SOIL SURVEY OF ADAIR COUNTY, IOWA.

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DESCRIPTION OF THE AREA.

Adair County is situated in southwestern Iowa, in the third tier of counties north from the Missouri line and in the third tier east from the Nebraska line. The county seat is approximately 50 miles southwest of Des Moines. The county is nearly square, having a length and breadth of about 24 miles, and contains 573 square miles or 366,720 acres.

Adair County is situated on the watershed separating the tributaries of the Missouri from those of the Des Moines River. This divide enters the county near the northwest corner, in the vicinity of Adair, and extends southeasterly nearly to the center of the county, where it bears eastward between the Middle and Grand Rivers, continuing into Madison County. A branch of this divide extends southward through Greenfield and Orient into Union County. A number of smaller ridges branch from these main divides. The southwestern part, the southeastern part, and the eastern part south of Middle River have the more broken topography.

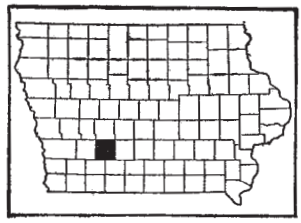

FIG. 31.—Sketch map showing location of the Adair County area, Iowa.

Northeast of Middle River the country slopes gradually upward, and most of this part of the area has a relatively smooth surface. Throughout the county the contours of the hills are rounded rather than angular. In most places the surface slopes gradually upward, grading imperceptibly into the ridges, though along the south sides of eastward and westward flowing streams it is generally steeper and in places somewhat abrupt and broken. Practically all the streams are bordered by bottoms, usually proportionate to the size of the stream. Fragmentary second bottoms occur in places, mainly along Middle River.

The highest elevations in the county, as well as among the highest in the State, are in the vicinity of Adair, which stands at 1,415 feet.[1] Casey, a railway station near the Middle River bottom, is 1,228 feet, and Stuart 1,207 feet above sea level. The elevation at Greenfield

[1] Dictionary of Altitudes. Gannett, U. S. Geological Survey, 1906.

is 1,368 feet and that at Orient 1,344 feet. Fontanelle lies at 1,244 feet, and Bridgewater, just above the bottom of Middle Nodaway River, has an elevation of 1,188 feet.

The direction of flow of the streams conforms to the general southeasterly and southerly slope of the surface. Northeast of the main divide the principal stream is Middle River, which rises in Guthrie County and flows southeast, and, with North River, a little northeast, finally enters the Des Moines River. The entire southwestern part and most of the western part of the county, constituting over half of the area, are drained by the southerly flowing branches of the Nodaway River. The Nodaway, with the southeasterly flowing Grand River and its branches in the southeastern part, and a few minor branches of East Nishnabotna River, in the northwestern part of the county, are tributaries of the Missouri.

Throughout the county the branching tributaries of these streams reach practically all its parts. A few flatter sections in the northeastern part, occupied by Grundy silt loam, have slightly deficient drainage. No lakes, ponds, or marshes worthy of mention exist. The streams generally have their courses worn down well toward their grade level in the glacial drift, and have a moderate and uniform rate of flow, though Middle River, which has cut into a rocky bed in many parts of its course in the county, has a somewhat more swift current.

Here, in the past, water power has been developed for small mills, though at present little or none is utilized.

Adair County, originally a part of Des Moines County, was formed by act of the legislature in 1851. The first settler arrived in 1849, locating in section 4 of Washington Township, and was soon followed by an increasing number of immigrants. The greater proportion of the inhabitants is native-born American, having come from the more eastern States. There is a small number of people of German and of Scandinavian origin. The population is quite evenly distributed over the county. According to the State census of 1915, the county has a population of 14,736, all of which is classed as rural. The 1920 census makes the number 14,277, in the preliminary announcement.

Greenfield, with a population in 1920 of 1,707, is the largest town within the county. Orient, Fontanelle, and Bridgewater, with populations of 500, 869, and 343, respectively, are the principal towns in the southern part. Adair, with a population of 952, is located in the northwestern part, and Casey and Stuart, situated farther east on the county line, but each mostly in Guthrie County, have populations of 908 and 1,658, respectively. These are post offices and shipping points. A few crossroads places do some business.

The southern part of the county is served by the Cumberland Branch of the Chicago, Burlington & Quincy Railway, which connects with the main line at Creston, 21 miles from Greenfield. The main line of the Chicago, Rock Island & Pacific Railway, between Chicago and Colorado, extends along the northern boundary, alternately in Guthrie and Adair Counties. Most of the country wagon roads are kept in good condition, usually being dragged after rains. Telephones and rural mail service reach all parts of the county.

Some miscellaneous produce is marketed at the several towns within the county. Most of the live stock is now shipped to St. Joseph, Mo., and some to Chicago. Grain is shipped to Chicago, St. Joseph, or Omaha. From Greenfield the distance to Chicago is 414 miles; to St. Joseph, 125 miles; and to Omaha, 124 miles.

CLIMATE.

The climate of Adair County is characterized by warm summers and moderately cold winters. Extremes in temperature are not usually sufficiently protracted to injure crops and live stock seriously.

According to the recorded temperatures, there is a range from a summer maximum of 107° F. to a winter minimum of −34° F. Periods approaching these extremes are rare, and are usually of short duration.

The average annual rainfall of 33.04 inches is ordinarily well distributed during the year and is sufficient to give normal crop yields. The heaviest precipitation occurs during May, June, and July. An average snowfall of 29 inches usually gives good protection to grass and winter grain.

The average date of the last killing frost in the spring is April 29 and of the first in the fall October 11, which allows a safe growing season of 165 days. A killing frost is recorded in spring as late as May 27 and as early in the fall as September 18. Farm work often begins by the middle of March, and in the fall, plowing and late gathering of crops frequently can be done until the early part of December.

The accompanying table gives the normal monthly, seasonal, and annual temperature and precipitation as recorded at the Weather Bureau station at Greenfield, situated at an elevation of 1,368 feet above sea level.

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

Month.	Temperature.			Precipitation.			Snow, average depth.
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1894).	Total amount for the wettest year (1902).	
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	25.0	63	−22	1.18	0.88	1.98	6.7
January	19.2	64	−34	.90	.91	.91	6.4
February	21.5	69	−33	1.14	1.03	.38	7.9
Winter	21.9	69	−34	3.22	2.82	3.27	21.0
March	34.5	88	−11	1.98	1.45	1.54	5.0
April	49.8	93	12	3.12	2.73	1.23	1.0
May	61.3	97	23	4.90	1.01	6.76	T.
Spring	48.5	97	−11	10.00	5.19	9.53	6.0
June	70.2	100	38	4.93	2.94	6.27	.....
July	74.6	107	43	4.08	.57	10.87	.....
August	73.3	105	37	3.80	.53	5.77	.....
Summer	72.3	107	37	12.81	4.04	22.91	.....
September	63.7	104	22	3.39	5.11	6.30	T.
October	51.6	92	10	2.48	2.10	2.91	.5
November	36.1	78	− 9	1.14	.53	1.46	1.5
Fall	50.4	104	− 9	7.01	7.74	10.67	2.0
Year	48.3	107	−34	33.04	19.79	46.38	29.0

AGRICULTURE.

Farming has been the predominant industry in Adair County since the first settlements, which began in 1849. During the early days of settlement the residents fenced off their lands as they were broken from the virgin condition, cattle and other live stock being herded on the open range, often by contract. With the increase of population the country was gradually fenced off, and after the late seventies or early eighties the open ranges were largely taken up. Flax, a crop not now raised, was frequently grown for a year or two on freshly broken land. Flax production was practically discontinued during the decade following 1900.

The raising of live stock, combined with production of the general field crops, the type of agriculture first engaged in, has gradually increased in importance. Its basis is the raising of live stock, principally beef cattle and hogs, and to a less extent sheep, horses, and mules, the various field crops being utilized to a large extent to support the animal industries, though some grain, especially corn and wheat, is marketed. Oats, rye, barley, sorghum, millet,

sudan grass, timothy, and clover, and rarely alfalfa, include practically all the animal-subsistence crops.

Corn is the leading crop both in point of acreage and relative importance. The 1910 census returns, covering the crop year of 1909, give a total acreage of 98,366, yielding 3,273,972 bushels, an average of 33.3 bushels per acre. In 1879 there was an acreage of 80,008, yielding 3,151,003 bushels, or an average of 39.3 bushels per acre, and in 1899, 112,723 acres yielded 4,798,250 bushels, or an average of 42.5 bushels. It would seem from these figures and from the present testimony of farmers that with more thought and care in farming yields of corn have increased, but seasonal conditions may have been in part the cause of the greater yields in the later years. Both yellow and white dent varieties are grown. Reid's Yellow Dent is the prevailing yellow variety, and of the white sorts Silver Mine, Johnson County White, and Boone County White. Some corn is grown for silage, which has come to have its proper place in stock feeding.

Oats rank next to corn in importance. For 1909 the census reports an acreage of 30,406, yielding 674,472 bushels, while in 1899, 46,618 acres yielded 1,434,970 bushels. Oats are fed largely to work stock, but to some extent to other animals. Seldom is there a surplus for market. Of the several varieties, Iowa 103 and Iowa 105 are the more commonly grown. Some farmers prefer the Kherson.

Owing to recent war demands more wheat has been grown the last year (1918–19) than formerly. Ordinarily wheat is not considered a profitable crop. In 1909 the census reports an acreage of 3,624, which yielded 38,893 bushels, or an average of 10.7 bushels an acre. Wheat is mainly a cash crop, being shipped to Chicago, St. Joseph, or Kansas City markets.

Barley is grown on many farms and ranks next to wheat in acreage and importance. According to the 1909 census the acreage was 5,697, which yielded 80,836 bushels, while in 1899, 575 acres yielded 15,760 bushels. Barley is primarily an animal-subsistence crop.

Rye, emmer, and buckwheat are grain crops occasionally grown. The 1910 census gives the total value of the cereals in 1909 as $1,923,311.

In the same year there were 52,041 acres in cultivated grasses, yielding 72,604 tons of hay. Of this area 15,681 acres in timothy alone produced a yield of 32,208 tons; 913 acres of clover alone produced 1,303 tons; and 35,004 acres of mixed timothy and clover produced 48,365 tons. There was a small acreage of alfalfa and millet, or Hungarian grass. Wild prairie grasses were cut on 3,869 acres, giving 6,515 tons of hay. Practically all the hay and forage is fed on the farms of the county. In 1909 these products had a gross value of $712,405.

Potatoes are a minor subsistence crop grown in small patches on most farms, the production usually meeting the farm home needs. The demand for potatoes in the small towns is largely supplied by shipments from outside the county. In 1909, 1,289 acres of potatoes were grown, yielding 98,520 bushels.

Many farmers grow small amounts of sorghum, both for the sirup and for forage. In 1909 this crop occupied 6,225 acres, from which 250,205 gallons of sirup were made. In the same year 1,051 acres were devoted to sugar beets.

Apple orchards, established on practically every farm, are maintained primarily to supply the home with fruit, though a small surplus is sometimes sold. Rarely is much attention given to the care of orchards, though some farmers prune and spray their trees with good results. In 1909, according to the 1910 census, there were 69,759 apple trees in the county, producing 64,630 bushels of fruit of all grades. There are also some peach, plum, and cherry trees on the farms and various berry fruits are planted to supply home needs. The value of fruits and nuts produced in 1909 was $43,642

Cattle are practically all of the beef type. Of the various breeds the Shorthorn seems to be preferred, with the Hereford nearly or quite as popular. There are some Aberdeen-Angus. Few herds are purebred, though most breeders use purebred sires. A very few grade Jerseys and Holsteins are in the county. Most of the cattle are raised in the county, but feeders are sometimes shipped in for finishing. Herds range in size from about 25 to 30 on an average 160-acre farm to 100 or more on larger tracts of land.

Of the swine, the Poland-China breed predominates, followed by the Duroc-Jersey and the Chester White. Many hogs are purebred or very good grades. Practically every farmer raises and fattens hogs in connection with his corn and forage crops. The average farmer usually has 10 to 15 brood sows and turns off from 50 to 60 pigs a year.

Sheep are raised more generally in the southeastern and western than in other parts of the county. The Shropshire is the predominating breed. Wool to the value of $12,595 was sold in 1909.

Poultry, consisting of chickens and often of geese, ducks, and turkeys, is raised on all farms. Poultry products are disposed of in local markets. In 1909 the value of such products was $328,060.

The draft horses are of medium weight, very few of the heavier weights being kept. Most of these are grade Percherons. A few farmers make a specialty of breeding horses, and almost all raise a few colts or mules each year. At present more attention is given the raising of mules, as they are in somewhat greater demand. Locally horses predominate as work stock.

No definite figures as to the present (1919) number of the different classes of livestock in the county are available. According to the

1910 census, in 1909 the value of livestock sold or slaughtered was $2,434,444. This included 1,553 calves, 28,610 other cattle, 68,328 hogs, 4,861 sheep and goats, and 2,338 horses and mules.

Dairying is an incidental farm industry throughout the county. Most farmers have some milk cows, chiefly Shorthorns, which produce milk in the summer and fall months. The cream is separated on the farm and sold to creameries. A creamery at Greenfield receives most of the cream from the interior of the county, and one at Adair and one at Menlo, Guthrie County, draw their supplies from the northern part. From the Greenfield creamery, which is cooperative, most of the butter is shipped to New York, but some is sold to local consumers. A few dairies supply whole milk to residents of the several towns. The value of dairy products, excluding home use, for 1909 is reported by the census as $274,356.

As a rule farmers recognize only the more apparent and general adaptations of soils to crops. The smoother parts of the uplands are held more regularly in cultivation, while the more broken locations, mostly of the Shelby loam, are kept in permanent pasture. The bottom lands composed of Wabash soils are recognized as excellent for corn when sufficiently drained and free from overflow, but not so well suited for small grains as are the upland soils.

Land to be cropped to corn may be plowed in the fall if time is then available, but much of it is not broken until spring. Prior to plowing, the soil may be disked, especially if corn stalks of a previous crop remain. Good uniform seed beds are generally prepared by disking or harrowing. Corn is planted during the first two weeks of May with check-row planters. At least three or four cultivations follow before the crop is laid by. The matured ears are snapped from the standing stalks and hauled to the storage cribs. Some corn is cut with harvesters if designed for silage, or it may be shocked if the fodder is desired for winter feeding.

In the preparation for small grains, land sometimes is disked and not turned if the field is clean of stalks, weeds, or other vegetable matter, but most farmers prefer plowing to disking. Grain drills are generally used in seeding. Oats may be sown the latter part of March if the season is favorable, but more often seeding takes place during the first half of April. The sowing of barley usually follows that of oats. Winter wheat is usually put in during the latter part of September, and spring wheat about the same time as oats.

Timothy may be sown in the fall with winter grain, but often not until spring. Clover, usually the red variety, is sown in the spring with oats or wheat some time before the soil is entirely settled after the winter freezing.

Most of the thrashing is done in the field, the grain being hauled from the shock to the machine. When time permits the grain is sometimes stacked. Hay is stored in barns as far as room is available,

but considerable quantities are stacked, either in the field or near the barn.

Farm buildings generally are well constructed and adapted for their purpose. The barns are of moderate size and are rarely provided with basements, which are common in a dairy-farming country. Silos, largely of the stave type, with some of hollow tile, are quite common. The buildings also include corncribs and usually tool sheds. Modern machinery well adapted for conducting the various farm operations is used. This includes sulky and gang plows, disk and smoothing harrows, manure spreaders, corn planters, riding cultivators, corn harvesters, grain drills, grain binders, and haying machines, consisting of mowers, both dump and side-delivery rakes, tedders, loaders, and stackers. A few corn elevators are in use.

Fences are largely of barbed wire, and where hogs are confined have woven-wire bases. The posts usually are of wood, but some of angle iron and of cement are used.

Heavy farm work, such as plowing and harrowing, is done largely with three to five horse teams. Tractors are coming into more general use. According to the census 75.2 per cent of the total average value of the farms is in land; 10.5 per cent in buildings; 2.2 per cent in implements; and 12.1 per cent in domestic animals.

No well-defined crop rotation is generally followed. The determination of the crop for a certain field may depend on general expediency rather than on any definitely worked-out plan. Corn may be grown on the same land several years in succession, and when fertilized often maintains satisfactory yields. Oats generally follow corn, and wheat, rye, or barley follow oats, after which clover and timothy may occupy the land for two or three years.

Stable and barnyard manure, the principal fertilizer, is generally conserved and applied advantageously with spreaders. No commercial fertilizer is used, though in the past small amounts have been used experimentally.

The supply of competent farm labor is inadequate. To a large extent farming operations are performed by the farmer and his family. The monthly wages for single men is about $50, with board and lodging. Married men are paid from $50 to $60, and furnished a house, garden lot, and milk or use of a cow. Men for corn harvesting are paid 8 cents a bushel when the corn is shoveled into the crib and 7 cents a bushel when an elevator is used. In 1909, on 1,031 farms reporting, the average expenditure for hired labor was $175.55.

The size of farms ranges from 80 acres to about 200 acres. A few larger holdings occur in the rougher country. In 1910 the average size of farms was 160.2 acres, of which 94.4 per cent was improved. According to the census figures the average size has gradually increased during the three decades from 1880 to 1910.

In 1909, according to the census, 58.3 per cent of the farms were operated by owners and 40.8 per cent by tenants. Most tenants pay a cash rent, averaging at present about $8 an acre, with some productive and well-located land commanding as much as $12 an acre. The share system is also common. Ordinarily the landowner furnishes half the seed and the tenant half the seed, the farming tools, and work stock, each receiving half the crops. Both tenant and landlord may have interest in the live stock.

Prices of land have rapidly advanced during the last few years, and during the decade 1900–1910 an increase of over 168 per cent was made, the average assessed value in the latter year being $80.91 an acre. Present prices indicate an even greater advance since 1910. Well located and improved land such as the Tama silt loam now (1919) sells for $250 to $400, averaging not far from $300 an acre. In the more rolling sections, less well adapted for cultivation, as in parts of the Shelby loam and the Wabash soils, the prices range from about $150 to $250 an acre.

SOILS.

On the basis of origin of the soil material the soils of Adair County may be classified in three divisions—glacial, loessial, and alluvial. The soil material, which was accumulated by glacial processes, is of heterogeneous character, having been gathered by the glacier from various places, thoroughly mixed, and dropped where it now lies upon the final recession of the ice sheet. Large fragments of rocks are rare, though a few small granite bowlders occur in the eastern part of the county. The glacial mantle has an estimated thickness of 200 feet, and only in a few places, mostly along the right bank of Middle River, is the underlying rock exposed. The other stream valleys which have been cut 150 feet below the general level of the upland do not expose the Paleozoic rock beds.

The exposed rock is limestone, belonging to the Upper Coal Measures, which presumably underlie the drift of the rest of the county, unless the border of the Nishnabotna sandstone may intervene in places.[2] These underlying formations have little or no influence on the soils of the county.

Overlying the glacial deposits there is a mantle of silty material. This is believed by some to be a wind deposit; by others it is considered as nothing more than the upper thoroughly weathered surface of the glacial drift mantle. Originally this doubtless was continuous over the county, but the long-continued action of drainage waters has washed much of it from the slopes, and in places has cut more or less deeply into the underlying glacial drift. This material gives rise to much of the soil of the county. In this report the term loess is used to describe this material, but such use is not based on an opinion

[2] Report on Geological Survey of State of Iowa, Vol. I.

of the Bureau of Soils that it is loess. No attempt has been made to determine its origin.

The materials carried down by drainage waters and deposited in bands along the stream courses give rise to the alluvial soils of the county. Along some of the streams, principally along Middle River, remnants of earlier flood plains, left in the further cutting down of the valleys, now exist as second bottoms or terraces.

The materials described and the conditions under which they have accumulated form the basis for classifying the soils of the county. Soils similar in origin, color, character of subsoil, topography, and drainage are classed into series, the members of which, designated as types, differ solely in texture. The upland soils, mostly prairie, of loessial origin, are grouped in the Tama, Clinton, and Grundy series; those derived principally from glacial materials are classified in the Shelby and Lindley series, and those of alluvial origin on the second bottoms in the Judson series, and in the first bottoms in the Wabash series.

The types of the Tama series have dark-brown to black surface soils and light-brown to yellow subsoils. The texture of the subsoil is silty and slightly heavier than the soil, but the structure is loose and friable. The topography varies from gently to sharply rolling. The series is derived from loess where weathering has not reached an advanced stage. In Adair County the Tama silt loam and shallow phase of the type have been mapped.

The Clinton series includes types characterized by gray or dark-gray surface soils and by a light-brown or yellowish-brown, compact, subsoil. The subsoil is not highly calcareous. The series is derived by weathering from loess and is typically developed north of Missouri in the loess belt on the eastern bank of the Mississippi. The topography is rolling to broken and drainage is well established. The Clinton silt loam is recognized in Adair County.

The types of the Grundy series have surface soils ranging from brown to black. The lower part of the soil typically is lighter in color than the upper part, giving a suggestion of a gray subsurface layer. The upper subsoil is mottled, heavy, and rather plastic when wet and hard when dry, the mottling consisting of dark drab and yellowish brown. This passes gradually into a layer of somewhat lighter color and texture. The topography is gently rolling. The Grundy soils come from silty material overlying the Kansas drift in Missouri, Kansas, Nebraska, and Iowa. The silt loam of the series is mapped in Adair County.

The surface soils of the types included in the Shelby series are dark brown to almost black in color and normally shallow. The subsoil is composed of yellow, reddish-brown, or brown sticky sandy clay containing in places coarse sand and gravel. Lime concretions and streaks of calcareous material occur in the lower subsoil. As a rule

the subsoil becomes more clayey and compact with increase in depth. The type is derived from the sandy Kansas drift. The topography is for the most part gently to sharply rolling, as the series occurs on slopes where the sandy drift is exposed by erosion. The Shelby loam is mapped in Adair County.

The types of the Lindley series normally have yellowish-brown surface soils, but the color ranges from gray on the one hand to brown on the other. The soil is usually shallow, the dark silt layer being rarely more than 8 inches deep. The subsoil is yellowish to yellowish brown, or in rare cases reddish brown, free from mottlings or only faintly mottled with gray. It is heavier than the soil, though containing in most places a considerable percentage of sand and gravel. Iron concretions are always present in the lower subsoil. The topography of these soils is rather rough, the series occurring where erosion has exposed the Kansas drift, from which most of the soil material comes. The Lindley occupies the same relative topographic position as the Shelby series and has similar sandy and gravelly subsoils. It differs from it in the lighter color of the surface soil. Only the loam of the series is mapped in the present survey.

The Judson series includes types of alluvial and colluvial origin. The surface soils are dark brown to almost black and the subsoils lighter brown. Neither soil nor subsoil is highly calcareous. These soils lie on terraces above overflow and on colluvial slopes at the foot of bluffs. The soil material is mainly wash from loess or silty drift soils. The Judson silt loam is the only type of the series mapped in Adair County.

The Wabash series includes soils of dark-brown to black color with high organic matter content, and dark-drab to gray heavy subsoils. Both soil and subsoil have a low lime content. The series is typically developed in the first bottoms of streams in the Central Prairie States, the material being derived principally from the loessial and silty glacial soils of this region. They are subject to overflow, but natural drainage is well established in some areas. Two types, the loam and clay loam, are identified in Adair County.

The following table gives the names and actual and relative extent of the several types of soil occurring in Adair County:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Tama silt loam	136,832	50.4	Lindley loam	5,632	1.5
Shallow phase	47,872		Clinton silt loam	2,432	0.7
Shelby loam	133,312	36.4	Judson silt loam	1,984	0.5
Wabash loam	30,976	8.4	Grundy silt loam	1,664	0.5
Wabash clay loam	6,016	1.6			
			Total	366,720	

TAMA SILT LOAM.

The surface soil of the Tama silt loam is a dark-brown to nearly black heavy silt loam to silty clay loam 12 to 20 inches deep, with an average depth of about 16 inches. The soil has an ample supply of organic matter and has a compact but friable structure. The lower surface soil grades downward through about 3 inches into a light-brown to light yellowish brown more compact but friable silt loam or silty clay loam, which at about 24 to 30 inches usually becomes lighter colored and frequently contains gray, yellowish, or brownish mottlings. At this depth, too, the structure becomes a little more sticky and less friable. No stones or gravel are present within the 3-foot section. Litmus paper tests show both soil and subsoil to be more or less acid.

Areas of this soil are rather evenly distributed throughout the county. They occupy divides and prominent ridges, and with the shallow phase border on the bands of Shelby loam in most places lying along the numerous streams. The topography varies from nearly level or undulating to somewhat rolling. This soil has the highest elevations in the county.

Good drainage prevails in both soil and subsoil, except in some of the shallow depressions, as at the heads of draws, and in a few of the flatter areas. Some of the small swales have been tile drained. A high content of organic matter makes the soil retentive of moisture and with careful tillage an ample supply is reserved for the use of crops.

Practically all of the type is improved and used regularly for cultivated crops. Comparatively little of it is ordinarily pastured, as pasture lands are available in the more rolling types and in the stream bottoms which are included in most farms having this soil. It is an excellent soil for corn, which crop is of first importance. Oats, wheat, barley, and other crops follow. The raising of hogs in connection with the corn crop is a widely developed industry.

Corn yields from 30 to upwards of 70 bushels per acre, depending on the condition of the soil, the season, and the methods of tillage. The average yield is around 40 to 45 bushels in normal years. Oats do well, yielding from 40 to 60 bushels per acre; winter wheat, from 15 to 30 bushels; spring wheat, from 8 to 15 or 20 bushels; and barley, from 20 to 35 bushels per acre. Timothy, while not extensively grown, is considered a profitable crop, yielding from 1 to 1½ tons of hay per acre. Occasionally timothy seed is gathered. Other forage crops, including sorghum, Sudan grass, and alfalfa, are sometimes grown.

No well-defined crop rotations are followed. Frequently corn is grown on the same land for several years in succession. More often there is some alternation with small grain crops, especially oats and wheat, after which the land may be seeded to clover and timothy. Less attention is given rotation on the rented lands than on owner-operated farms. Plowing and preparation of the seed bed is usually

thoroughly done. Commercial fertilizer and green manures are rarely used, but barnyard manure is saved and applied to the fields. Manure spreaders are in general use.

Farms with good buildings and other improvements ordinarily bring from $250 to $300 an acre, and a few holdings have brought $400 the present season (1919). In the last year or two values have increased $75 to $100 an acre.

Tama silt loam, shallow phase.—The Tama silt loam, shallow phase, consists of 6 to 12 inches of grayish-brown to dark-brown silt loam or silty clay loam resting on a light-brown or dull-yellowish moderately friable silty clay loam, in many places mottled with gray and brown. Lighter color and more pronounced mottlings, with less friable structure, usually characterizes the lower part of the 3-foot section. A variation of this phase occurs in the SW. ¼ of section 29, Washington Township, where the soil is underlain by a stiff plastic subsoil of light-brown color, mottled with gray, yellow, and brown. Owing to its situation in sloping and rolling areas, the shallow phase shows other variations. On the lower parts of slopes the soil in narrow and irregular strips in many places is apparently of colluvial origin and may have the depth and other characteristics of the typical silt loam, while farther up on the slopes the surface may have been eroded to such an extent that the underlying glacial material is exposed, giving small patches of the Shelby loam. Here and there conditions are so variable that it is difficult to determine whether certain areas should be shown on the map as Tama silt loam, shallow phase, or Shelby loam.

This phase occurs in numerous detached areas bordering areas of the typical soil and of Shelby loam. It occurs around the heads of draws and on slopes along stream courses, especially the slopes of southern exposure. In position it is lower than the typical soil but in most cases lies higher than neighboring areas of Shelby loam. The surface is more or less rolling or sloping. Drainage is usually good, but is deficient in some depressions and small swales along the minor streams.

A large part of this phase is cultivated with the typical soil. Owing to the rolling topography and tendency to surface washing, more of it is used for pasture. Where not badly eroded, crop yields are about the same as on the typical soil, but the average yields are somewhat less.

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

Mechanical analyses of Tama 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.*
333101, 333103.....	Soil.....	0.3	0.5	0.2	1.3	12.5	59.1	26.4
333102, 333104.....	Subsoil....	.0	.4	.3	1.3	13.5	56.6	28.3

CLINTON SILT LOAM.

The surface soil of the Clinton silt loam consists of about 8 inches of dark grayish brown or grayish-brown friable silt loam. This changes quickly below into a compact though friable light-brown silty clay loam, which at about 24 to 28 inches becomes lighter in color and less friable in structure. Mottlings of various shades of brown and gray appear, which become more pronounced as the material becomes more dense and impervious with increase in depth. Accompanying the mottling are black concretionary substances.

The Clinton silt loam is of small extent. It occurs entirely in the eastern part of the county, mostly in the eastern parts of Harrison and Grand River Townships, where it is a continuation of areas of this soil in Madison County. It occupies the ridges and most of the slopes, though some areas of Lindley loam or Shelby loam are associated with it.

The topography varies from undulating to rolling and is in a few cases sharply rolling. Drainage is well established.

The greater part of this type is in improved farms, but many of the more rolling areas are in forest. It is said to have been originally more or less occupied with woods. The present species include several kinds of oak, hickory, elm, and box elder.

About the same crops are grown as on the Tama silt loam, corn being the most important. Apparently the Clinton is not so well adapted to corn as is the Tama silt loam, though the yields reported are about the same. Small grains and other crops give fully as good results.

GRUNDY SILT LOAM.

The Grundy silt loam consists of 8 to 15 inches of a dark-brown or nearly black, friable, silt loam, resting on a more compact and less friable silty clay loam, which at about 20 to 24 inches changes into a drab, rather plastic clay loam, more or less mottled with gray and dull brown and containing occasional small, black, iron concretions. At 28 to 30 inches the material usually becomes a compact, plastic, silty clay, mottled bright yellow, drab, and rusty brown, also containing concretions.

Most of this soil is found in the northeastern part of the county, where it occurs in irregular strips and patches in flat ridge-top positions surrounded by Tama silt loam. Some of it extends eastward, continuing into Madison County. A few other areas lie in Orient Township.

The surface in all cases is nearly level, in noticeable contrast with the more rolling topography of the Tama silt loam. Because of this feature and the stiff, impervious subsoil the run-off is slow and drainage is somewhat deficient. In dry seasons the soil has a tendency to crack, especially in untilled fields.

Practically all the areas are improved and cropped regularly. The crops grown and general methods of cultivation are about the same as on the Tama silt loam. In wet seasons yields of crops, especially of corn, are lower than on the latter type. On account of the slow run-off care must be taken in choosing the time for cultivation, or puddling and impairment of the soil structure will ensue.

SHELBY LOAM.

The Shelby loam consists of a surface layer 8 to 12 inches thick, of brown to dark-brown loam or gritty silt loam, grading downward into a loamy sandy clay, in color brown or yellow, mottled with brown, yellow, and gray. Below 20 to 22 inches the color becomes lighter, the mottling more pronounced, and the structure a little more compact and sticky. Black iron concretions and nodules or concretions of lime are common in the subsoil and substratum. Some small rounded gravel of quartzite, granite, and other crystalline rocks are scattered on the surface and in many places mixed with the soil material throughout the 3-foot section. The content of sand is higher in the southeastern part of the county than elsewhere. In road cuts large lumps of calcareous material or streaks of the same substance are seen. Considerable variation occurs in the character of the soil material, especially in the zone of transition between this type and the Tama silt loam and its shallow phase.

The Shelby loam next to the Tama silt loam is the most extensive type in the county. It occurs in nearly all parts, though it forms less of the northeastern part. It occupies a position between the stream bottoms and the areas of Tama silt loam, which normally lie on the ridges or in other elevated positions. It is thus developed partly in strips bordering the slopes of valleys and ravines in their dendritic branching, and in broader and more continuous tracts in the vicinity of the larger streams.

The surface varies from sloping and rolling to somewhat hilly. Areas along the south side of eastward or westward flowing streams are steeper and more broken than areas on the slopes descending from the north.

In general, drainage is good, owing to the sloping and rolling topography. In some of the depressions along small streams there are sometimes narrow swales and seepy places. Some erosion is going on and gullies form easily where care in handling the soil is not exercised.

Probably less than half of the Shelby loam is regularly cultivated. The rest is set aside for pasture or to some extent for hay land. Almost all the type is said to have been originally covered with trees and brush, and some of the steeper and more broken areas still have a somewhat scrubby growth of white, black, and bur oak, with some

hickory, elm, and hazel brush. In the fields sand bur is a common plant.

Of the crops grown, corn is easily first, followed by oats and wheat. Occasional crops of barley and rye are produced. Some millet, Sudan grass, and sorghum, and in a few cases alfalfa are raised. When the soil is in good tilth and the season favorable, good stands of clover and timothy are easily obtained. Good pastures, largely bluegrass, exist on this soil, and it supports large numbers of cattle, horses, mules, and sheep, and also hogs during the grazing season.

Corn is reported to yield from 25 to 60 bushels per acre, depending on the condition of the soil, methods of handling the growing crop, and the season. Oats yield from 20 to 40 or 50 bushels, averaging around 35 bushels; wheat 15 to 25 bushels and barley 20 to 30 bushels per acre. Timothy and clover produce 1 to 2 tons and wild grasses from one-half to 1 ton of hay per acre.

Reasonably efficient farming methods are followed, especially in the matter of plowing and other preparation for crops. Some fall plowing is done, but on the steeper lands this is considered undesirable on account of washing during winter and spring rains. Well-planned crop rotations are not generally followed, though some attention is given to alternating the different crops. Fertilization is confined to applications of stable manure, which is generally applied with a spreader.

In the smoother and more accessible sections land and buildings are maintained in good condition, but in some of the rougher areas more distantly located from towns the improvements are poorer. Farms composed of the Shelby loam are valued at present (1919) at $175 to $275 or $300 an acre, the price varying with the improvements, desirability of location, and topography.

The most vital problem connected with the handling of this soil is that of erosion. Unless skillfully tilled the steeper slopes often wash badly, and gullies once started are difficult to control. Recourse is frequently had to filling the erosions with brush, and in a few cases concrete dams are placed at suitable intervals across them. Where slopes of more than moderate gradient are cultivated, short rotations should be adopted, and if possible a cover crop, such as rye or oats, should be sown to reduce winter erosion. The best use for the steeper and more broken areas is permanent pasture.

LINDLEY LOAM.

The surface soil of the Lindley loam consists of 6 to 7 inches of grayish to yellowish-brown loam or silty loam. This is underlain by a moderately friable yellowish-brown silty loam, which at about 24 inches normally contains noticeable amounts of fine and very fine sand and shows mottlings of gray and rusty brown, which become

more pronounced with increase in depth. Below 30 inches material in places is mottled with reddish brown and is compact and sticky. Small rounded gravel are common on the surface and throughout the soil section.

This soil type has a small extent. It is developed in the vicinity of Arborhill and farther southeast to the county line. Another area lies southeast of Bridgewater in Washington Township.

The surface is prevailingly rolling to broken, and comparatively little of it is suitable for cultivation. The more rolling places are dissected by small streams and ravines, and here the surface is much eroded. Owing to the rolling surface the drainage is good.

Most of the type is used for pasturing various kinds of live stock, for which purpose it is best adapted. A few tracts are used with fair success in the production of the general farm crops. Much of the land is forested, chiefly with species of oak, hickory, elm, and hazel brush. The type has about the same value as the Shelby loam, to which it is closely related.

JUDSON SILT LOAM.

The surface soil of the Judson silt loam consists of 10 to 14 inches of dark-brown to dark grayish brown friable silt loam. This grades downward through 2 or 3 inches into a somewhat heavier light-brown but friable silt loam or silty clay loam, which at about 22 or 24 inches becomes a more compact and a little less friable silty clay loam. In many of the depressions and lower lying situations, slight mottlings of gray and brown are noticed in the lower part of the 3-foot section, but in the more elevated and well-drained locations mottling is normally absent. The surface soil is well supplied with organic matter. A few of the smaller areas, as in the east half of section 27 of Harrison Township and in section 9 of Washington Township, have a light-brown to grayish-brown surface soil.

The Judson silt loam is developed in Adair County principally along Middle River, where it occurs as fragmentary second bottoms located in the larger bends of the stream. A few areas occur along the Middle Nodaway River.

Most of the surface is nearly level or very slightly undulating. In some cases there is a fairly well-defined line of division between the terrace and the adjoining upland, but in others the terrace grades upward over a belt one-fourth mile or more wide into the uplands, and in such cases it may be difficult to determine the boundary between this and the upland soils. The terrace level ranges from 8 to 20 feet above that of the adjoining first bottom, the boundary line here being more distinct than the upland boundary. The Judson silt loam is an easy soil to till and the nearly level surface renders washing a negligible factor. Except in a few sags and depressions the drainage is good. The underdrainage in a few places has been improved by tile drains.

Practically all the areas form parts of well-improved farms, on which the crops and general methods are about the same as those on the near-by uplands. Small parts, usually in connection with the Wabash soils of the first bottoms, are kept in permanent pasture. The Judson silt loam is an excellent corn soil, and small grains and various other crops give fully as satisfactory returns as on the better parts of the Tama silt loam.

WABASH LOAM.

The surface soil of the Wabash loam is a dark-brown friable loam of silty texture, 8 to 12 or more inches deep. It is underlain by a grayish-black, dark slate colored, or nearly black heavy loam or silty clay loam, which in well-drained areas may continue to a depth of at least 3 feet. In many places at 24 or 30 inches there are faint mottlings of brown, and these become more noticeable with increase in depth. In places there is no appreciable difference between the soil and the subsoil, except that the latter becomes gradually more dense and plastic. Some borings show a stratum of dense plastic clay in the upper subsoil and streaks or pockets of sandy material may occur in any part of the 3-foot section.

The soil material in some of the narrower bottoms along lateral streams has less uniformity in both color and texture. Most of these bottoms evidently are receiving varying amounts of fresh soil material washed from near-by slopes. They have a surface soil of brown or grayish-brown gritty loam or heavy sandy loam, which at any depth between 4 and 12 inches rests on a dark-brown to black loam or silt loam, which appears to have been the surface soil before erosion and wash was increased by cultivation on the adjoining slopes. The soil near the stream channels usually is lighter both in texture and in color than the soil farther back.

The Wabash loam is found throughout the county, occupying the bottoms of nearly all the smaller streams and most of the larger ones. The coarser materials have been deposited where the stream currents have been moderately swift and the heavier where the water has moved slowly.

The surface is nearly level or slightly sloping. In places it is slightly uneven where former courses of the stream have existed, and here and there it slopes gradually upward toward the upland, colluvial deposition emphasizing this feature in narrow valleys. Many of the smaller bottoms are dissected by the meandering streams.

The drainage as a whole is fair. In areas drainage is good, but in others it is deficient, especially in the low swaly parts. Most of the type is subject to periodic overflow, which occurs after nearly every heavy rain.

By far the larger part of the type is reserved for pasture land, the tendency to overflow discouraging any extensive utilization of the

land for tilled crops. Where sufficiently well drained and reasonably exempt from overflow, good success is had with corn and other crops.

Some parts, especially strips along the stream channels, are timbered with elm, willow, cottonwood, walnut, and some oak.

According to the condition of the soil, corn yields from 20 to 70 or 75 bushels, but the average return is around 40 or 50 bushels per acre. Small grains are not quite so satisfactory as on upland soils. Oats will yield anywhere from 30 to 40 bushels and wheat from 15 to 25 bushels per acre. Red clover grows well in well-drained situations, and on more poorly drained areas white clover and bluegrass grow luxuriantly. Some wild grass is cut for hay, yielding from one-half to 1 or more tons per acre.

No well-defined cropping system is followed. Corn may be grown several years in succession, but often is followed by oats or wheat. Fall plowing is practiced whenever possible to give time for proper preparation of the land in the spring. Practically no fertilizers or manures are used.

Seldom does the Wabash loam form more than a small part of any one farm, and with the varying degrees of use values differ considerably. Lands suitable only for pasture may be valued at $100 to $150 an acre, while better drained and better situated lands are valued at $250 to $275 or more an acre.

The principal needs of this soil seem to be improvement of drainage and protection from overflow. The former need may be met most efficiently by installing tile drains, though where conditions would not seem to justify the expense open ditches may prove beneficial. By straightening the stream channels and keeping them clear of driftwood overflows may be reduced to a minimum.

WABASH CLAY LOAM.

The surface soil of the Wabash clay loam consists of 8 to 10 inches of dark-brown to black clay or silty clay loam. The subsoil, into which the soil passes gradually, is nearly black compact clay or silty clay. The subsoil ordinarily continues to a depth of 3 feet or more, without change, but at 24 or 30 inches the color not uncommonly becomes a little lighter and shows faint mottlings of brown or yellowish brown. In places small iron concretions occur in this deeper stratum. When wet the surface soil is sticky, and when dry hard and cracked. Stiff intractable variations are known locally as "gumbo." Bordering stream channels the soil texture is usually lighter than elsewhere, and streaks of fine and very fine sandy material are often encountered at varying depths in the soil section.

The largest area of this type is mapped in the southwestern part of the county along Middle Nodaway River. A few other areas lie in the northeastern part. The surface is nearly level, though in places

abandoned channels cause some unevenness. Fair drainage is established on some of the land, but many slightly lower lying parts are poorly drained.

Like the Wabash loam, most of the type is extensively used as pasture land. It affords good grazing. The parts under cultivation are handled in about the same manner as the tilled areas of Wabash loam. It is best adapted to corn, and this is the principal crop.

SUMMARY.

Adair County is situated in southwestern Iowa. The county, mainly prairie, occupying a part of the drainage divide between the Des Moines and Missouri River systems, has a generally rolling surface, with sharply rolling to broken belts along some of the larger streams. The drainage is carried mainly by Middle River, in the northeastern part, and by branches of Nodaway River in the western and southwestern parts. There is a range of less than 250 feet in elevation, or from about 1,175 feet to about 1,415 feet above sea.

The county was organized in 1851, and was settled largely by people from eastern States; most of them are native-born Americans. In 1915 the population amounted to 14,736. Greenfield, with a population of 1,624, is the county seat and principal town. The railway facilities are good, and the roads generally are kept in good condition.

The mean annual temperature is about 48.3° F., and the mean annual precipitation, 33.04 inches. There is a growing season of about 165 days.

Adair County is essentially a farming section. The agriculture consists of general farming, with the raising of beef cattle and hogs as the most important activity. Corn is the leading grain crop, though oats, wheat, barley, and other grain and forage crops are produced. Crops are grown primarily to support the animal industries, but occasionally some wheat and corn are marketed. Dairying is of secondary importance.

Most of the land is in improved farms. In 1909 according to the census 58.3 per cent of the farms of the county were operated by owners, and most of the remainder by tenants. The price of farm lands ranges from about $150 to $400 an acre. Land prices have advanced greatly in recent years.

The great mass of the soil material is of glacial origin, over parts of which rests a mantle of loess. Erosion has modified the surface and streams have deposited bands of alluvial soil. The soils therefore are derived from three classes of material—loess, glacial drift, and stream-laid deposits.

The loessial soils occupy the more elevated land surfaces and are correlated with the Tama, Clinton, and Grundy series. The glacial

soils occupying the more sloping and rolling situations, from which erosion has removed the loess, are classified in the Shelby and Lindley series. Alluvial soils, representing wash from the upland soils, are grouped in the Judson and Wabash series, the former developed on terraces and the latter in the first bottoms.

The Tama silt loam and a shallow phase of the same type occupying the rolling divides have a dark color and good drainage. This soil forms 50 per cent of the area. It is well adapted to corn, as well as other grain and forage crops.

The Clinton silt loam has a soil of lighter color and a more compact subsoil than has the Tama silt loam. It is of small extent, and confined to the eastern part of the county. It is extensively used for general farming.

The Grundy silt loam, also of small extent, differs from the Tama silt loam mainly in having a more level surface, and a stiff plastic mottled clay subsoil, with somewhat deficient drainage. It is all improved and used for general farming.

The Shelby loam comprises about two-fifths of the county. It occupies the more rolling and rougher country. The smoother parts are successfully used for general farming, while the rougher areas are pastured. The Lindley loam is similar to the Shelby loam, but is of small extent.

The Judson silt loam, found principally along Middle River, is a dark-colored soil, with fair to good drainage. It is well improved and extensively used for general crops.

The Wabash loam and clay loam are dark-colored soils, generally more or less deficient in drainage and subject to overflow. They are naturally productive, and where reasonably free from overflow make excellent corn soils. Most of their area is at present used for pasture.

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