U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS.
IN COOPERATION WITH THE IOWA AGRICULTURAL EXPERIMENT STATION.

SOIL SURVEY OF BOONE COUNTY, IOWA.

BY

A. M. O'NEAL, JR., OF THE U. S. DEPARTMENT OF AGRICULTURE, IN CHARGE, AND A. M. DEYOE, OF THE IOWA AGRICULTURAL EXPERIMENT STATION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1920.]

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1923.

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[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.]

CONTENTS.

	Page.
SOIL SURVEY OF BOONE COUNTY, IOWA. By A. M. O'NEAL, JR., OF THE U. S. DEPARTMENT OF AGRICULTURE, IN CHARGE, and A. M. DEYOE, OF THE IOWA AGRICULTURAL EXPERIMENT STATION	135
Description of the area	135
Climate	137
Agriculture	138
Soils	144
Carrington loam	148
Clarion fine sandy loam	150
Clarion loam	151
Webster loam	154
Webster silty clay loam	155
Conover silt loam	157
Waukesha loam	158
O'Neill fine sandy loam	159
O'Neill loam	159
Buckner loamy fine sand	160
Buckner loam	161
Buckner silt loam	161
Wabash loam	162
Wabash silty clay loam	163
Sarpy silt loam	163
Peat and muck	164
Alkali	165
Summary	165

ILLUSTRATIONS.

FIGURE.

	Page.
FIG. 5. Sketch map showing location of the Boone County area, Iowa	135

MAP.

Soil map, Boone County sheet, Iowa.

SOIL SURVEY OF BOONE COUNTY, IOWA.

By A. M. O'NEAL, Jr., of the U. S. Department of Agriculture, In Charge, and A. M. DEYOE, of the Iowa Agricultural Experiment Station.[1]

DESCRIPTION OF THE AREA.

Boone County is situated just west of the geographic center of the State of Iowa. Boone, the county seat, is 340 miles from Chicago and 148 miles from Omaha, Nebr. The county is 24 miles square and contains 16 full townships. It has an area of 569 square miles or 364,160 acres.

Boone County is located within the boundaries of the Great Plains region of the United States and within the limit of the Wisconsin drift sheet of Pleistocene age. Since the retreat of the ice the surface has been only slightly modified, and the greater part has a level to gently rolling topography. Flat, poorly drained areas, with small, low knolls rising here and there, are common, especially throughout the greater part of Grant, Des Moines, Jackson, and Garden Townships. Along the Hamilton-Boone County line, in the northern part of Dodge and Harrison Townships, a moraine gives rise to a more pronounced relief.

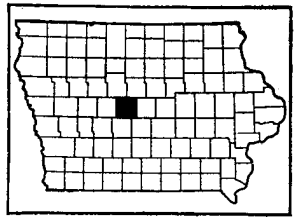

FIG. 5.—Sketch map showing location of the Boone County area, Iowa.

The present drainage system has had little effect upon the original surface, except for narrow strips along the larger streams, where the topography varies from gently rolling to rough and broken. The Des Moines River has cut a deep, narrow gorge through the county, and the slopes along this stream are heavily eroded and intricately carved. These steeper slopes in places extend back into the uplands from 1 to 3 miles, following the channels of the creeks and drainage ways. Narrow discontinuous terraces have been developed along the Des Moines River and some of the larger creeks, and strips of first bottom are found along nearly all the streams.

The elevation of the greater part of Boone County above sea level varies from 1,000 feet to 1,180 feet. The prairie is rather uniform in elevation, and in many places the difference is so slight that

[1] Area inspected by Thomas D. Rice, of the Bureau of Soils, and P. E. Brown, of the Iowa Agricultural Experiment Station.

natural drainage is poor. Along the Des Moines River the relief is more pronounced, and in places the valley floor is from 130 to 250 feet below the adjoining prairie. The maximum elevation, 1,200 feet, is reached one-half mile north of Mineral Ridge, and the minimum, 850 feet, where the Des Moines River leaves the county. The prevailing slope is toward the south.

The drainage of the county is carried entirely by the Des Moines River, which flows in a southerly direction and divides the county into two nearly equal parts. The tributary streams have a sluggish flow. Near their sources they occupy broad, shallow areas and have poorly defined channels. Here natural drainage is poor and tiling is necessary for best results. Along their lower reaches erosion has been more active, the uplands have a rolling to gently rolling topography, and the drainage is sufficient for all needs. All the first bottoms are subject to overflow, and crop yields on bottom land are uncertain.

Water for domestic use is obtained from wells, most of which are drilled and from 50 to 200 feet deep. A few flowing wells are found along Beaver Creek. The water everywhere is hard, but of excellent quality.

Boone County was established in February, 1847, by an act of the legislature, two months after the State was admitted to the Union. Settlements had been made along the Des Moines River some time prior to this date by immigrants moving in from States farther east and south. A considerable proportion of the present population is of foreign birth or foreign descent, with Swedes, Germans, Norwegians, and Irish predominating. The agricultural population is quite uniformly distributed over the county. The total population, as reported in the 1920 census, is 29,892.

Boone, with a population of 12,451, is the county seat and principal town. Ogden, with a population of 1,451, Madrid with 1,783, Pilot Mound with 311, Fraser with 391, Boxholm with 296, and Luther with 145, are towns of importance. Jordan, Beaver, Berkley, Angus, Ericson, and Napier are smaller towns with railroad and trolley facilities. There are several other small villages in the county.

The transportation facilities of the county are good. The main line of the Chicago & North Western Railway traverses approximately the center of the county from east to west, while the main line of the Chicago, Milwaukee & St. Paul Railway crosses the southeastern corner. The county is also traversed by branches of the Minneapolis & St. Louis Railroad and the Chicago, Milwaukee & St. Paul Railway. The Fort Dodge, Des Moines & Southern interurban line, connecting Des Moines and Fort Dodge, crosses the county diagonally from northwest to southeast.

The public roads follow section lines, except in the rougher sections along the river, where they wind around hills, and the system is quite complete. The Lincoln Highway, which crosses the county from east to west along the line of the Chicago & North Western Railway, is graveled. A number of other main highways are being graded and graveled. A considerable mileage was completed this year (1920). The roads are kept in fair shape by the use of drags after rains.

Rural mail routes serve all parts of the county. Telephones are in general use. Power lines serve a large part of the area, furnishing current for use on the farms. A considerable number of rural schools have been consolidated and handsome brick school buildings erected in various towns, the pupils being carried back and forth in school wagons. Churches are located at convenient places throughout the county.

Although agriculture is the leading industry in Boone County, the mining of coal is an industry of some importance. During the year 1920 mines were in operation in the vicinity of Boone, Ogden, and Madrid, furnishing employment for a large number of men. Two tile factories are in operation at Boone and manufacture an excellent grade of tile.

CLIMATE.

The climate of Boone County is marked by a wide range in temperature during the year, with a mean annual temperature of 46.7° F. The summers, as a rule, are short and pleasant, with a mean temperature of 71.7° F. Occasional hot spells are experienced, accompanied by hot winds from the southwest. During these spells the temperature may range above 100° F., and a maximum of 108° F. has been recorded. The winters are cold and often severe, with a recorded mean of 19.6° F. and an absolute minimum of −35° F. The winds from the northwest are very cold, and stock must be protected by shelters. The country homes are nearly all protected on the north and west by windbreaks of trees. The ground freezes to a considerable depth, especially when left uncovered, and winter wheat is seldom a profitable crop, except along the river, where the wooded areas give more protection.

The average date of the last killing frost in the spring is May 1 and that of the first in the fall is October 8, which gives an average growing season of 161 days. The latest recorded killing frost in the spring occurred on May 20 and the earliest in the fall on September 22. Early killing frosts in the fall once in a great while prevent the maturing of the corn crop. In such cases the crop is either used for ensilage or else fed to stock on the farms as quickly as possible.

The mean precipitation for the year is 32.11 inches. The greater part takes place during the spring and summer months, the least in the winter, and then generally in the form of snow. Late spring rains often interfere with planting, but the weather in the fall is generally favorable for harvesting.

Heavy rain and wind storms often occur during the growing season, and hailstorms are not unknown, but the damage from these storms is generally slight and local in extent. Droughts are rare and need not be feared if the land is properly prepared.

The following table, compiled from records of the United States Weather Bureau station at Boone, gives the normal monthly, seasonal, and annual temperature and precipitation for Boone County:

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

[Elevation, 1,134 feet.]

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1910).	Total amount for the wettest year (1900).
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*
December	23.1	60	−21	0.97	0.21	0.16
January	16.8	58	−35	.79	1.79	.31
February	19.0	58	−25	.90	.39	1.09
Winter	19.6	60	−35	2.66	2.39	1.56
March	32.4	85	−4	1.53	.32	2.09
April	47.9	93	17	2.76	.84	3.49
May	59.7	94	25	5.12	1.82	4.82
Spring	46.7	94	−4	9.41	2.98	10.40
June	69.0	99	38	4.68	3.21	6.30
July	74.3	108	45	3.94	1.86	8.03
August	71.8	107	35	3.78	2.97	8.34
Summer	71.7	108	35	12.40	8.04	22.67
September	62.5	96	28	3.56	4.95	6.86
October	50.6	90	19	2.71	.88	3.17
November	34.6	77	0	1.37	.38	.66
Fall	49.2	96	0	7.64	6.21	10.69
Year	46.7	108	−35	32.11	19.62	45.32

AGRICULTURE.

Originally a large part of Boone County was wet and poorly drained, and only the better drained sections were settled at first. The early settlers located in the wooded areas along the Des Moines

River, where the forest furnished fuel and afforded protection from the severe storms in winter. Game was plentiful, and hunting and trapping constituted an important occupation. Agriculture was restricted to a few small fields in which grain was grown to help supply the home demand. Corn, wheat, and oats were the principal crops. A few head of cattle were kept on nearly every farm, as the prairie afforded excellent natural pasturage. The increase in population and in the number of farms was gradual up to the early fifties. After the building of railroads, giving improved marketing facilities, the growth was much more rapid, and agriculture received a marked stimulus. Later, with the increased demand for agricultural land and its consequent increase in value, a complete system of drainage was worked out, with the result that at present there are very few poorly drained areas left in the county.

The following table, showing the acreage and production of the leading crops, as reported by the last five censuses, indicates the general advance of crop production in this area:

Acreage and production of leading crops.

Crop.	1879	1889	1899	1909	1919
Corn:					
Acres	94,109	104,106	117,303	108,059	119,181
Bushels	3,916,693	4,815,379	4,714,840	3,740,355	5,367,297
Oats:					
Acres	16,884	46,411	60,150	59,429	77,358
Bushels	604,235	2,192,635	2,466,030	1,685,382	3,057,165
Wheat:					
Acres	18,055	1,014	9,403	1,832	6,430
Bushels	182,580	13,995	162,600	26,935	102,244
Barley:					
Acres	1,203	131	882	1,136	668
Bushels	22,031	4,280	22,450	18,078	19,747
Hay:					
Acres	34,591	51,901	46,069	46,731	24,637
Tons	51,889	65,761	57,139	64,041	33,912

At the present time the agriculture of the county consists of the growing of grain and hay and the raising and feeding of cattle and hogs. Corn, oats, and timothy and clover are the principal crops. Wheat, barley, rye, buckwheat, sweet corn, and all kinds of garden truck are grown to some extent.

Corn is the principal crop and occupies the largest acreage. According to the census of 1920, 119,181 acres were devoted to corn for grain in 1919, producing 5,367,297 bushels, or 45 bushels per acre. The greater part of the crop, probably 75 to 85 per cent, is used on the farms for feeding work stock and dairy cows, and for fat-

tening beef cattle and hogs; the remainder is sold and shipped out of the county. The number of silos is increasing and each year a larger acreage of corn is cut for silage. In addition a considerable acreage is cut for forage. Only dent corn is grown, the yellow varieties predominating, but a few farmers prefer the white. Strains of Reid Yellow Dent which mature early are most popular, while the varieties of white corn most favored are Boone County White, Silvermine, and Silver King.

Oats were grown on 77,358 acres in 1919 and produced 30.5 bushels per acre, or a total of 3,057,165 bushels. The crop ranks second to corn. It occupies an important place in the general rotation, as it fits in well with the growing of corn, because the harvest time comes early and the land can be plowed before the husking season starts. Practically all the crop is fed on the farm to the work stock, dairy cattle, beef cattle, and hogs. The part that is sold is hauled to the local elevators at threshing time and shipped out of the county. The varieties best suited to the soils of this section are the Iowar, Iowa 105, and Iowa 103.

Timothy and clover rank third in importance. They are nearly always grown together and seeded with oats as a nurse crop. After the second year the clover nearly all dies out and the timothy is left the third year for hay. Red clover can be grown profitably anywhere in the county. Clover is sometimes grown alone and harvested for seed. The hay is all fed on the farm, and the supply is not equal to the demand. While liming is beneficial it is not absolutely necessary.

The growing of wheat is not as important as formerly. The acreage, which has fluctuated widely in the last 40 years, has shown a general decline and in 1919 was only one-third that in 1879. The best results are obtained along the river, where the fields are protected. At present spring wheat is the more popular and occupies the largest acreage. During 1918 there were 3,843 acres in spring wheat and 872 acres in winter wheat; in 1919, 6,430 acres were in wheat. The entire crop is used on the farms.

Barley is grown on a few farms and takes the place of oats in the general rotation. In 1919 there were 668 acres in barley, producing 19,747 bushels. The crop is used on the farms as feed for hogs.

Alfalfa is becoming more popular. It is not only an excellent forage crop but a soil builder as well. In 1919, 459 acres were in alfalfa, and the acreage is increasing rapidly. Inoculation and good drainage are absolutely necessary, and yields have been increased by the use of lime. Weeds often decrease the yield and lower the quality of hay. The use of a scarifier once a year has proved profitable. Good stands are somewhat difficult to get, but when the crop is once well established the fields last from five to eight years. The

crop is either pastured or cut for hay, which is all fed on the farms.

Sweet clover gives promise of becoming a valuable forage crop. Good stands can be obtained anywhere in the county. The plant grows wild along the roads, railroads, and ditches, and often attains a height of 3 to 6 feet. During the year of the survey a few fields were grown for forage. For hay this clover should be cut before it reaches the tough, woody stage.

Potatoes are grown on nearly every farm, but some of the farmers prefer to buy their supply. In 1919, 19,690 bushels were produced. The entire crop is used locally.

Sorghum is grown on a number of farms and used for making sirup for home use. There is a small surplus which is sold in the local markets.

The growing of soy beans is becoming more common. The beans are generally sown with the corn by means of an attachment which fits on the corn planter. The greater part of the crop is cut for ensilage; some is used to pasture hogs.

The raising of beef cattle is an important industry, herds of from 10 to 40 being found on most farms. The most popular breed seems to be the Shorthorn. The smaller herds are either raised or bought locally; the larger operators buy their feeders in the Omaha or Sioux City market. The prevailing plan is to buy feeders late in the fall, feed intensively during the winter, and sell early in May or June. When young animals are bought, it is customary to buy in the spring, pasture during the summer and early fall, and sell the next spring. There are from 30 to 35 breeders of purebred stock in the county. They raise mostly the Shorthorn, although a few prefer the Aberdeen Angus or Hereford. According to the census, there were 37,958 head of cattle in the county on January 1, 1920.

Hogs are found on every farm. Most of the hogs produced are shipped out of the area, although some are sold in the county. In years of bumper crops, when the number of locally raised hogs is not sufficient to consume the increased amount of feed, hogs are bought on the open market and shipped in. The Poland-China, Duroc-Jersey, Chester White, and Hampshire are breeds well liked.

The dairy industry, while not very important, is a source of considerable income. During 1918 there were 10,093 milk cows in the county, the average per farm being 3 or 4. The whole milk is usually separated on the farms and the cream sold to the local creameries, or to cream stations for shipment to creameries located outside the county.

There are a number of permanent flocks of sheep in the county, but as a rule most of the sheep are feeders which are shipped in each year. In 1918, 4,979 sheep were raised locally and 5,688 were shipped in. The sheep are generally turned into the cornfields late

in the fall, and when they have thoroughly cleaned the fields they are fed for a few months and then sold. The permanent flocks are sheared and the wool marketed. The wool sold in 1919 amounted to 18,948 pounds.

The income derived from the sale of chickens and eggs in 1919 is reported at $458,347, but the value of those produced is much greater. Flocks of chickens are raised on practically every farm, but little time is given to their care. The poultry and eggs are sold to the commission houses or merchants in the towns of the area. The produce men, after supplying the local demand, ship the surplus to outside markets.

Rye, sweet corn, buckwheat, and millet are crops of minor importance. Rape is grown on a number of farms and used for hog pasture. Watermelons and muskmelons are successfully grown on some of the sandy knolls. Apple orchards are found on a majority of the farms, and those that are sprayed and cared for produce excellent fruit.

The adaptability of certain soils to certain crops is recognized by the farmers of Boone County only in a general way. The Conover silt loam is considered an excellent clover soil. Wheat gives best results on the Waukesha and Buckner soils, which are well protected. The Clarion loam, steep phase, and the Wabash silty clay loam and loam are seldom cultivated, but are left in their natural state and utilized for pasture.

The agriculture of the county is centered around the production of corn, and the only rotations used are those that fit in with the growing of the crop. Systematic crop rotations are in use on the better type of farms, the one most commonly followed consisting of corn for two years, oats for one year, and timothy and clover for two years. In a number of cases corn is grown for many years before seeding to small grain and clover.

The methods used in preparing the soil for the different crops are practically identical with those employed in other parts of the State. When corn follows corn it is not practicable to plow in the fall; consequently, after the corn is husked the cattle are turned in to forage on the stover. The next spring the land is plowed, disked, and harrowed. When corn follows small grain or timothy and clover fall plowing is the rule. Corn is generally planted with a planter in check rows 3 feet 6 inches apart, and is cultivated three or four times. The larger part of the crop is husked in the field, some is harvested with a binder and shocked, and a considerable part is cut for ensilage.

Oats are sown in the spring, and when they follow corn the land is generally disked twice and harrowed before sowing. Formerly all the oats were sown broadcast, but in late years the drill has come

into use. The crop is usually harvested after corn has been laid by, or about the middle of July.

Commercial fertilizers are used very little, but the excellent results obtained from the use of phosphates on similar soils in some other parts of the State would indicate that they might be profitably applied to some of the soils of Boone County. Stable manure is carefully saved and is usually scattered over the stubble or sod before plowing. The application of lime has proved beneficial. During 1919 eight carloads of lime were shipped in and used.

The farms of the county are all fenced. Much of the fencing is hog tight, consisting of woven wire at the bottom and three or four strands of barbed wire at the top. Only a few of the old willow hedges remain. Some of the farms are divided into plots of 20 and 40 acres by hog-tight fences, so that crops in any one field can be hogged down or pastured without injury to the crops in other fields.

The farm dwellings are in most cases well built, substantial, and comfortable. The outbuildings are generally in keeping, and many of the farmsteads have an artistic appearance. The barns are large and contain room for crop storage as well as for the stock. Silos are found on a number of farms Many of the silos are built of concrete or hollow tile. In 1918 there were 209 silos in the county, and the number has greatly increased since then. A few circular, rat-proof, hollow-tile corn cribs were observed during the survey.

The work stock consists of draft horses of medium to heavy weight and a few mules. Tractors are becoming quite numerous, and in many places are supplanting the horse. Gang plows, drills, manure spreaders, corn planters, corn binders, reapers, hay loaders, and cultivators are in general use. Windmills are found on every farm and are used for pumping water for the stock. Independent lighting plants have been installed on a number of farms. Other farms are electrically lighted by purchase from central power stations.

The labor question during the last few years has been a very important one. Monthly wages in 1920 showed a range of $60 to $70 a month and board. If married, the laborer receives in addition the use of a house, a garden, a milk cow, and fuel. Day laborers during the harvest season receive from $4 to $6 a day. Corn huskers receive from 8 to 10 cents a bushel and board.

Farms are rented either for cash or on shares. Cash rent ranges from $8 to $20 an acre, with an average of about $12. Share rent is generally on a half-and-half basis, the owner furnishing the land and the tenant the labor and equipment.

According to the 1920 census there are 2,541 farms in the county, with an average size of 134.1 acres. In 1919, 53.1 per cent of the farms were operated by owners, 45.9 per cent by tenants, and 1 per cent by managers.

Land values vary according to improvements, location, and topography. They range from $250 to $400 an acre, with an average of $325.

SOILS.[2]

Boone County lies in the central Prairie Region, where the topography and moderately high moisture supply favor a grass vegetation. The entire area was prairie until within comparatively recent times. The topographic changes developed greater relief and better drainage on narrow belts along the stream courses, and forest growth has spread over them, but has not yet invaded the areas unchanged by recent erosion. Accordingly, the native vegetation under which the soils were developed was grass over the relatively smooth upland and forest along the deeper stream valleys.

Differentiation of the soils of the area may be made, upon the basis of their most obvious characteristic, into dark-colored and light-colored soils.

The area of the dark-colored soils is coextensive with the area of the upland prairie, and includes also areas of dark-colored alluvial soils. The dark-colored soils fall into three subclasses or groups, whose differentiation is based on drainage conditions of soil or subsoil, or of both, during their development.

The heavy growth of grasses flourishing upon soils generally retentive of moisture resulted in the accumulation of large amounts of organic matter. The percentage of the organic matter and the depth to which it affected the color and physical structure of the soil was determined very largely by average drainage conditions. In flats and sloughs the black organic matter extends to a depth of 20 or 30 inches, but in well-drained areas it does not affect the soil beyond the depth of a few inches. The soils mapped as Peat and Muck represent the maximum accumulation of organic matter. In flat or undulating areas the average moisture content was originally high, and the ground-water level was within 2 or 3 feet of the surface, and in many places even nearer. Under these conditions there has been a large accumulation of carbonaceous material in the surface soil and the middle subsoil, while the lower subsoil almost escaped leaching and oxidation, resulting in a deep dark-colored soil filled with organic matter, over a light-colored or

[2] Boone County adjoins Webster and Hamilton Counties on the north and Polk County on the south. In certain cases the maps of the counties do not appear to agree along the boundaries. This is due mainly to changes in correlation, resulting from a fuller understanding of the soils of the State. The types mapped as Fargo loam and Fargo clay loam in Webster County are placed with the Webster series in Boone County, and the Miami silt loam is now correlated with the Conover series. The Webster clay loam of Hamilton and Polk Counties, on account of its small area, has not been mapped in Boone, but has been included with the Webster silty clay loam. For the same reason the Lamoure silty clay loam of Polk County has in this area been included with the Wabash loam.

mottled calcareous subsoil. These are the characteristic features of the soils which have been classed with the Webster series. Similar conditions in the river flood plains have produced the heavy soils of the Wabash series.

Where the topography ranges from gently to sharply rolling, the better surface drainage, the more vigorous movement of the soil water, and deeper aeration have resulted in leaching and oxidation to a depth of 3 or 4 feet. Soils formed under these conditions are represented by the Carrington series, which occurs in the better drained part of the upland. The typical profile has a dark-brown surface layer with a fine granular structure, ranging in depth from 8 to 18 inches. This is underlain by a dark-brown stratum, usually very thin, or a few inches in thickness. The lower subsoil is brown or yellowish brown, heavier in texture than the upper layer and usually friable and coarsely granular. The carbonates, as a rule, have been removed to a depth of more than 3 feet below the surface. To this group belong also the Waukesha, O'Neill, and Buckner soils of the terraces.

The soils of the Clarion series belong to a stage of development intermediate between the Webster and Carrington groups. The topography ranges from undulating to gently rolling. These soils occupy the more gentle slopes near the valleys of the small streams, and rather poorly drained areas within the Carrington soils. The better drainage, as compared with Webster soils, has resulted in more or less leaching to a depth of 3 or 4 feet. The surface soils are dark brown to black. The upper subsoil grades downward from a dark brown into a brown, and the texture is heavier than that of the surface soil. The lower subsoil is grayish brown to gray, approaching the color of the glacial drift from which it is derived. It has sufficient carbonates to effervesce with acid, and streaks of lime and lime concretions are common. With this group are also included areas of eroded slopes where the unleached calcareous drift is near the surface.

The areas of light-colored soils are almost coextensive with the area covered by forest when the country was first settled, and where the soils were developed under a vegetation consisting of trees. The type developed in this area, called the Conover silt loam, has a surface soil of a light-colored floury silt loam, ranging in depth from 6 to 8 inches. This is underlain by a brown or grayish-brown, tough, compact, gritty clay. Below this layer the texture is lighter and the structure less compact. With the light-colored group must be placed the Sarpy silt loam of the river flood plains. This soil is formed of recent alluvium, varying widely in texture, and has developed no distinctive soil profile.

The whole of Boone County was overrun by ice sheets during the glacial period, and the parent material of all the soils of the area except Peat and Muck is composed of rock ground up to varying degrees of fineness and redeposited by the ice. The Wisconsin drift, which covered the entire county, was originally a heterogeneous mixture of bowlders, gravel, sand, and clay. These rock fragments consisted of granite, gneiss, limestone, and diabase. By the process of weathering the surface of the drift has been reduced to a more uniform condition with respect to texture and composition. It is now believed that the most striking characteristics of the soil in its present stage of development have been determined to a greater extent by the soil-forming processes, such as the accumulation of organic matter, weathering, oxidation, and leaching near the surface, than to variations in the character of the original parent material. The composition of the original drift in this area has been expressed mainly in the texture, particularly of the coarser soils and of areas where gravel and bowlders are abundant, and in the highly calcareous nature of the subsoils due to the large proportion of limestone in the Wisconsin drift material.

The soils mentioned above have been grouped into series on the basis of difference in structure and minor details of the soil profile, and on the basis of the source, character, and process of accumulation of the material from which the soils have developed. The series are divided into soil types on the basis of texture.

The soils derived from glacial till are included in the Carrington, Clarion, Webster, and Conover series.

The Carrington series includes types with brown to dark-brown surface soils and a yellow to yellowish-brown subsoil. Neither soil nor subsoil is calcareous. The topography varies from undulating to rolling. The Carrington loam is the only type of this series mapped in Boone County.

The types in the Clarion series are characterized by dark-brown to black surface soils. The upper subsoil is generally brown to yellowish brown, and the lower subsoil is gray to grayish brown, in places containing small fragments of the original limestone. The lower subsoil is sufficiently calcareous to effervesce with hydrochloric acid. The Clarion fine sandy loam and the Clarion loam, with a steep phase, are the types mapped.

The Webster series embraces types having very dark brown to black surface soils and a gray, drab, or mottled gray and brown subsoil. The topography varies from level to undulating, and the drainage was originally poor. The subsoil is, as a rule, highly calcareous. Two types, the Webster loam and silty clay loam, are mapped.

The types of the Conover series are gray to light grayish brown in the surface soil. The upper subsoil is a gray to brown compact

gritty clay. The lower subsoil is a grayish-yellow to mottled brown and yellow clay less compact than the overlying layer. The silt loam is the only type mapped in the Conover series.

The materials of the old-alluvial or terrace soils were laid down when the streams carried more water and the valley floors occupied higher elevations. As the amount of water in the streams decreased deeper and narrower channels were cut, leaving remnants of the former flood plains in many places from 4 to 15 feet above the present first bottoms. These soils are correlated with the Waukesha, O'Neill, and Buckner series.

The Waukesha series includes types having brown to dark-brown surface soils and a light-brown to yellowish-brown subsoil. Occasional faint gray mottlings are found in the lower subsoil, but these are not caused by poor drainage. The subsoil is heavier than the surface soil, but not impervious or compact. The topography varies from level to sloping. One type, the Waukesha loam, is developed in the county.

The surface soils of the types in the O'Neill series range in color from brown to black. The subsoil is light brown to yellowish brown, grading at 22 to 30 inches into a loose sand or gravel. Neither soil nor subsoil is calcareous. The series occupies high level terraces that are slightly eroded in places. Drainage is excessive. The O'Neill loam and O'Neill fine sandy loam are mapped.

The Buckner series consists of types with dark-brown to black surface soils and a lighter brown subsoil. The subsoil differs little in texture from the surface. They are retentive of moisture and have a high agricultural value. The topography varies from level to gently undulating. Three types are developed in this area, the loamy fine sand, loam, and silt loam.

The recent-alluvial or flood-plain soils are comparatively inextensive. The material was washed from the glaciated uplands, reworked, and deposited during periods of overflow. The alluvial soils are classed with the Wabash and Sarpy series.

The Wabash series includes types having black surface soils and a dark-drab to gray subsoil. The black soil in places extends to a depth of 3 feet or more, with little change in color or texture. The organic content is high. The Wabash loam and Wabash silty clay loam are the only types mapped in the county.

The Sarpy series includes types with brown surface soils and a subsoil of lighter texture, in places passing into loose sand or gravel within the 3-foot section. Both soil and subsoil are calcareous. The soils occupy first bottoms subject to overflow. The Sarpy silt loam is the only type mapped.

The luxuriant growth of water-loving plants in pond areas and shallow lakes, scattered throughout various parts of the county, has resulted in the accumulation of a large amount of organic material. With this is mixed a considerable amount of mineral matter which has been washed from the surrounding slopes. In many places this material retains its fibrous structure and is classed as Peat; in other places it is in a more advanced stage of decomposition and is classed with Muck.

The following table gives the actual and relative extent of the various soils mapped in Boone County:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Carrington loam	147,264	40.4	Buckner loam	2,176	0.6
Clarion loam	48,384	20.1	Clarion fine sandy loam	1,664	.5
Steep phase	24,832		Waukesha loam	1,536	.4
Webster loam	59,520	16.3	O'Neill fine sandy loam	1,344	.4
Webster silty clay loam	40,512	11.1	O'Neill loam	704	.2
Conover silt loam	17,664	4.9	Buckner silt loam	640	.2
Wabash loam	6,976	1.9	Buckner loamy fine sand	192	0.1
Wabash silty clay loam	4,160	1.1			
Peat and Muck	3,520	1.0	Total	364,160	
Sarpy silt loam	3,072	.8			

CARRINGTON LOAM.

The surface soil of the Carrington loam is a brown mellow loam, 14 to 18 inches deep. The content of fine and medium sand is sufficiently high to give it a friable structure and render it free from stickiness even when wet. The subsoil is a brownish-yellow to yellowish-brown sandy clay loam to sandy clay. Faint gray mottlings are found in places in the lower subsoil, but do not appear to be caused by poor drainage. In some localities the lower subsoil is gritty in spots, and small gravel and remnants of the parent till are encountered within the 3-foot section. Throughout the more rolling areas along some of the creeks the surface soil is shallower and of lighter color than typical. In the northeastern corner of the county along the Hamilton County line where the moraine has given rise to a more rolling topography, the surface soil over small areas is a lighter brown friable loam approaching in places a fine sandy loam and the subsoil is a friable sandy clay passing in places at 30 to 34 inches into the gravelly till. On hill crests and sharp knolls, where erosion has been more active, the surface layer is thin and of yellowish-brown color. Throughout some of the flatter interstream areas, where drainage is less complete, the surface soil has a darker color and the subsoil is mottled here and there with brown and yellow.

Some areas of fine sandy loam have been mapped with this type on account of their small extent. They occur mainly on isolated ridges and hills. The largest areas lie in the vicinity of Pilot Mound and Mackey, and two small bodies east of Beaver. The surface soil is a brown fine sandy loam, 8 to 10 inches deep. The subsoil is a yellowish-brown heavy fine sandy loam or clay loam. As a rule crop yields are lower than on the typical Carrington loam.

The Carrington loam, which is developed in all parts of the county, is confined mainly to the rolling to strongly rolling country bordering the creeks and smaller streams. The largest areas lie along Beaver Creek, southeast of Boone, and in Peoples Township. The topography varies from undulating to strongly rolling, and the drainage is good.

This is an important agricultural soil, and practically all of it is under cultivation. The only forested areas consist of a few belts of native trees on the steeper slopes along the streams and the windbreaks that have been set out to the north and west of most of the farm dwellings.

Of the cultivated crops corn occupies the largest acreage, oats second, and hay third. Most of the corn and oats, and all of the hay, is fed to the work stock, hogs, and cattle on the farms. The surplus corn and oats is sold to the local elevators and shipped out of the county. The corn crop is nearly all husked from the stalk, although a small amount is harvested with a binder and left in the shock until fed. An increasing acreage is being cut each year for ensilage. When planted for this purpose soy beans are planted with it. A number of fields of rape were observed. The rape is planted with corn or oats, and is utilized for hog pasture after the grain crops are harvested. The excellent condition of the few fields of alfalfa seen during the progress of the survey would indicate that the growing of the crop on this soil could be profitably extended. Wheat, barley, and rye are grown to some extent and used for feeding hogs. Small apple orchards and gardens are found on nearly every farm.

The crop yields[3] on the Carrington loam are: Corn, 35 to 65 bushels per acre; oats, 38 to 60 bushels; wheat, 12 to 28 bushels; barley, 18 to 35 bushels; and hay, 1 to 2 tons.

The main live-stock industries consist of the raising of hogs, the raising and feeding of beef cattle, the raising and feeding of sheep, and dairying. There are two breeders of draft horses in the county who raise animals for sale. Herds of purebred cattle are found on a number of farms, and annual sales are held to dispose of the animals. The feeding of beef cattle is a very important industry, and each year many animals are bought and shipped in. The beef

[3] Crop yields are based on information obtained from the farmers.

cattle, hogs, and sheep are now sold to a large extent through a farmers' cooperative association that maintains offices at Boone. The draft horses are sold mostly within the county, although a few go outside.

The surface soil of the Carrington loam contains a high percentage of silt and fine and medium sand, which gives it a mellow, friable structure and permits cultivation under varying moisture conditions. The soil is plowed in the fall when possible, as this allows thorough aeration and improves the physical condition. The soil is naturally rich in organic matter, and the more progressive farmers not only try to conserve this but endeavor to add to it by proper rotations in which legumes play an important part. Corn is never planted on the same ground more than three or four years in succession, and a growing practice is to limit the crop to two years. A rotation in more or less general use on the better type of farms consists of corn two or three years, oats one year, and timothy and clover two years. On the majority of the rented farms very little care is taken to maintain fertility, and corn is often grown for many years before seeding to clover. Commercial fertilizers are never used. During the year of the survey a small amount of ground limestone was used and excellent results obtained. Stable manure is carefully saved and scattered over the land before plowing.

The value of farms located on the Carrington loam ranges from $250 to $400 an acre, depending upon the condition of improvements and the location. During the recent land boom much higher prices were obtained, but such prices were based on speculation rather than worth.

The Carrington loam is naturally a strong, durable soil, and with proper handling and systematic crop rotation, including legume crops, can be kept in a high state of productiveness. The constant cropping to corn and small grain without the use of clovers or other legumes has in many cases reduced the content of organic matter to such an extent that crop yields are much below normal. Where this is the case it may require several years to restore the soil to its former productive state. Fall plowing is recommended when possible, as it helps to kill the weeds and promotes aeration. Deep plowing is necessary for best results and the depth should be increased gradually until 9 or 10 inches is reached. A deep, well-cultivated seed bed is capable of absorbing a great amount of water without injury to the growing crops, and it serves as a storehouse for moisture during droughts.

CLARION FINE SANDY LOAM.

The Clarion fine sandy loam consists of a dark-brown fine sandy loam 8 to 12 inches deep underlain by a yellowish-brown fine sandy

loam to sandy clay loam, mottled or streaked with gray below 30 inches. The lower subsoil contains a relatively large quantity of lime carbonate. On the top of the sharper knolls, where erosion has been active, the surface soil over small areas is not so deep and has a lighter color, ranging from light brown to pale yellowish brown. In such areas the parent till is encountered within the 3-foot section, and the gray color in the lower part of the subsoil is more pronounced. Included with the type are a few small areas of Carrington loam and Clarion loam too small to separate on the map.

The Clarion fine sandy loam is not extensively developed in the county. It is confined to the morainic area in the northeastern corner of the county, where it occurs on the crests of the knolls and ridges. The elevation above sea level ranges from 1,100 to 1,150 feet. The topography is rolling to strongly rolling and surface drainage is good to excessive.

Practically all of the Clarion fine sandy loam is under cultivation or in pasture. The only forest growth consists of a few willows along old fence rows and the windbreaks that have been set out on the farms.

The Clarion fine sandy loam is handled in practically the same way as the Carrington loam, with which it is closely associated. It is not as strong an agricultural type, and the yields are lower.

The type is always sold with the Carrington loam or Clarion loam but is not considered as valuable a soil.

The open porous structure of the soil has allowed more active leaching, consequently it is deficient in organic matter. Clovers and legumes should be more commonly grown as green-manuring crops. The methods suggested for the improvement of the Clarion loam will apply to this type.

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

Mechanical analyses of Clarion 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.*
333811	Soil	2.3	8.2	6.3	28.0	19.8	27.3	8.0
333812	Subsoil	3.1	8.4	6.0	25.5	22.8	27.8	6.5

CLARION LOAM.

The surface soil of the Clarion loam is a brown to very dark brown or black, mellow, friable loam 15 to 18 inches deep. The subsoil is a yellowish-brown to grayish-brown friable clay loam, passing at 28 to 30 inches into a yellowish-gray or mottled gray, brown, and yellow

clay loam or clay. In the more level areas the content of organic matter is high and has imparted a black color to the surface soil. Gray mottlings are found in many places in the lower subsoil and here and there a gray layer is encountered that contains bits of soft limestone. Throughout the eastern half and the southern part of the western half of the county the calcareous layer lies deeper and in many places just within the 3-foot section.

In the vicinity of Angus and Berkley and just west of Ogden, the surface soil is a brown to dark-brown loam underlain by a yellowish-brown friable clay loam mottled with gray below 30 inches. The areas where the calcareous layer is found between 32 and 36 inches approach closely the Carrington loam, and the boundaries are more or less arbitrarily drawn. The lower subsoil is always sufficiently calcareous to effervesce with acid. Included with the type are a few areas of Clarion fine sandy loam, and Carrington loam and fine sandy loam too small to separate on the soil map.

The Clarion loam is developed in all parts of the county. West of the Des Moines River and in the vicinity of Madrid the areas are moderately large, in other parts of the county they are small. The type, as a rule, occupies a topographic position intermediate between the soils of the Carrington and the Webster series. The surface varies from undulating to rolling, and the drainage is generally sufficient. The subsoil is friable but retentive of moisture.

The Clarion loam is considered a valuable agricultural soil, and practically all of it is either in cultivated fields or pastures. The only forested areas consist of the windbreaks that have been set out to the north and west of the farm dwellings.

Corn, oats, and hay are the principal crops grown, and corn occupies the largest acreage. After supplying the demands on the farms, the surplus corn and oats is sold at the local elevators and shipped to outside markets. All the hay is fed on the farms, and the supply is not equal to the demand. The hay crop consists principally of timothy and clover, grown separately and mixed. Most of the corn is husked in the field, a comparatively small part being harvested with a binder and shocked in the field until required for feed. An increasing acreage is cut each year for ensilage. Wheat, barley, rye, alfalfa, rape, and sorghum are also grown. The wheat and barley are generally fed on the farm, but some years there is a small surplus sold and shipped. Rye is grown on a few farms, principally for early spring pasturage. Alfalfa is not extensively grown, but is a profitable crop. It is generally cut for hay. Rape is grown in the corn and oats, and is used as hog pasture after harvest. The principal live-stock industries consist of the raising of hogs, the raising and feeding of beef cattle, and, to a small extent, dairying. A few sheep are brought in and fed each year. Apple orchards and gardens

are found on nearly all the farms and supply in part the home demand.

The crop yields on this type of soil under ordinary conditions are as follows: Corn, 35 to 70 bushels; oats, 35 to 50 bushels; wheat, 15 to 18 bushels; barley, 20 to 35 bushels; and hay, 1 to 2 tons per acre. The yields on the better farms are much higher, corn frequently producing as much as 80 to 90 bushels and oats 60 to 70 bushels per acre.

The Clarion loam is easily tilled, but can not be handled under as wide variations of moisture as the Carrington loam. It is a strong soil, and its productiveness can be easily maintained by the use of proper methods. On a number of farms, particularly those operated by tenants, corn is grown for years without rotation with clover or other legumes, and as a consequence the productiveness of the land is impaired. The better farmers on this type are using up-to-date methods, including deeper plowing, more thorough preparation of the seed bed, and the use of rotations in which clover appears. The rotation that is most popular consists of corn two or three years, oats, wheat, or barley one year, and clover and timothy two or three years.

Stable manure is carefully saved and distributed with manure spreaders. Some lime is used. Commercial fertilizers are not used. The methods suggested for the improvement of the Carrington loam apply equally as well to this type.

The price of land of the Clarion loam type ranges from $250 to $400 an acre, according to the condition of the improvements and the location with reference to towns and railroads.

Clarion loam, steep phase.—The surface soil of the Clarion loam, steep phase, is a brown to dark grayish brown loam, 7 to 12 inches deep. The subsoil is a yellowish-brown to brownish-yellow clay, mottled with gray and brown, and calcareous in the lower part of the 3-foot section. On some of the steeper slopes, where erosion has been active, the surface soil has been almost entirely washed away, exposing the yellowish clay. Along the lower slopes or in swales the soil is deeper, owing to colluvial wash, and has a darker brown color. In many places along the Des Moines River, especially between Sixteen-to-One Bridge and New Bridge, the surface soil is a lighter brown to grayish brown in color, probably owing to the fact that the slopes are directly below areas of Conover silt loam. There are a few areas in which the subsoil contains a considerable proportion of fine gravel, and in other sections erosion has exposed beds of gravel.

The phase is confined to the steep slopes along the Des Moines River and the larger tributary streams. The slopes are steep and often precipitous. Drainage is good to excessive.

The Clarion loam, steep phase, is comparatively inextensive and not of much agricultural importance. A few of the more gentle slopes are cultivated, but the greater part of the phase is in forest consisting mostly of red oak, white oak, bur oak, basswood, maple, hickory, and some walnut. On the slopes that are not thickly forested bluegrass grows luxuriantly and affords excellent pasture.

The area in cultivation is small. Corn, oats, and wheat are the principal crops grown. The growing of apples and small fruits, such as raspberries, strawberries, and gooseberries, should prove profitable on the lower protected slopes.

This phase should be kept in forest, as it erodes badly when cleared. The growing of bluegrass should be extended, both for protection of the slopes and to improve the pastures.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the typical Clarion loam:

Mechanical analyses of Clarion 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.*
333836.....	Soil.....	1.3	7.6	6.7	26.6	14.8	31.9	10.9
333837.....	Subsoil.....	2.1	7.3	5.8	24.5	16.3	29.3	14.6

WEBSTER LOAM.

The surface soil of the Webster loam is a very dark brown to black mellow loam, 16 to 18 inches deep. The high content of organic matter makes the soil appear much heavier than it really is, especially when wet. The subsoil is a grayish-brown to dark-drab silty clay to clay, mottled with gray, brown, and yellow. In a number of the flatter, more gently undulating areas the soil is a heavy loam, approaching in places a clay loam or silty clay loam, and the subsoil is more mottled. North of Madrid and in a few other areas the surface soil is a dark-brown to black loam. This passes at 18 to 20 inches into a darker brown to dark-drab heavy loam, which in turn grades at about 30 inches into a gray to grayish-brown silty clay. Included with this type are bodies of silty clay loam and silt loam too small to separate on the map.

The Webster loam occurs in all parts of the county and in a number of places covers important areas. The topography varies from level or gently undulating to gently rolling. Natural drainage throughout the more level areas is inadequate, and tiling is necessary for the best results.

The Webster loam, when well drained, is highly prized for farming, probably ranking second among the soils of the area, and practically all of it is under cultivation. Corn occupies the largest acre-

age. The greater part of the crop is fed on the farm; the remainder is sold to the local elevators and shipped out of the county. Under ordinary methods of cultivation corn yields 40 to 65 bushels per acre, but yields of 70 to 90 bushels are not uncommon on the better type of farms. Oats, the crop of second importance, yields 35 to 70 bushels per acre. The Iowa 103 and Iowa 105 are the varieties best adapted to the type. Practically all the crop is fed within the county. Wheat, barley, and rye are grown on a small scale. Some sorghum is grown for making sirup. Rape is grown for hog pasture. Hogs are raised on all the farms, and the feeding of beef cattle and a few sheep constitutes an important industry.

The Webster loam is handled in practically the same way as the Carrington and Clarion loams, with which it is closely associated. Owing to its level to undulating topography and the impervious nature of the subsoil the type is not naturally well drained, and a considerable proportion of it has been tiled. Grain growing with very little use of leguminous crops has lowered the yields on many farms on this type. At present a more or less definite crop rotation is practiced, the land being seeded to timothy and clover every four or five years. It is generally cut once for hay and the second crop turned under for green manure.

The price of land of the Webster loam type varies from $225 to $375 an acre, according to the condition of improvements and the location with reference to towns and railroads.

Artificial drainage is essential in this soil, and owing to the impervious nature of the subsoil, which causes the subsurface water to travel slowly, the laterals need to be placed closer together than on the more open types of soil. It is also necessary to use care to see that there is sufficient fall for the outlets of the drains. It was noted that in many places the main drains have been laid with tile too small to carry the water delivered to them by the laterals. Deeper plowing and crop rotations in which clover or other legumes are grown as green-manuring crops, should be more common. Alfalfa can be grown successfully on well-drained areas. Crops do not mature as quickly on the Webster loam as on the more rolling types, and more attention should be given to the selection of early maturing varieties of corn.

WEBSTER SILTY CLAY LOAM.

The surface soil of the Webster silty clay loam consists of a black silty clay loam 10 to 12 inches deep. This grades into a subsoil of dark-brown to grayish-brown silty clay loam, to silty clay, which extends to a depth of 20 or 24 inches. From 24 to 36 inches the subsoil is a grayish-brown to dark-drab tenacious silty clay to clay, mottled with brown, gray, and yellow. The quantity of organic

matter in the soil is high, as indicated by the intense black color. Throughout the more poorly drained areas quantities of small mollusk shells are scattered over the surface, and the soil is usually calcareous. The lower part of the 3-foot section in places contains small particles of limestone, sand, and gravel, and the reaction with acid is generally strong. Included with this type are a few small areas of Webster loam and clay loam too small to map.

The Webster silty clay loam is developed in all parts of the county in small and more or less isolated bodies. It occupies principally the lower flatter areas along the intermittent drainage ways, and the depressed level sections of the uplands. The topography varies from level to very gently undulating. Natural drainage is poor, and it has been necessary to prepare the land for cultivation by constructing ditch and tile drains.

This type, when drained, is considered a valuable farming soil. An increasing area is being put in cultivation, and in 1920 approximately 75 per cent was devoted to the production of general farm crops. The poorly drained areas support a luxuriant growth of natural grasses, which are pastured and harvested for hay. The only tree growth consists of a few willows, which commonly grow along old fence rows.

The principal crops are corn, oats, and hay, with by far the largest acreage in corn. Oats have a tendency to lodge, but this has been overcome in late years to a great extent by the use of the Iowa 103 and Iowa 105, which are particularly adapted to rich soils. Wheat, barley, and rye are also grown to some extent. Flax is occasionally sown the first year on breaking virgin soil.

Corn yields ordinarily range from 38 to 55 bushels, oats 35 to 70 bushels, and hay 1½ to 2½ tons per acre.

The Webster silty clay loam is handled in about the same way as the Webster loam, except that it can not be worked under as wide variations of moisture content. Stable manure is scarcely ever used. Tiling is necessary for best results, and a considerable acreage was tiled and ditched during the year of the survey.

The methods suggested for the improvement of the Webster loam and Clarion loam are applicable to this type.

The following table gives the 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.*
333805.....	Soil.....	0.4	3.0	4.6	14.2	6.2	46.4	24.8
333806.....	Subsoil.....	.3	3.5	4.8	8.1	6.6	52.0	24.8

CONOVER SILT LOAM.

The surface soil of the Conover silt loam consists of a gray to light grayish brown floury silt loam, 6 to 8 inches deep, underlain to a depth of 18 or 20 inches by a yellowish-gray to grayish-brown compact clay loam mottled with gray, brown, and yellow. The subsoil is a yellow, grayish-yellow, or mottled gray, brown, and yellow, tough, compact, gritty clay. The surface soil is light gray and floury when dry and darker colored when wet. The content of sand and fine gravel increases with depth, and below 30 inches the subsoil is usually more friable. Where this type merges with the darker-colored prairie soils the transition is gradual and the boundaries in many places are difficult to draw.

The Conover silt loam is confined to narrow strips of level to undulating upland bordering the Des Moines River and the lower reaches of some of the larger tributary streams. The strips vary in width from an eighth of a mile to a mile. The largest areas are found on the east side of the river just west of Boone and south of Hull School. The topography varies from level to gently undulating and the drainage is sufficient for all needs.

The Conover silt loam was originally in forest, but the greater part has been cleared and put in cultivation. The remaining tree growth consists mostly of white oak, red oak, hickory, ash, elm, maple, and some walnut. Hazel bushes grow along roads and in abandoned fields.

Corn, oats, wheat, and clover are the principal crops, ranking in the order named. Barley, rape, millet, rye, and timothy also do well and are grown on a small scale. Small gardens are maintained to supply the home. Most of the corn, oats, and wheat is fed on the farm. The live-stock industries consist of the raising of hogs, and to some extent the feeding of cattle and sheep. A few milk cows are kept on most farms, the surplus milk and cream left after supplying home needs being sold to creamery stations. The hogs and cattle are now marketed through a cooperative association with headquarters at Boone.

The crop yields are slightly lower than on the Carrington loam, probably owing to the lower organic content of the Conover soil.

The Conover silt loam is not as easily tilled as the Carrington and Clarion loams. The surface soil packs and becomes hard when dry, and a good mulch is more difficult to maintain. The soil is cropped in practically the same way as the Carrington loam, with which it is closely associated. Its productiveness could no doubt be improved by deeper plowing, the more liberal use of stable manure, and the turning under of green-manuring crops. Definite crop rotations, in which legumes play a part, would prove beneficial. The use of ground limestone would sweeten the soil and no doubt increase the yields.

Land of this type is valued at $150 to $250 an acre, according to location and improvements.

The following table gives the results of mechanical analyses of samples of the soil, subsurface, and subsoil of the Conover silt loam:

Mechanical analyses of Conover silt 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.*
333824	Soil	1.0	5.3	3.8	15.0	13.7	49.1	12.2
333825	Subsurface	1.6	7.1	6.9	26.8	10.6	33.1	13.9
333826	Subsoil	3.4	9.0	8.4	34.5	12.1	20.9	11.6

WAUKESHA LOAM.

The surface soil of the Waukesha loam is a brown to dark-brown mellow friable loam, 14 to 16 inches deep. The subsoil is a yellowish-brown sandy clay loam to sandy clay. In some areas the surface soil contains much organic matter and has a black color. A few faint mottlings of gray appear in the lower part of the 3-foot section but these apparently are not caused by poor drainage.

In areas situated a mile north of New Bridge, on the west side of the river, and just across the river from Logansport, the content of fine sand is sufficient to give a soil approximating a fine sandy loam in texture.

Included with this type are a few very small areas of typically fine sandy loam and fine sand. A silty variation also occurs in three small areas along the Des Moines River, the largest lying on the west side of the river opposite Madrid. The soil to a depth of 14 to 18 inches is a dark-brown mellow silt loam containing a high percentage of organic matter. The subsoil is a yellow-brown clay loam.

The Waukesha loam is confined to the terraces along the Des Moines River and Beaver Creek. The largest bodies lie in bends of the river 1 and 2 miles south of the Webster County line, and just across the river from Logansport. The topography varies from level to gently sloping. The type is above overflow, and the drainage is adequate.

The Waukesha loam covers a relatively small area, but is considered a valuable agricultural soil. Practically all of it is under cultivation. A few butternut, walnut, and oak trees, along the edge of some fields, constitute the only timber. Corn, the principal crop, occupies probably 85 per cent of the cropped acreage. Wheat is grown on a small scale, with excellent results, probably owing to the fact that the type is in a protected position.

The Waukesha loam is easily cultivated. It is handled in the same way as the Carrington loam. Owing to its open structure

and good drainage the soil warms up early in the spring, and crops are seldom caught by frost in the fall. The yields as a rule are slightly lower than those obtained on the Carrington loam.

The methods suggested for the improvement of the Carrington loam apply equally well to this type.

O'NEILL FINE SANDY LOAM.

The surface soil of the O'Neill fine sandy loam consists of a brown to dark-brown to nearly black fine sandy loam, 7 to 9 inches deep. The subsoil is a light-brown to yellowish-brown fine sandy loam, which grades at 22 to 26 inches into a yellow fine sand or loamy fine sand. A few areas exist in which the surface soil is comparatively shallow and the upper subsoil grades at 18 to 20 inches into a loose bed of sand and gravel. Included with the type are a few small areas of loam too small to be shown on a map of the scale used in this survey.

The O'Neill fine sandy loam is developed in small areas on the terraces of the Des Moines River and Beaver and Squaw Creeks. It lies above ordinary overflows, the terraces ranging in elevation from 40 to 60 feet above the normal level of the river and from 10 to 15 feet above that of the creeks. The surface is level to gently sloping. Drainage is excessive, and the soil is droughty.

Practically all of the type is in cultivation or used for pasture. Corn is the principal crop. The yields are best during wet seasons and average 20 to 35 bushels per acre. Oats, which rank second in acreage, yield 25 to 40 bushels per acre. Some wheat, rye, and barley are grown. Sorghum is grown on most of the farms, the entire crop being used for making sirup. Watermelons and muskmelons do well. Some melons are sold in the local markets. Irish potatoes and all kinds of garden truck are grown for home use.

The O'Neill fine sandy loam is easily handled. It is farmed in the same way as the upland types. Stable manure is scattered over the fields, preferably in the fall before plowing. Lime and commercial fertilizers are not used, but the former material would be of value.

Deeper plowing is essential for best results. Definite crop rotations should be used, and the crops should include clovers or other legumes to be turned under as green manure. The use of lime would probably improve the physical condition of the soil and increase the yields. Along the river, where the type occupies high, well-drained terraces, alfalfa probably could be grown successfully.

O'NEILL LOAM.

The O'Neill loam consists of a dark-brown to almost black light-textured loam, 8 to 10 inches deep, underlain by a light-brown to yellowish-brown sandy clay loam, which grades at 20 to 23 inches into a sticky sand or gravel layer. The surface soil has a high con-

tent of organic matter. Included with the type are a few small areas of O'Neill fine sandy loam too small to be shown separately on the map.

The type is confined to the terraces of the Des Moines River and Beaver and Squaw Creeks. The areas are small and scattered. The largest lie in the bends of the river about 2 miles southwest of Boone, and just west of Sixteen-to-One Bridge. The surface is level to gently sloping. Drainage is inclined to be excessive, and crops suffer during dry seasons.

The O'Neill loam is a soil of small extent. Practically all of it is either in cultivation or used for pasture. The principal crops are corn and oats, with corn occupying the largest acreage. Wheat, barley, rye, sorghum, and Irish potatoes are grown also on a small scale. Small gardens are maintained on practically every farm. The principal live-stock industries consist of the raising of hogs and to some extent the feeding of beef cattle.

Crop yields are smaller than on the upland soils and heavier terrace types, and are more variable. The largest yields are obtained during wet years, when corn produces 20 to 40 bushels per acre, and oats 28 to 43 bushels.

The soil is handled in practically the same way as the Carrington loam. Fall plowing is practiced whenever practicable, and it is customary to scatter manure over the fields before plowing. Lime has been used with good results.

The improvement of this type can be effected by the use of the methods suggested for the Carrington and Clarion soils.

BUCKNER LOAMY FINE SAND.

The surface soil of the Buckner loamy fine sand consists of a brown to dark-brown loamy fine sand, 10 to 14 inches deep. The subsoil is a yellow to yellowish-brown fine sand to loamy fine sand. The color and texture of this type is quite variable. Where the organic content is high the surface color is dark brown; in other places it is a light brown to brown. Included with the type are small areas of Buckner fine sand and fine sandy loam too small to show on the map.

The Buckner loamy fine sand is confined to the terraces of the Des Moines River. It generally lies along the outer border of the terraces in the form of a low dikelike ridge. The topography ranges from level to gently undulating. Drainage is generally excessive.

The total extent of this soil is small, but it is all in cultivation. It is used solely for the production of corn, which yields less than on the Buckner silt loam. The soil is handled in practically the same way as the silt loam, with which it is closely associated.

The Buckner loamy fine sand should prove a valuable soil for the growing of melons and potatoes.

BUCKNER LOAM.

The Buckner loam consists of a surface soil of dark-brown to black mellow loam, 18 to 20 inches deep, underlain by a subsoil of a lighter brown to yellowish-brown loam to fine sandy loam. The difference between soil and subsoil is slight, and in places the surface soil extends to 3 feet or more without any appreciable change in color or texture. In the vicinity of Fraser the soil has a light-brown color, and the content of fine sand is sufficient to give approximately a fine sandy loam. Included with the type are a few small areas of fine sand and fine sandy loam too small to separate on the map.

The Buckner loam is confined to the terraces of the Des Moines River and is principally developed north of Moingona. It occupies positions some 20 to 40 feet above the normal level of the river and beyond the reach of ordinary overflow. The topography varies from level to very gently undulating, and drainage is good.

A small area is in forest, but by far the greater part is devoted to agriculture. Corn is the principal crop and yields about the same as on the Carrington loam. Oats and other small grains are not grown as generally as on the upland types. Sorghum is grown for sirup. Melons and all kinds of garden truck do well. Rotations are not in use on this type of soil, and corn is grown for years without seeding the land to grass or resting it in any way. The soil is open and warm and crops mature a little earlier than on the upland types.

The Buckner loam is well suited to the growing of melons, potatoes, and vegetables, and the production of these crops could be profitably extended. Wheat, no doubt, would be a satisfactory crop, owing to the sheltered position of the areas.

BUCKNER SILT LOAM.

The Buckner silt loam, to a depth of 18 to 20 inches, consists of a very dark brown to black silt loam. Below this the subsoil is prevailingly a light-brown to brown silt loam. In many places the subsoil differs little from the surface soil, and here and there the surface soil extends to a depth of 3 feet or more without change. Included with the type are a few areas of loam too small to map separately.

The Buckner silt loam is developed on terraces of the Des Moines River in comparatively small and scattered areas. It is above the reach of ordinary overflow and has an elevation of 2 to 8 feet above the first bottoms and of 20 to 30 feet above the normal level of the river. The surface is level to gently sloping and the drainage conditions favorable for farming.

The type, although of small extent, is prized as an agricultural soil and practically all is in cultivation. Corn occupies the largest acreage; oats and hay follow in the order named. Wheat and rye are

grown on a small scale. All the grain, except a small amount of corn which is sold, is fed on the farm. The leading live-stock industries are the raising of hogs and the feeding of a few beef cattle and sheep. The hogs, cattle, and sheep are sold through a farmers' cooperative association. Corn yields 35 to 70 bushels per acre, oats 30 to 60 bushels, and hay 1½ to 2 tons. Manure and commercial fertilizers are not used.

The methods suggested for the improvement of the upland types would apply equally well to this soil. Deeper plowing and the incorporation of more organic matter will help to maintain the fertility, and the rotation of crops in which legumes are used is recommended. The use of lime would no doubt prove beneficial. The price of land of this type varies from $150 to $250 an acre.

WABASH LOAM.

The surface soil of the Wabash loam is a very dark brown to black friable loam, 14 to 16 inches deep. The subsoil is a dark-drab to dark-gray clay mottled with gray and brown. The content of organic matter is high, as indicated by the black color, which in places extends to a depth of 3 feet or more. Variations in color and texture over small areas are characteristic of this type. In many places the soil consists of a black heavy loam, 15 to 18 inches deep, underlain by a drab or gray silty clay mottled with rusty brown. In other areas the black loam grades at 18 to 20 inches into a black silt loam, which, in turn, either extends to a depth of 3 feet without change or passes into a drab silty clay at 30 to 34 inches.

The Wabash loam is developed along the first bottoms of the creeks and smaller streams in the eastern half and southwestern corner of the county. The strips are narrow, varying from 50 feet to one-fourth mile in width. The surface is flat or slopes gently toward the streams. The type is subject to overflow, and the drainage is poor.

Only a very small area is in cultivation, the larger part being left in grass and used for pasture. The only tree growth consists of a few willows along streams and fence rows, and an occasional elm, oak, or ash. Hay is the principal crop, but the production is small as most of the land is used for pasture. The yield per acre varies from 1½ to 2 tons. The excellent condition of the few fields of corn seen during the survey would indicate that this would prove a valuable soil for this crop, if properly drained. A few hogs, beef cattle, and sheep are raised or fed. From 2 to 4 milk cows are kept on each farm.

Careful drainage and deeper plowing are the first requisites for the improvement of this soil. The stream channels should be deepened and straightened, and in some places levees built to protect

the land. Tiling is necessary, and owing to the impervious nature of the subsoil the laterals must be placed relatively close together.

WABASH SILTY CLAY LOAM.

The surface soil of the Wabash silty clay loam consists of a black silty clay loam to clay loam, 14 to 16 inches deep, rich in organic matter. The subsoil is a black to very dark gray silty clay with faint brown mottlings and iron stains in the lower part of the 3-foot section. In places the surface soil for a few inches is a silt loam or heavy loam. The subsoil in places grades at 30 to 34 inches into a dark-gray plastic clay mottled with rusty brown and dull yellow. Included with the type are areas of loam and silt loam which were not separated on the map because of their small extent and indefinite boundaries.

The type is developed principally along the creeks and streams in the northwestern corner of the county, although a few bodies lie along the creeks in other sections. It is not an extensive type. It occupies a position 2 to 4 feet above the normal level of the streams and is subject to overflow. The topography is level to gently sloping, and natural drainage is inadequate.

The Wabash silty clay loam is practically all utilized for pasture. It supports a luxuriant stand of native grasses. The only forest growth consists of a few willows, oaks, and elms along the streams. The few narrow strips along the outer edges of the bottom that have been included in fields produce excellent corn. This would indicate that the type, if properly drained, could be made a valuable agricultural soil.

The improvements recommended for the Webster loam apply equally well to this type.

The Wabash silty clay loam is always sold in connection with the adjoining types and is valued at $200 to $375 an acre.

SARPY SILT LOAM.

The Sarpy silt loam varies considerably in texture, as is often the case in first-bottom soils. In its most common development the surface soil consists of a gray to brownish-gray silt loam, 8 to 12 inches deep, underlain by a gray loamy fine sand. This, in turn, grades at 18 to 20 inches into a brownish-gray to brown fine sandy loam. Both soil and subsoil are high in lime carbonate. In a number of places the intermediate loamy fine sand layer is absent, and the surface soil rests directly on the moderately heavy fine sandy loam. In other areas the silt loam extends to a depth of 3 feet without change in texture or color. The subsoil in places consists of stratified beds of silt, fine sand, and medium sand, varying in thickness from 2 to 10 inches. Included with the type are areas of fine sandy loam which

were too small and too intricately associated with the silt loam to separate.

The Sarpy silt loam is developed as narrow strips in the first bottoms of the Des Moines River. The type is subject to overflow, and the drainage is poor.

The greater part of the type is in cultivation. The remainder supports a tree growth consisting mostly of oak, maple, elm, willow, and some hickory and walnut.

The Sarpy silt loam is easily tilled, and owing to the high content of very fine sand and silt it does not clod when plowed in a wet condition. Corn and hay are the principal crops. When crops are not injured by overflow, yields are obtained that compare favorably with those on the Buckner silt loam. A few hogs and cattle are raised and feeders pastured.

If this soil could be protected from inundation it would prove a valuable soil for the production of corn, wheat, and oats.

PEAT AND MUCK.

Peat, as developed in this county, consists of a brown, dark-brown or almost black mass of partly decomposed vegetation, with which is mixed a small amount of mineral matter washed from the adjoining soils. The organic accumulation varies in depth from 6 to 30 inches, the greater part being 6 to 20 inches deep. It is underlain by a black or dark-drab silty clay or fine sandy clay. The mass when dry, is spongy and porous and in places exceptionally fibrous. It is capable of absorbing much water, and when wet has a black color. Small mollusk shells are scattered over a few of the areas. As a rule the subsoil is calcareous. By constant cultivation the fibrous material has been pulverized and mixed with the black silty clay material brought up by the plow, and improved drainage has facilitated decomposition, so that in most of the Peat areas the Peat character is fast disappearing and the soil is approaching a silt loam or silty clay loam. Included with the Peat are a few areas of Muck, which is Peat in an advanced stage of decomposition. Muck consists of a black mass of thoroughly decomposed plant remains mixed with considerable mineral matter. It ranges in depth from 8 to 20 inches and rests on a black to drab silty clay to clay.

Peat and Muck occupy basinlike areas throughout the uplands where conditions have been favorable for a rank growth of water-loving plants. The largest bodies are found in the northwestern part of the county. The areas as a rule are comparatively small and isolated; they range in size from a few to 80 acres. Some very small areas could not be shown on a map of the scale used.

Formerly the areas of Peat were all poorly drained. In recent years many of these beds have been reclaimed and much valuable

agricultural land added to the cultivated area. Corn is probably the most important crop. On the shallower areas the yields compare favorably with those obtained on the Webster loam. Timothy gives good yields. Oats do well but have a tendency to lodge. Crops on this type are caught by early frost more frequently than on the higher lying soils.

ALKALI.

Scattered throughout the flatter parts of the county are small areas locally known as alkali spots. These are so small that they can not be mapped, but they are easily distinguished by their ashy-gray color when dry. In such areas soluble salts are present in sufficient quantities to cause some injury to crops. Corn and oats generally have a pale, unhealthy color and do not yield well. These areas occur principally as narrow marginal strips around Peat beds and other shallow depressions, and some occur on low knolls in wet regions. Drainage, deep plowing, and the application of manure or straw are the methods suggested for the improvement of this condition.

SUMMARY.

Boone County is located just west of the geographic center of the State of Iowa. It comprises an area of 569 square miles, or 364,160 acres.

The county lies within that part of the State covered by the Wisconsin glaciation. The topography of the greater part ranges from level to gently rolling, and the only areas of strong relief occur along the Des Moines River and some of the larger creeks. The elevation of the greater part of the county ranges from 1,000 to 1,180 feet above sea level.

The county is drained by the Des Moines River and tributary creeks. In many parts of the area the stream channels are poorly defined and the drainage is inadequate.

The population, as reported by the 1920 census, is 29,892, of which 58.3 per cent is classed as rural.

The county is well supplied with transportation facilities and markets. The public roads are nearly all graded and in many places are graveled. A number of consolidated schools have been built. Telephones are in general use, and power lines furnish current for use on the farms of many sections.

The climate is characterized by a wide range in annual temperature, the absolute extremes being −35° F. and 108° F. The mean annual temperature is 46.7° F. The mean rainfall is 32.11 inches and is well distributed over the year. The average growing season is 161 days.

Agriculture is the chief occupation, although some coal mining is done.

The greater part of the land of the county, approximately 95 per cent, is in cultivation. According to the 1920 census there are 2,541 farms in the county, and the average size is 134.1 acres. The value of land ranges from $250 to $400 an acre.

The farm dwellings are well built and the barns large and substantial. Farm machinery is in general use.

The soils of Boone County are derived mainly from glacial drift material which has been changed by weathering and the accumulation of organic matter into soils having a rich black color. Sixteen soil types are mapped. These soils can be arranged into four groups—upland residual soils, terrace soils, first-bottom soils, and soils derived from organic accumulations.

The Carrington loam occupies the largest acreage and is probably the most important soil. It is characterized by dark-brown to black soils and a yellowish-brown subsoil. The type occupies the rolling to strongly rolling uplands, and has good drainage. It is a productive and durable soil, giving good yields of corn and hay.

The more level to undulating prairie land is occupied by soils of the Clarion and Webster series. The Clarion soils, as a rule, occupy positions intermediate between the Carrington and Webster, and differ from the Carrington soils only in that the lower part of the 3-foot section contains considerable lime. The Webster soils have a black color and a high content of organic matter. Natural drainage is not as well established as on the Carrington and Clarion soils. The Webster soils are durable and fertile.

A light-colored type occurs in the wooded areas along the larger streams. The soil is a gray to light grayish brown silt loam underlain by a compact clay loam or clay. The lower subsoil is a more friable clay loam. This type is the Conover silt loam.

The terrace soils have been classed with three series—the Waukesha, O'Neill, and Buckner. The O'Neill soils occupy the high terraces, while the Buckner soils nearly always occur on the lower terraces. The terrace soils are not as productive as the upland types.

The alluvial soils, the Wabash and Sarpy, are of relatively small extent and of little agricultural importance. They support a good growth of grass and are devoted for the most part to pasture. With thorough drainage and protection from overflow they will become valuable general farming soils.

The areas of Peat and Muck are generally small and scattered. They consist of a mass of partly decomposed vegetation. With drainage and cultivation these areas become productive lands.

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