. The run-off is ample, and the underdrainage, owing to the porosity of the subsoil and substratum, causes the type to be somewhat droughty in periods of little rainfall.

Practically all of the O'Neill loam is in cultivation. It is devoted almost exclusively to corn, but some oats and hay are grown. Corn yields ordinarily 25 to 45 bushels per acre, but in some seasons parts of the type may give higher yields.

This land sells for $125 to $200 an acre, depending on the improvements and the nearness to towns.

Barnyard manure should be applied on this soil, to increase its power to hold moisture. Liming would be beneficial where it is desired to grow clover or alfalfa.

A small area of O'Neill silt loam has been included with the O'Neill loam on the map. The surface soil is a dark-brown (almost black when wet), friable silt loam, extending to 16 inches. The subsoil is a brown heavy silt loam to silty clay loam. The color becomes lighter with depth, and the lower part of the subsoil is yellowish-brown. Some gravel may occur in the lower part of the 3-foot section, but there is no gravel on the surface or in the surface soil. It is probable that this soil, like the other O'Neill types, is underlain by a stratum consisting principally of sand and gravel, but this lies

farther below the surface, and the type is consequently more drought resistant than either of the other O'Neill types. Both surface soil and subsoil are noncalcareous. The O'Neill silt loam occurs in two areas with a combined area of 70 acres. It occupies the level higher terrace adjoining the upland slopes. Both surface drainage and underdrainage are sufficient. Yields are slightly higher than on the other O'Neill soils and the land valuation is slightly greater.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the O'Neill loam:

Mechanical analyses of O'Neill loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
331823	Soil	2.8	18.2	9.4	19.3	7.0	29.4	14.0
331824	Subsoil	2.6	20.8	13.3	34.0	6.8	12.4	10.4

WABASH SILT LOAM.

To a depth of 14 inches the Wabash silt loam is a black, friable silt loam, with a grayish tinge when dry. The subsoil is a black, heavy silt loam which at about 28 inches becomes a silty clay loam. Both surface soil and subsoil are noncalcareous. In some places the surface soil is heavier than typical, approximating a silty clay loam.

The Wabash silt loam occurs in all parts of the county where streams have developed first bottoms, and is the most important first-bottom type. Although of level topography it has good surface and underdrainage.

Most of the type in the Little Sioux Valley is in cultivation, while elsewhere it is practically all used for pasture. None of the type is forested except some of the uncultivated areas along the Little Sioux River. Here the timber is largely red oak, soft maple, and elm. Nearly all of the type is overflowed in rainy periods, but even in the Little Sioux Valley there is sufficient time after the subsidence of the spring floods to mature crops.

Corn is the principal crop. Some hay and small grain are grown, the latter as a nurse crop for grasses. Corn ordinarily yields 35 to 55 bushels per acre, and hay 1 to 2 tons. The type in most cases forms only a small part of any one farm, and agricultural methods vary with the predominating soil. Little manuring is done on this type.

Land of the Wabash silt loam sells at $75 to $125 an acre, depending on the improvements and the location.

The Wabash silt loam as mapped includes two areas of another Wabash soil whose texture varies within short distances but averages a loam. Both areas occur adjoining the Little Sioux River, one at

the edge of Linn Grove and the other where the river leaves the county. Their total extent is probably less than 75 acres. Owing to numerous stream channels, practically none of this land is in cultivation. It is used for pasture.

WABASH SILTY CLAY LOAM.

The surface soil of the Wabash silty clay loam is a black, semiplastic silty clay loam extending to a depth of 11 inches. The subsoil is a black silty clay loam to silty clay which becomes increasingly heavy and plastic with depth. There is no abrupt change between soil and subsoil. Neither is sufficiently high in lime to give a reaction with hydrochloric acid. Areas of Wabash silt loam and Lamoure silt loam and silty clay loam too small to be mapped separately are included with this type.

The Wabash silty clay loam occurs in the first bottoms of many of the smaller streams. Only one area, comparatively small, is mapped in the Little Sioux bottoms. The greatest development of the type is in northwestern Nokomis and Elk Townships and close to Storm Lake. It is of small extent in the region of morainic topography, most of the bottom land along the few streams that exist here being occupied by the Wabash silt loam. Both surface drainage and underdrainage are sufficient, although the latter is not as thorough as on the silt loam of this series.

The Wabash silty clay loam is comparatively inextensive and unimportant. Practically all of it is used for pasture or as hay land. Where it is used for hay the native grasses or timothy are grown. Yields of hay average 1 to 1½ tons per acre.

Land of this type makes up only a small percentage of any one farm and is therefore sold only with other land. Its value in such sales is estimated to be $65 to $125 an acre.

LAMOURE SILTY CLAY LOAM.

The surface soil of the Lamoure silty clay loam is a black, semiplastic silty clay loam. The subsoil is a black silty clay loam changing at about 16 inches to a silty clay and becoming increasingly heavier and more plastic with depth. Both surface soil and subsoil are calcareous, giving a reaction with hydrochloric acid. A few areas of Lamoure silt loam and Wabash silt loam and silty clay loam, too small to be mapped separately, are included with this type. In the Coon River bottoms the subsoil shows some gray mottling and the soil resembles the Webster silty clay loam.

The Lamoure silty clay loam occupies part of the level first bottom of a few of the smaller streams. One area of 100 acres or more is mapped in the Coon River bottoms just above the south county

line. This area is devoted to corn, which gives about the same yield as on the Webster silty clay loam. The remainder of the type is used as hay and pasture land, and has about the same value as the Wabash silty clay loam.

One area of Lamoure silt loam is included with this type, south of Storm Lake. The surface soil is a friable, black silt loam, 12 to 14 inches deep, with a subsoil of black silty clay loam which becomes heavier and more plastic with depth, passing into a silty clay at about 32 inches. Both surface and subsoil are calcareous. This soil is used only for pasture and hay production. It has the same selling value as the Wabash silt loam.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Lamoure silty clay loam:

Mechanical analyses of Lamoure silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
331833	Soil	0.1	1.0	1.4	10.2	12.5	51.9	23.1
331834	Subsoil	.4	.9	.9	4.4	8.2	57.5	27.7

MUCK.

The surface soil of Muck is a black, light, fluffy soil extending to a depth of about 12 inches. It is composed of 15 to 35 per cent of well-decomposed organic matter, a very small percentage of very fine sand, and the remainder of silt and clay, the former predominating. At a depth of about 12 inches the soil gradually changes to a dark-brown to black silty clay loam which grades heavier with depth and becomes a silty clay at about 30 inches. At 30 to 32 inches yellowish-brown and gray mottling becomes very prominent. Snail shells and some mussel shells occur on the surface in many places. Lime concretions are generally found in the subsoil. Both surface and subsoil are sufficiently calcareous to react with hydrochloric acid.

Owing to close association of the Webster and Peat soils, the boundary lines between them are frequently arbitrary. A few areas of Webster silt loam and silty clay loam too small to be mapped separately are included with this type.

The mineral matter of Muck is derived from glacial drift worked in from the higher land and weathered under poor drainage conditions.

Muck, with the exception of three small areas in the northwestern corner of the county, occurs entirely within the region of morainic topography, and, with the exception of one small area about 5 miles

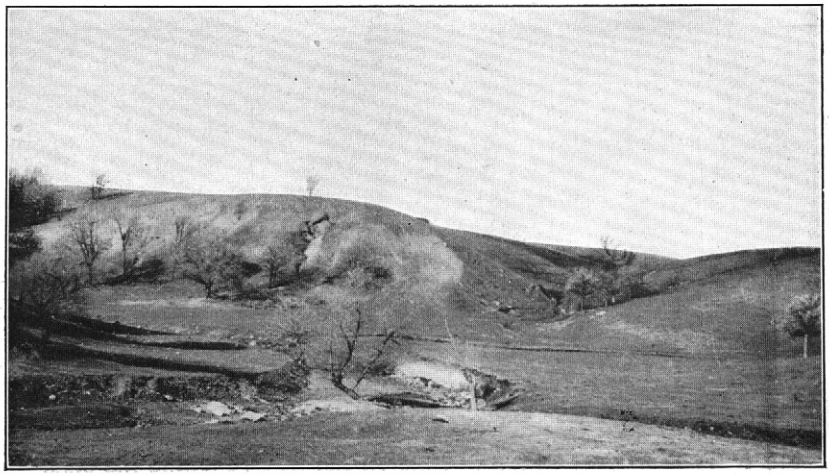


FIG. 1.—CHARACTERISTIC BROKEN TOPOGRAPHY OF THE CARRINGTON LOAM, STEEP PHASE.

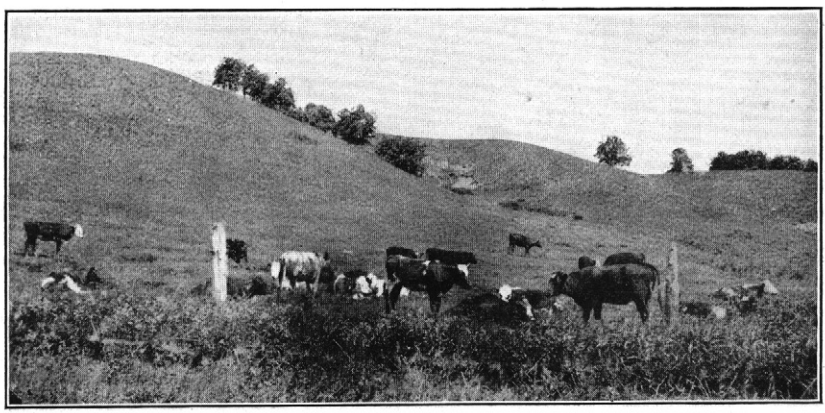


FIG. 2.—CARRINGTON LOAM, STEEP PHASE, IN PASTURE.

This soil is generally well suited to use as pasture, as springs are abundant along the slopes.

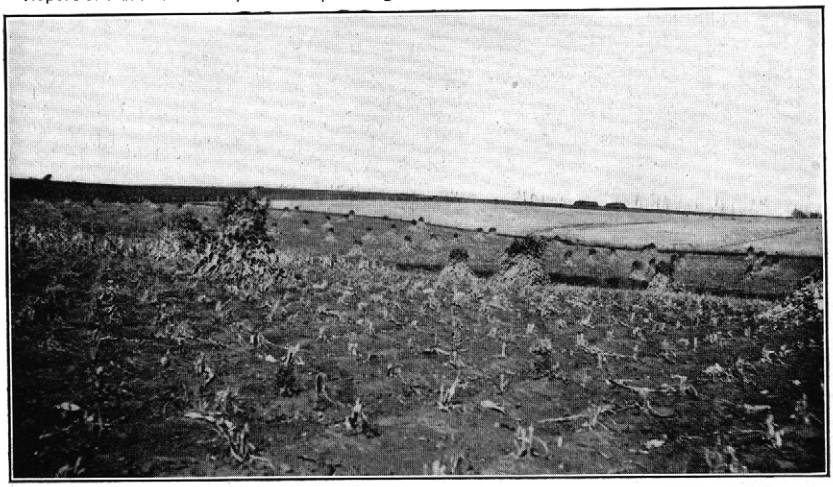


FIG. 1.—TYPICAL SCENE ON THE CARRINGTON SILT LOAM, SHOWING THE CHARACTERISTIC BROAD, GENTLE SLOPES.

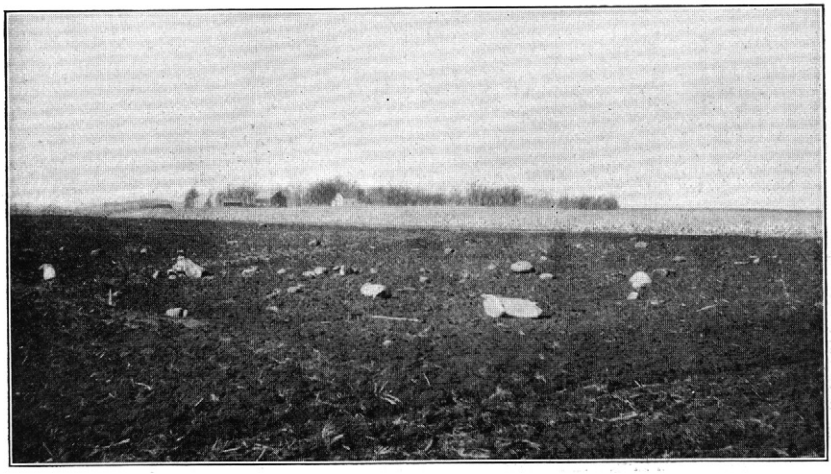


FIG. 2.—FIELD ON THE WEBSTER SILTY CLAY LOAM.

Note the bowlder-strewn surface. This condition is not typical, as most fields have been cleared of bowlders.

southwest of Rembrandt, is confined to the eastern half of the county. Several areas occur in the vicinity of Newell and near the northeast corner of Grant Township. The largest continuous area is in what was formerly known as Grassy Lake, about 5 miles southeast of Sioux Rapids. In some places the type forms a narrow margin about areas of Peat.

Muck has a level surface and occupies slightly depressed areas. Before the construction of artificial drainage systems these areas were inundated the greater part, if not all, of the year. Owing to its light, loose nature, the surface soil readily drains off when an outlet is provided, and good underdrainage can be effected by properly laid tile drains.

The total area of this type is relatively small, but practically all of it has been adequately drained and is in cultivation. This land has never been forested. Corn is apparently the only crop grown. It yields 25 to 50 bushels per acre. The undrained land is covered with rushes, sedges, and flags, and can only be used for the little grazing these afford. The soil is handled in the same manner as the Webster silt loam. As it occupies topographic positions even more subject to frost than the areas of Webster soil, it is especially advisable to grow early maturing varieties of crops.

The land classified as Muck sells at $160 to $200 an acre, depending on the improvements and nearness to towns.

PEAT.

Peat has been derived from the same material, and in practically the same manner, as Muck. It is probable, judging from its situation, that in its earlier development Peat was covered by water more continuously than Muck. The distinction between the two types is the greater proportion of organic matter in Peat and its slightly less advanced stage of decomposition.

The surface soil of Peat, extending to a depth of 10 to 14 inches, is composed of over 35 per cent of black organic matter, much of which is undecomposed so that the original plants may be distinguished, and the remainder of a mixture of very fine sand, silt, and clay. Of the three last named, silt predominates, and the amount of very fine sand present is very small. The surface soil merges into a silty clay, which becomes heavier and more plastic with depth through the 3-foot section. Below 24 inches yellowish-brown and gray mottlings occur and below 30 inches gray predominates, with only slight yellowish brown mottling. Snail shells and some mussel shells are found on the surface and lime concretions generally occur in the subsoil. Both surface soil and subsoil are calcareous, giving a strong reaction with hydrochloric acid.

Much of the type is surrounded by a narrow margin of Muck. The two types are so clearly associated that boundaries are in some cases arbitrarily drawn, and some areas of Muck too small to be mapped separately are included with the Peat. Several small spots where the organic soil has been burned occur within the areas of this type. In these places the surface is quite perceptibly sunken and the top soil has a reddish-brown color and an ashy consistency. In other small spots alkali salts have formed on the surface. These have an injurious effect on crops when first put in cultivation, but the effect lasts for only three or four years. Neither the burned areas nor the alkali spots are of sufficient extent to be shown on a map of the scale used in this survey.

Peat occurs only in three areas within the region of morainic topography. The largest, covering 350 to 400 acres, occurs in Grassy Lake; the second largest, containing about 80 acres, lies just east of the Chicago, Milwaukee & St. Paul Railroad, about 2 miles southeast of Juniata; and the smallest, comprising approximately 10 acres, is located about 5 miles southwest of Rembrandt.

The areas occupied by this type were formerly sloughs, and drainage is wholly dependent on systems of tile drains eventually having an outlet in open ditches. Where properly installed these systems take care of both surface drainage and underdrainage.

Practically all the areas mapped as typical Peat are in cultivation. Corn is almost the only crop grown. A very small area is devoted to oats. The average yield of corn when allowed to mature is 25 to 50 bushels per acre. As this type is probably more susceptible to frost than any other soil in the county, much of the corn is cut early for fodder or silage. The soil is handled in the same manner as the Webster silt loam and Muck. The selling price of the land ranges from $150 to $200 an acre.

Means suggested for the improvement of the Webster silt loam and Muck are equally applicable to Peat. In addition, manure should be applied to burned-out spots to replenish the lost organic matter, and where alkali spots are troublesome the soil should be cultivated as frequently as possible to promote leaching by rains.

The small areas mapped as Peat, but distinguished with swamp symbols, comprise undrained basins or sloughs which are covered with water the greater part of the time. These areas were inundated at the time of the present survey, and in most parts inaccessible. Where they could be examined the surface soil beneath the water was a spongy Muck or Peat extending to a depth of 10 to 12 inches, underlain by the subsoil characteristic of Muck and Peat. Probably all of this land will be reached by artificial drainage systems in the near

future and put in cultivation. Many of the small areas doubtless have been drained and put in cultivation since the time of the survey. It is possible that they may prove to include areas of Webster silt loam and to a lesser extent Webster silty clay loam. So far as known all the areas can eventually be drained.

DRAINAGE.

While the knolls and swells in the morainic area are naturally well drained, the intermediate land, which consists of the Webster soils or Muck or Peat, has inadequate natural drainage. In addition, there are a few poorly drained areas in the region of erosional topography. Other parts of the county where drainage is not sufficient for best results include the natural drainage ways which have been choked with glacial deposits.

In the early days of the county only a small part of most farms could be cultivated on account of the numerous sloughs or marshes, either permanent or intermittent. From an early date the farmers tried to remedy this condition. Open ditches gave relief for a few seasons, but in unusually dry years grass and weeds would become firmly established in the ditches, soon resulting in their obstruction and rendering them useless. Much land which had been put in cultivation was allowed to return to its natural condition, in which it was still of some value for the wild hay and pasturage it produced. Within recent years the enactment of drainage laws has made it possible to eliminate poor drainage as a critical factor in the development of farm land. The laws provide for interfarm drainage to be carried on by organized drainage districts. At present there are 119 drainage districts in Buena Vista County, and the total cost of projects completed or under construction is estimated to be over $1,000,000. In some of the districts only tile drains have been necessary, in others tile drains and some open ditches, and in a few, where the volume of water to be carried was so great as to make the cost of sufficiently large tile prohibitive, open ditches only.

The ordinary per acre cost for tile-drain systems is from $8 to $15, and in open-ditch systems somewhat less. The cost for both systems has ranged from $1 an acre for some high land to as much as $50 for some very low lying land.

The average fall possible for open ditches for the whole county is about 4 feet per mile. The ditch east of Brooke Creek has been held to a grade of 2 feet per mile, the additional fall being taken up in vertical drops. The Coon River ditch has probably the least fall in the county. The main ditch of the river, which begins north of Marathon, has for 18 miles a fall of only 1½ feet per mile.

SUMMARY.

Buena Vista County is situated in the northwestern part of Iowa, two counties separating it from the State of South Dakota and two from the State of Minnesota. It is 24 miles square and contains 571 square miles, or 365,440 acres.

The county includes two main topographic divisions, morainic and erosional. The morainic area, which is the more extensive, consists for the most part of an orderless succession of mounds, swells, kames, potholes, and flats, with almost no natural drainage. The erosional area varies from level to strongly rolling and broken, and is throughout practically its entire extent well supplied with natural drainage ways.

The Mississippi-Missouri divide winds through the county in a general north and south direction. The elevation of the county above sea level ranges from 1,250 to 1,525 feet, the highest point being in the vicinity of Alta. The county is drained mainly by Maple Creek, Little Sioux, Boyer, and Coon Rivers.

The total population in 1910 was 15,981, of which all but 2,428, the population of Storm Lake, is classed as rural. The principal towns are Alta, Sioux Rapids, Newell, Marathon, Linn Grove, and Albert City. The percentage of foreign born at the present time is 17.3.

The county is well supplied with transportation facilities. The public roads are well constructed and well kept. All parts of the county are supplied with telephone lines. The educational facilities are modern, 11 consolidated schools being located within the county.

The mean annual precipitation is 29.8 inches, and this is distributed favorably for crops. The mean annual temperature is 46.3° F. There is an average growing season of 151 days.

The agriculture of Buena Vista County consists of grain production and live-stock farming. Hog raising, cattle feeding and raising, and to a limited extent dairying are the leading animal industries. The principal crops are corn, oats, timothy, clover, and alfalfa. A definite rotation is followed by most farmers. Practically no fertilizer other than barnyard manure is used. Labor is scarce.

The average size of farms is approximately 160 acres. About half of the farms are operated by owners and half by tenants. Farm land rents for $6 to $12 an acre, or for one-third to four-fifths of the crop, depending on the owner's contribution. Farm land ranges in value from $50 to $300 an acre.

Buena Vista County lies just within the glacial portion of the Glacial and Loessial Province. The upland soils have been derived from the Wisconsin and Kansan drifts or from a layer of silty material capping the latter. They are classed in the Carrington, Webster, and Clyde series, in addition to Muck, and Peat. The Carrington soils

occupy naturally well drained areas. The Webster soils and Muck and Peat have developed under poor drainage conditions. The alluvial soils include the O'Neill series on the terraces along the Little Sioux River, and the Wabash and Lamoure soils which occupy the first bottoms along the natural drainage ways of sufficient size to have developed flood plains.

Twelve soil types and one phase are mapped in Buena Vista County. The Carrington loam, Carrington silt loam, and Webster silt loam occupy by far the greater part of the county. All the soils are predominantly dark colored, and well supplied with organic matter. They are well suited to the production of the common farm crops of corn, oats, and hay, particularly corn.

The natural drainage, originally poor over the greater part of the county, has been improved by the construction of artificial systems of open ditches and tile drains. The cost of drainage work completed or now under construction is estimated to be over $1,000,000.

○

[PUBLIC RESOLUTION—No. 9.]

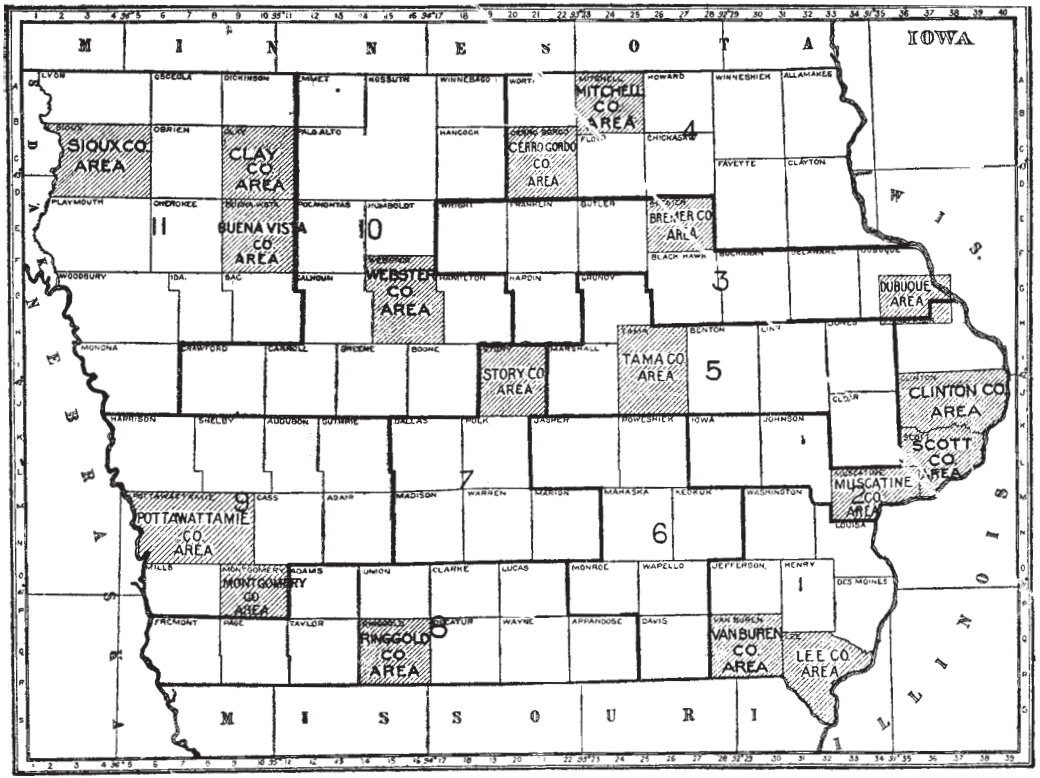
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]



Areas surveyed in Iowa.

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