Series 1928 Number 30

UNITED STATES DEPARTMENT OF AGRICULTURE

Soil Survey
of
Crawford County, Iowa

By

T. H. BENTON
Iowa Agricultural Experiment Station, in Charge
and
M. H. LAYTON
United States Department of Agriculture

Bureau of Chemistry and Soils
In cooperation with the Iowa Agricultural Experiment Station

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - - - Price 20 cents

BUREAU OF CHEMISTRY AND SOILS

HENRY C. KNIGHT, *Chief*
A. G. McCALL, *Chief, Soil Investigations*
SYDNEY FRISSELL, *Editor in Chief*

SOIL SURVEY

CURTIS F. MARBUT, *in Charge*
T. D. RICE, *Inspector, District 3*
J. W. McKERICHER, *in Charge Map Drafting*

COOPERATION

IOWA AGRICULTURAL EXPERIMENT STATION

C. F. CURTISS, *Director*
P. E. BROWN, *in Charge Soil Survey*

CONTENTS

	Page
County surveyed	1
Climate	3
Agriculture	4
Soils	10
Marshall silt loam	10
Knox silt loam	17
Carrington loam	18
Waukesha silt loam	19
Judson silt loam	20
Wabash silt loam	21
Wabash silty clay loam	23
Ray silt loam	24
Soils and their interpretation	24
Summary	28

SOIL SURVEY OF CRAWFORD COUNTY, IOWA

By T. H. BENTON, Iowa Agricultural Experiment Station, in Charge, and M. H. LAYTON, United States Department of Agriculture

COUNTY SURVEYED

Crawford County is situated in the western part of Iowa, midway between the northern and southern State boundary lines, in the second tier of counties east of Missouri River which forms the western boundary of the State. (Fig. 1.) Omaha, Nebr., is about 50 miles from the southwestern corner, and Sioux City, Iowa, is about 45 miles from the northwestern corner of Crawford County. The county is rectangular in shape, including five townships east and west and four townships north and south. It includes an area of 715 square miles, or 457,600 acres.

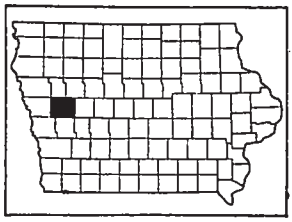


FIGURE 1.—Sketch map showing location of Crawford County, Iowa

The land area of the county, once a comparatively smooth plain but now greatly modified by erosion and stream action, includes two general types of relief, eroded upland plain and flat alluvial land.

The upland plain has been cut by many streams, whose auxiliary branches and intermittent drainage ways penetrate all parts of the county. Erosion by these drainage ways has formed a gently rolling, hilly, or rough region from the once nearly level upland plain. The surface is characterized by rounded ridge tops and smooth gentle slopes leading down to the stream channels. No remnant of the original flat table has entirely escaped erosion. The more hilly and rough areas occur on the stream slopes where erosion has been most severe. The belts of steep land are fully as wide along some of the smaller streams and along their short tributaries as along Boyer River, the largest stream. The most sharply dissected areas are in Boyer and Union Townships, and in parts of Washington, Willow, Denison, Goodrich, and East Boyer Townships, but only a small proportion of the entire land surface in this section is too rough for cultivation.

Gently rolling land and land of more uniform surface relief make up a larger proportion of the area of the eastern part of the county and of small divides around Schleswig in the northern part of the county. Other smaller gently rolling areas are 3 miles southwest of Buckgrove, a ridge top northeast of Deloit, and the wider interstream divides in the vicinity of Charter Oak and Ricketts. The most rapidly eroded and roughest land coincides with the areas mapped as Marshall silt loam, shallow phase.

The land of the county has a sharp general slope toward the southwest. The lowest part of the county is in Boyer River Valley

in the southwestern corner, where the elevation is about 1,092 feet above sea level. The highest points are the interstream divides in the southeastern part, where an elevation of 1,369 feet is reached. Other elevations [1] are Westside, 1,326 feet; Vail, 1,260 feet; Manilla, 1,320 feet; Denison, 1,176 feet; Dow City, 1,132 feet; and Charter Oak, 1,232 feet.

The alluvial lands occur as comparatively narrow strips along the many streams, the widest development being along Boyer River at the point where it leaves the county in the extreme southwestern corner. Here the valley reaches a width of more than 1½ miles. The alluvial lands are mostly first bottoms, probably three-fourths of which are subject to overflow. The lower course of Boyer River has been straightened by an artificial channel which largely eliminates damage from flood waters. The channels of Soldier River in the northwestern corner and Nishnabotna River in the southeastern corner of the county have also been straightened, practically eliminating flood damage by these streams, and artificial drainage channels have been constructed for a short distance back from the larger stream channels on some of the creeks, in order to prevent overflow near the junction of the streams.

Forested areas are very inextensive in Crawford County, occurring only on the steeper stream slopes and along deep ravines. Thinly scattered clumps of trees, most of them along the stream banks, grow in some of the bottom-land pastures. Most of the forested land is in Union, Washington, and Boyer Townships and along Boyer River north of Deloit. Originally there was considerable forest along many of the stream slopes, but most of this has been removed and the land planted to crops.

Crawford County was organized in 1851. The first settlement was made in 1849, 6 miles east of Denison, along East Boyer River Valley.

Agriculture is practically the sole interest in Crawford County, and the entire population is dependent on that industry. Grain elevators, creameries, and cream and poultry buying stations are located in nearly every town.

The 1930 census [2] reports the population of the county as 21,028, of which 17,123 are classed as rural. Of the rural population, 12,027 are classed as farm population and 5,096 as nonfarm population. The population is practically all white and predominantly of German descent, especially in the north-central and central parts of the county. A good many people are of Scandinavian descent and some of Irish.

Denison, the county seat and largest town in the county, has a population of 3,905. It is the principal distributing point for merchandise and for the shipping of farm produce. Manilla, with a population of 1,032, a division point of the Chicago, Milwaukee, St. Paul & Pacific Railroad, is the principal shipping point for the southeastern corner of the county. The population of other towns, all of which are shipping points, are Schleswig 638, Kiron 259, Ricketts 157, Charter Oak 688, Dow City 588, Arion 269, Aspinwall 107, Vail 622, Westside 341, and Deloit 280.

---

[1] GANNETT, H. A DICTIONARY OF ALTITUDES IN THE UNITED STATES. (FOURTH EDITION.) U. S. Geol. Survey Bul. 274, 1072 p. 1906.

[2] Soil survey reports are dated as of the year in which the field work was completed. Later census figures are given when possible.

The county is well supplied with railroad facilities. Main lines of the Illinois Central Railroad and the Chicago & North Western Railway pass through the center of the county. A main line of the Chicago, Milwaukee, St. Paul & Pacific Railroad crosses the southeastern corner, and a branch line runs across the southern part of the county, thence northwestward toward Sioux City. A branch line of the Chicago & North Western also crosses the southeastern corner, and another crosses the northern end of the county. These lines give direct connections to the Chicago, Omaha, and Sioux City markets. Several bus lines operate through the county.

Most of the county roads are of dirt construction. The Lincoln Highway (United States Highway No. 30), which enters the county about midway of the eastern side, follows a southwesterly direction, and leaves near the southwestern corner, is paved along its entire length. State road No. 141, which extends west from Denison through Charter Oak to the county line is also paved. All the county roads are graded and good bridges have been built. Several of the main county roads are graveled.

Rural mail delivery and telephone lines serve all parts of the county. Excellent rural schools are located conveniently to most farms, and a number of consolidated schools serve a large community. Many country churches are scattered over the county in convenient locations.

The greater part of the farm produce, consisting mainly of livestock, is shipped to Omaha, and a smaller part goes to Chicago and Sioux City.

CLIMATE

The climate of Crawford County is similar to that of the midwestern Corn Belt region. The winters are variable, averaging moderately cold. The temperature for the winter months ranges from −40° to 70° F., with a mean temperature of 21.4°. The average annual snowfall is 23.3 inches. Severe winter blizzards are few but are likely to occur at any time, as are also winter thaws. Temporary blocking of roads by snowdrifts occurs after severe storms in some of the rougher areas. The main-traveled roads are well protected by a system of temporary snow fences and are kept open all winter by the State and county highway crews. The summers are warm, with periods of excessive heat and some cold spells, usually of but few days' duration and not protracted enough to cause crop damage. The temperature for the summer ranges from a maximum of 106° to a minimum of 30°, with a mean of 71.3°.

The precipitation is well distributed throughout the growing season, with short periods of dry and droughty weather during harvest, but there is usually sufficient moisture for good crop production. The mean annual precipitation at Denison, 2 miles southeast of the geographical center of the county, is 29.44 inches. Early rains seldom delay planting except on the heavier bottom-land soils. Abnormal seasons, in which maturity is sufficiently delayed to cause soft corn, are rare. Hail sometimes damages the crops but usually occurs in narrow strips from 1 to 2 miles wide and from 4 to 6 miles long, thus localizing the damage done.

The latest killing frost on record occurred on June 4 and the earliest on September 12. The average date of the latest frost is

May 9 and of the earliest is October 2, giving an average frost-free season of 146 days, which is sufficient to mature all field crops common to this region. Spring work usually starts about the middle of March, and fall plowing continues as late as December 15 in some years. The grazing season ranges from 5½ to 7½ months, averaging about 6 months.

Table 1, compiled from the records of the United States Weather Bureau station at Denison, gives the normal monthly, seasonal, and annual temperature and precipitation for Crawford County.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Denison, Crawford County, Iowa*

[Elevation, 1,171 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1895)	Total amount for the wettest year (1909)	Snow, average depth
	° F.	*° F.*	*° F.*	*Inches*	*Inches*	*Inches*	*Inches*
December	23.8	65	−22	0.87	(1)	1.90	4.6
January	18.0	60	−40	.66	0.40	.86	5.4
February	22.4	70	−37	.94	.45	1.92	6.7
Winter	21.4	70	−40	2.47	.85	4.68	16.7
March	35.0	87	−15	1.53	.95	.28	3.9
April	49.2	95	11	2.83	4.76	2.20	.9
May	60.1	98	17	4.28	1.93	5.65	.0
Spring	48.1	98	−15	8.64	7.64	8.13	4.8
June	69.1	100	30	4.09	3.87	7.75	.0
July	73.4	106	39	3.75	1.95	6.08	.0
August	71.5	104	34	3.81	3.45	.71	.0
Summer	71.3	106	30	11.65	9.27	14.54	.0
September	64.0	98	18	3.12	1.78	4.43	.0
October	51.7	91	9	2.23	.18	1.71	.3
November	35.6	77	10	1.33	.65	8.13	1.5
Fall	50.4	98	9	6.68	2.61	14.27	1.8
Year	47.8	106	−40	29.44	20.37	41.62	23.3

[1] Trace.

AGRICULTURE

The first permanent settler arrived in Crawford County in 1849 and established a home along East Boyer River, 6 miles east of Denison. Owing to the large area of well-drained upland soils the county was settled rapidly, particularly after the building of the railroads. Denison was made the county seat in 1856. Agriculture has progressed rapidly from the time of the first settlement, and some changes in cropping have taken place, mainly in the shifting of areas devoted to certain crops. The growing of staple field crops and livestock raising have always been the major agricultural enterprises.

Table 2 shows the trend of agriculture, giving a compilation of acreages and yields of the various crops as reported by the United States census for the decades from 1879 to 1929, inclusive.

TABLE 2.—*Acreage and production of the principal crops in Crawford County, Iowa, in stated years*

Crop	1879		1889		1890	
	Acres	*Bushels*	*Acres*	*Bushels*	*Acres*	*Bushels*
Corn	73,920	3,047,849	140,214	5,752,354	151,831	5,575,410
Oats	7,695	234,810	34,218	1,196,797	49,862	1,622,470
Wheat	46,461	704,020	12,936	195,131	53,757	787,060
Rye	603	10,773	772	12,475	438	5,300
Barley	2,489	58,402	24,996	615,499	4,082	115,370
Potatoes		66,832	2,163	204,799	2,056	229,996
		Tons		*Tons*		*Tons*
All hay	17,489	28,091	46,810	71,249		
Tame hay					30,312	51,587
Alfalfa [1]					25	38
Wild hay					12,256	18,067
Grains cut green					1,952	3,728
Coarse forage					5,599	16,389

Crop	1909		1919		1929	
	Acres	*Bushels*	*Acres*	*Bushels*	*Acres*	*Bushels*
Corn	141,548	5,704,842	130,716	5,685,446	143,933	6,277,658
Oats	56,422	1,414,870	62,138	1,943,662	79,550	2,523,292
Wheat	17,358	208,252	30,426	283,043	5,938	123,708
Rye	113	1,413	214	2,844	121	2,350
Barley	10,565	197,753	2,593	59,134	11,691	334,119
Potatoes	2,542	270,548	1,552	72,488	1,261	138,668
		Tons		*Tons*		*Tons*
All hay					43,228	69,143
Tame hay	51,541	82,770	47,868	74,926		
Alfalfa [1]	339	1,040	6,824	16,470	10,415	25,537
Wild hay	6,395	11,044	4,759	6,859	2,768	3,472
Grains cut green	163	250	836	1,145	635	913
Annual legumes cut for hay			34	49	99	102
Silage crops			1,319	11,206	[2] 962	[2] 9,368
Coarse forage	508	1,523	2,156	6,860		

[1] Included in tame hay.
[2] Corn.

The most striking change in the agriculture of the county is the decrease in the acreage of wheat, which, however, showed a temporary stimulation in 1919, owing to the effects of the World War, but the acreage and production in recent years have been negligible.

The present system of agriculture includes the production of grain and hay. Corn, oats, and barley are at present the most important grain crops, and timothy and clover, clover, and alfalfa are the principal hay crops. A large acreage of sweetclover is grown for pasture and green manure. All farming activities center around the production of corn in conjunction with the raising and feeding of hogs and cattle.

According to the Iowa Yearbook for 1929, the average yield of corn in Crawford County in that year was 43.2 bushels an acre, but yields of corn following sweetclover, alfalfa, or red clover average about 50 bushels an acre. On the rich well-drained bottom-land soils, yields also average high, about 50 bushels an acre, and where the land is well farmed, yields range from 65 to 70 bushels an acre in favorable seasons. Reid Yellow Dent and strains of this variety are grown for the most part. A fairly large acreage is devoted to white corn, principally Iowa Silvermine, Silver King, and local strains of both varieties. Average yields of corn on the gently rolling uplands in

the eastern, northeastern, and north-central parts of the county are a little higher than on the more rolling parts. Average yields on the rich well-drained bottom lands equal those on the better areas of Marshall silt loam. Seed corn is largely grown locally. Field and crib selection are both practiced, field selection becoming the more popular. Only a small part of the seed is tested for germination. Most of the corn is husked from the standing stalk. According to the 1930 census, 12,397 acres, or about 8 per cent of the total acreage in corn, was hogged down in 1929, and 962 acres were cut for silage, with a total yield of 9,368 tons. Most of the corn is fed to cattle and hogs. Some of the corn grown on the bottom lands is sold for grain. It is marketed locally, in neighboring counties, and in Omaha.

Oats are of second importance in acreage. They occupy about one-half the acreage of corn. Oats are used largely as a nurse crop for sweetclover, red clover, and alfalfa. The average acre yield in 1929 was 31.7 bushels. The favorite varieties are Iowa 103, Iowa 105, Kherson, Silvermine, and Green Russian. The yield varies greatly with the season, but in favorable seasons from 40 to 50 bushels an acre are common. Oats are broadcast and are seeded the last part of March or the first part of April. Most of the crop is fed to horses and hogs, and a small quantity is shipped out of the county. Rust and smut cause some damage. However, smut can be controlled by the formalin treatment.

Barley, the next grain crop in importance, is grown on smaller acreages and is used entirely as feed for hogs and chickens. In 1929 it occupied 11,691 acres, or about one-seventh the oat acreage. The average yield in 1929 was 29.4 bushels an acre. Small acreages are devoted to rye, buckwheat, and flax.

Wheat was grown on 5,938 acres in 1929, of which 3,970 acres was winter wheat and 1,968 acres spring wheat. The average yield was 22.3 bushels an acre for winter wheat and 18 bushels for spring wheat. Turkey, Marquis, and Kanred are the favored varieties. Wheat is grown on both bottom land and upland, but mostly on the former. Most of the grain is threshed from the shock and hauled direct to the elevators, whence it is shipped to Omaha and Sioux City markets.

Timothy and clover, mixed, is the most extensively grown hay crop, followed by red clover and alfalfa in extent of acreage. Timothy and clover, mixed, was grown on 16,734 acres in 1929, practically all on the uplands, principally in the eastern, northeastern, and north-central parts of the county. The average yield was 1.28 tons an acre.

Clover alone, mostly medium red, was grown on 12,344 acres in 1929, with a yield of 17,332 tons. Most of the crop is sown with oats as a nurse crop. It is grown on the more gently rolling lands corresponding largely to the parts of the county indicated for timothy and clover, mixed. Almost the entire crop is fed to livestock.

Alfalfa is not so widely grown as in some of the counties to the west, 10,415 acres being reported in 1929. However, the acreage is increasing gradually. Most alfalfa fields range in size from 5 to 30 acres, averaging between 15 and 20 acres. Although alfalfa is grown over all parts of the county, liming seems to be important

for obtaining the best stands in the areas where timothy and clover are grown, on account of the slight acidity of the topsoils. In the western, central, and southwestern parts of the county alfalfa grows readily without either liming or inoculation. It is usually left from three to five years. Three cuttings a season are the average, but four cuttings are made in very favorable seasons. The average yield in 1929 was 2.45 tons an acre, which was much higher than yields of other hay crops. Sweetclover is sometimes sown with alfalfa, both fall and spring seeding being practiced. The crop is largely fed to cattle, sheep, and horses, and a large alfalfa acreage is used for pasturing hogs and cattle. In some parts of the county, acidity and poor drainage, principally acidity, are the limiting factors in alfalfa and sweetclover production.

Sweetclover is increasing in use because of its high manurial value, and most of the crop is used for pasture and green manure. More yellow sweetclover is now grown than formerly, but probably 85 per cent of the crop is white sweetclover. This crop is seeded at the rate of 10 or 12 pounds an acre. Although the yellow sweetclover has a finer root system, making it easier to plow under and eradicate, the white has the higher manurial value and can be easily controlled if fall plowed before the second-year buds appear or after growth starts in the spring. When fall plowed, the land should be gone over thoroughly with a spring-tooth harrow the following spring at the first appearance of sprouting. Only a small acreage is threshed for seed, as most of the seed used in the county comes from western Nebraska and the Dakotas.

Other tame grasses were grown on 243 acres in 1929, with an average yield of 1.34 tons an acre. Wild hay was cut from 2,768 acres, averaging 1.25 tons an acre. Practically all the wild hay is cut from the more poorly drained Wabash soils, including the colluvial phase. Pastures were reported on 123,827 acres in 1929, of which 85,746 acres were plowable pasture, 13,843 acres woodland pasture, and 24,238 acres were listed by the census as other pasture.

Soybeans are grown on a small acreage. A few farmers grow them mostly with corn for silage. They are poorly adapted to rolling land, which is easily eroded, as they do not furnish enough cover for the land. Sudan grass is grown on a small acreage for summer pasture. Sorgo is raised in small quantities for sirup and feed; some millet is grown for hay and pasture; and on many farms rape is grown on a few acres for hog pasture.

Potatoes were grown on 1,261 acres in 1929, with an average yield of 110 bushels an acre. They are used entirely for home consumption. Little if any commercial fertilizer is used on potatoes. Truck and vegetable crops are produced for farm and home use. A few melons are grown commercially for local markets but not in sufficient quantities to supply the demand.

Pop corn is produced to some extent, mostly in the north-central and northeastern parts of the county. Sac County, adjoining Crawford County on the north, markets an immense quantity of pop corn, and the area devoted to pop corn extends southward into parts of Crawford County.

Fruit growing, principally of apples, reached its height in 1899, according to the census, and has been decreasing ever since. The

1930 census reports 9,915 apple trees of bearing age and 8,721 trees not of bearing age in the county in 1929. The apple yield in that year was 9,774 bushels. Orchards are largely restricted to small farm orchards ranging in size from one-fourth to 2 acres, and on most farms only about 12 trees are planted. During the course of the survey plum and cherry trees were noticed on many farms, with a few pear trees, and an occasional peach tree. Grapes are grown to some extent, Concord being the leading variety. Strawberries, raspberries, and blackberries are grown near towns and on farms for local use. Most of the fruit used in the county is shipped in fresh or canned, mostly canned. Shepherd's-purse, foxtail, dock, smartweed, and cocklebur are the most common weeds in the orchards. Dry rot, smut, and rust cause some damage to fruit at times.

The raising and feeding of livestock is of importance second only to grain growing in Crawford County. Table 3 gives the number and value of livestock in 1930 and the quantity and value of livestock products in 1929.

TABLE 3.—*Number and value of livestock on farms in 1930 and quantity and value of livestock products in 1929*

Livestock	Number	Value	Livestock products	Production	Value
		Dollars		*Gallons*	*Dollars*
Horses	14,332	1,171,771	Milk produced	6,840,573	--------
Mules	1,117	106,775	Whole milk sold	576,227	121,008
				Pounds	
Cattle	63,527	3,807,232	Butter churned	482,066	212,109
Swine	190,389	2,563,124	Cream sold as butterfat	1,301,553	585,699
Sheep	8,247	67,171	Wool shorn	40,394	13,330
Goats	269	1,369	Mohair clipped	504	171
				Number	
Chickens	395,772	324,533	Chickens raised	609,279	493,516
Turkeys	138	----------	Chickens sold alive or dressed	255,527	222,308
				Dozens	
Ducks	11,635	----------	Chicken eggs produced	2,140,521	556,535
Geese	4,978	----------	Chicken eggs sold	1,639,630	426,304

More hogs are raised than any other type of livestock. The principal breeds are Poland China, Duroc-Jersey, Chester White, Hampshire, and some Tamworth. The hogs are fattened on corn, with some barley and oats fed, and alfalfa, sweetclover, red clover, and rape furnish pasture. Most of the hogs are marketed from October to May and are sold through cooperative shipping associations or to local buyers. A large number are sold direct to dealers, increasing numbers being hauled to Omaha and Sioux City.

Beef-cattle feeding and raising ranks next to hog raising in importance. The cash return for cattle often exceeds that for hogs. Shorthorn grades predominate, with many Hereford and some Aberdeen Angus. Purebred sires are used extensively. Several thousand cattle are shipped in annually in the fall and fed corn, alfalfa, red clover, clover and timothy, are pastured on sweetclover, and finished on concentrates. Fat cattle are marketed mostly from December to February at Omaha, Sioux City, and Chicago, many being trucked direct to Omaha and Sioux City. From 25 to 30 head of cattle are raised on the average farm.

Dairying, in conjunction with general farming, provides an important source of revenue on the farm. Milking Shorthorns predominate among the dairy cattle, with Holstein and Guernsey next, and a few Jerseys. Most of the products are sold as cream at local cream-buying stations. Most of the dairy products find their way to Denison to a large manufacturing creamery.

Sheep are raised only as a side line, mainly on some of the rougher areas of the county. Many farmers buy feeders, mostly lambs weighing from 50 to 65 pounds, in the Omaha and Sioux City markets, feed them for a short time, and sell them as fattened animals. Corn is fed with alfalfa and clover for fattening. "Sheeping down" corn is practiced on many farms. The wool clip in 1929 amounted to 40,394 pounds and was valued at $13,330.

The number of horses on all farms on April 1, 1930, was 14,332, of which 672 were under 2 years of age. From 6 to 8 horses are kept on the average farm, most of them light and heavy draft animals and farm chunks of the Percheron breed. Enough colts are raised to maintain the supply of work animals. Mules are used to some extent, 1,117 being reported by the 1930 census.

A few bees are kept, mostly around towns. The 1930 census reports 716 hives of bees in the county, which produced 59,863 pounds of honey valued at $7,483 in 1929.

Poultry is raised on every farm, the ordinary flocks ranging from 125 to 200 fowls. The 1930 census reports 395,772 chickens, valued at $324,533. In 1929, 255,527 chickens were sold, bringing a total revenue of $222,308. Poultry is bought throughout the county and hauled by truck to Denison, thence shipped, dressed or alive, to eastern markets. Most of the farm flocks are mixed, but numerous purebred flocks of Rhode Island Red, Leghorn, Barred Plymouth Rock, and other breeds are maintained. Turkeys, geese, ducks, and guinea fowl are raised to some extent.

Methods of farming in different parts of the county vary but little. The adaptation of certain crops to certain soils is recognized, but the general cropping system and crop distribution is much the same over the entire county. The sharply rolling hill land is not cropped to corn more than one year, and corn is ordinarily followed by oats and sweetclover. Corn, oats, barley, wheat, together with the hay crops, clover, clover and timothy mixed, alfalfa, and sweetclover, are the major crops and are grown over the entire county. On some areas of bottom land corn is grown for several years in succession.

Crop rotation is practiced to some extent on every farm but with no definite system. The most common rotation is corn, corn, oats, and red clover or sweetclover. Barley or wheat are sometimes substituted for oats. Alfalfa is usually left three or four years. Some difficulty has been experienced in growing legumes, mainly in the eastern part of the county on the gently rolling areas, because of the slight acidity of the topsoils. The lower parts of the subsoils are usually rich in carbonate of lime at varying depths.

Farm equipment is usually sufficient to enable thorough handling of the farm. Farm buildings are as a rule adequate and well kept. Of the 2,556 farms in the county, the 1930 census reports 2,322 with telephones, 978 with water in the dwelling house, and 505 with electric lights. The average size of the farm is 175.8 acres. All land in farms amounted to 449,377 acres in 1930, of which 389,912 acres was classed

as improved land. All other land in farms, which includes woodland, woodland pasture, land occupied by buildings and highways, and waste land not utilized for any purpose, amounted to 59,465 acres. There has been little change in the average size of farms since 1900. The value of farm land in Crawford County on April 1, 1930, was $45,112,870, and the value of farm buildings was $15,223,343, a total of $60,336,213.

Tractors are used on the less rolling uplands and some of the bottom lands. According to the 1930 census there are 1,028 tractors on farms, 402 motor trucks, 220 electric motors for farm work, and 1,690 stationary gas engines. Farm implements and machinery, including automobiles, trucks, tractors, and other implements, are valued at $762,435. Many auto trucks in the small towns haul large numbers of livestock from the farms to markets.

Tenants, of whom 944 were cash tenants, operated 1,283 or 50.2 per cent of all farms in 1930. The average cash rent paid is $7.08 an acre. Some land is rented on the grain-share basis, the owner receiving one-half the grain in addition to cash for the pasture and hay land.

Hired labor was reported on 1,636 farms, at a total expenditure of $603,923, in 1929. The supply of farm labor is adequate, and wages range from $40 to $45 a month with board for single men. A house, cow, and garden is usually supplied for a man with a family. Day labor is paid $3.50 during harvest and from $2 to $2.50 with board at other times.

A comparatively small amount of farm land has changed hands recently. Many factors influence the selling price, such as the general condition of the farm, extent and condition of improvements, location, type of roads, schools, and the community. Farms close to town, with good improvements, bring the maximum selling price.

SOILS

In the following pages of this report the soils of Crawford County are described in detail and their agricultural relationships are discussed; the accompanying soil map shows their location and distribution in the county; and Table 4 gives their acreage and proportionate extent.

TABLE 4.—*Acreage and proportionate extent of the soils mapped in Crawford County, Iowa*

Type of soil	Acres	Per cent	Type of soil	Acres	Per cent
Marshall silt loam	294,528	73.7	Wabash silt loam	52,928	23.0
Shallow phase	32,512		Colluvial phase	52,352	
Light-colored phase	9,920		Wabash silty clay loam	2,240	.5
Knox silt loam	1,152	.2	Ray silt loam	320	.1
Carrington loam	3,200	.7			
Waukesha silt loam	5,248	1.1	Total	457,600	
Judson silt loam	3,200	.7			

MARSHALL SILT LOAM

The surface soil of Marshall silt loam is dark grayish-brown friable silt loam with a faintly granular structure, extending to a depth of about 9 inches. When the soil is moist, it is very dark grayish

brown or almost black. The lower part of the surface layer, below a depth of 4 inches, is slightly heavier than the upper part. In areas of virgin sod the soil material shows a definite granulation but is very fine. The average thickness of the dark surface layer on the uplands is probably 8 inches, but on the less rolling areas the soil is slightly deeper, being about 11 inches thick. The topsoil is thinner on the sharper breaks of the slope and thicker at the base of the slope, in places being from 15 to 20 inches thick. Lying directly under the dark topsoil layer and extending to an average depth of 16 inches, is brown silt loam containing some darker organic coloring. On cursory examination the material in this layer appears to be dark grayish brown, but closer examination shows that the darker grayish-brown color is caused by organic infiltration and consists of a coating of dark organic matter over the granules or on breakage plane surfaces. When crushed the soil particles lose their darker outside coating, showing the inner part to be brown. The granulation, if any, is very faint in this layer. Many wormholes, channels of decayed roots, and insect burrows occur in this layer and extend below it to a depth of more than 30 inches. These have allowed the rapid carrying down of organic filtrate which has produced a coloration of the upper part of the subsoil. This is the transitional layer. Below this layer and extending from a depth of 16 to a depth of 21 inches the soil is heavier in texture, being yellowish-brown heavy silt loam, with a few faint organic stains in the form of fine hairlike or rodlike streaks. This layer is more compact than the overlying layers, and the material is somewhat granular. The next distinct layer extending from a depth of 21 to a depth of 29 inches is yellow or yellowish-brown heavy silt loam which seems to be faintly granular, but the granules are indistinct. The color of the material in this layer is uniform and solid. Underlying this layer is yellowish-brown or light-yellow silt loam, lighter in color than the layer above and containing a few faint iron stains and gray mottlings. The granulation decreases with depth of the profile. It is barely distinguishable in this layer and disappears entirely below a depth of 45 inches. A sharp change occurs in the profile below this depth, and the material becomes very light gray or pale-yellow silt loam which is powderlike and smooth to the feel. The color is uniform, except for a few faint brown and rust-brown threadlike pencilings, or iron stains, and a very few small rust-brown iron concretions.

The soil mass is soft and structureless, and breaks into irregular-shaped clods and lumps, which crumble readily when handled. This layer is the unweathered parent material which contains a high percentage of lime. Lime concretions, ranging in size from a wheat kernel to a castor-bean, occur in the lower part of the subsoil.

Marshall silt loam, with its two phases covers an area of 336,960 acres in Crawford County, constituting 73.7 per cent of the area of the county.

Variations occur in depth of the soil profile above the parent material, which is high in lime, characteristic of the Marshall soils in this section of the country. The gray finely powdered limy silt material occurs within 10 inches of the surface in places and in other places lies as deep as 10 feet below the surface, as shown in some of the deeper road cuts. There seems to be no definite correla-

tion between the surface relief and depth of leaching. On one side of the crest of a gentle slope, limy parent material may occur at a depth ranging from 15 to 30 inches, and only a few feet away, on the opposite slope, no lime may be found within a depth of 10 feet. A striking illustration of this is in a 10-foot road cut in section 31, East Boyer Township, on the graveled county road from Denison to Manilla. On one side of the road the limy parent material is within 22 inches of the surface, and 59 feet away on the other side, lime is not present at a depth of 10 feet. This condition also occurs in many long road cuts throughout the county.

In several areas another distinct and important variation occurs, consisting of a deeper dark-colored topsoil which is more acid than in the average dark-colored Marshall soil in other parts of the county. Most of these areas occur in the less rolling country along the eastern side of the county, particularly north and east of Vail, the gently rolling upland divides around Schleswig, Ricketts, and Charter Oak, and the uplands northeast of Deloit. Another conspicuous gently rolling upland area is 3 miles south of Buckgrove, near and along the county line. It was impractical to separate the soils of these areas into a deeper phase of Marshall silt loam, on the basis of depth of topsoil and acidity, because of the extreme variability of the soil at the same topographic position. The depth to lime in the northeastern part of the county, as the eastern limit of Marshall silt loam is approached, is uniformly greater than in other parts. This soil disappears in Carroll County, from 4 to 6 miles east of the northeastern county line of Crawford County.

The surface relief of Marshall silt loam is rolling. The entire surface has been brought to a gently or sharply rolling configuration by the carving of a network of drainage ways. The more rolling areas with steeper relief are largely in the southwestern part of the county. The shallow phase and light-colored phase of Marshall silt loam occur within these more rolling areas where sheet erosion has reached its maximum activity. In places the surface soil has been washed off the slope shoulder, leaving the light-brown calcareous subsoil exposed. These spots and narrow strips are low in organic matter and extremely high in lime, the lime content ranging from 20 to more than 30 per cent.

Marshall silt loam is the most extensive soil in Crawford County. The soil is very uniform and varies but slightly in color over the entire county. There is a difference in the depth of the dark topsoil layer, largely depending on the surface relief, the areas having the shallower topsoils occurring on the more rolling ridges and hill slopes.

Drainage of this soil is well established. Many fair-sized streams, with their intricate system of tributaries dissecting every part of the upland, give ample or excessive surface drainage. The range in relief along the more deeply cut streams is from 100 to 120 feet, but the average relief is between 30 and 40 feet.

Practically all this soil is under cultivation or in pasture. It is fertile, has good moisture-holding capacity, and crops withstand prolonged droughts with but little damage. Tree growth is limited to a few thinly wooded slopes and hillsides and planted windbreaks of cottonwood, elm, maple, and evergreens.

Corn, oats, and hay are the most important crops. Corn, the principal crop, occupies about double the acreage of oats. The hay crop, exclusive of sweetclover, occupies about one-half the acreage of oats and one-fourth that of corn. Corn yields in 1929 averaged about 40 bushels an acre. On the better farms a yield of 60 or 70 bushels is common in a normal season. The greater part of the corn crop is used for feeding cattle and hogs. Pop corn is grown to considerable extent in the north-central and northeastern parts of the county.

Oats, the second crop of importance, is largely used as a nurse crop for clover, alfalfa, and sweetclover, and is sometimes cut for hay where sown with sweetclover. The average yield of oats is about 30 bushels an acre, but yields as high as 60 or more bushels are obtained in favorable seasons on the better farms. Most of the oats are fed on the farm where produced.

Hay crops are red clover, mixed timothy and clover, alfalfa, and timothy. Sweetclover is grown extensively, mostly in the western and southwestern parts of the county, the soil in the southwestern part being particularly adapted to sweetclover and alfalfa because of excellent drainage and a calcareous subsoil lying close to the surface soil. Red clover, mixed clover and timothy, and timothy alone are grown, principally on the more gently rolling land, especially in the northeastern part of the county where the surface soil is more acid. The hay crops average about 2 tons an acre. Alfalfa averages three cuttings a year and produces about 3 tons an acre. It is cut for hay, and most of it is fed on the farm where produced. Very few soybeans are sown because of the ease of growing clovers and alfalfa. Sweetclover is grown mainly for pasture and green manure. Difficulty is experienced on the more gently rolling farms in obtaining a good stand of sweetclover, because of the acidity of the topsoil. This is also true of alfalfa and to some extent of red clover. Large quantities of lime are now being used, with excellent results, on the acid areas.

Winter wheat and spring wheat are crops of little importance. More than twice as much winter wheat is grown as spring wheat. The average yield of winter wheat is 23 bushels and of spring wheat is 15 bushels an acre. The acreage in barley is about 7 per cent that in corn. Barley produces about 27 bushels an acre. It is largely fed to hogs and calves. Little rye is grown.

Orcharding is carried on to a small extent and consists mostly of small farm orchards, containing a few trees each. Little care is given the trees. Very little truck is grown, hardly sufficient to supply the local demand in small towns, but small gardens are on nearly every farm.

Cattle and hog raising and feeding are the most important livestock industries. From 30 to 40 head of hogs are raised on the average farm. The number of beef cattle on each farm averages between 25 and 35 head, and on most farms from 6 to 8 cows, mostly Shorthorns, are milked. Many carloads of western feeder beef cattle are shipped in each year, fed from four to six months, then marketed. Most of the dairy products are marketed as cream at local creameries or cream-buying stations. A few sheep are raised in the county, and some feeders are shipped in.

Commercial fertilizers are used only to a very small extent at present, but experiments are being carried on with phosphate fertilizers. Liming is being done largely in an experimental way and is showing profitable results. The tonnage of lime used is increasing annually. Barnyard manure is used on sod before fall plowing or on cornland in the spring. Sweetclover is used most extensively for green manure.

Marshall silt loam is normally a fertile mellow soil which is easy to plow and cultivate. It warms up early in the spring, owing to its physical structure and excellent natural drainage. Although some legumes are grown on this soil on nearly every farm, on most farms an insufficient acreage is grown to maintain the organic-matter content and give maximum crop yields. Where difficulty is had in obtaining stands of sweetclover and alfalfa, liming and inoculating should give good results, and when once started, no difficulty should be experienced at later seedings. In some places trouble is experienced in growing red clover, but liming greatly improves the stand.

Some system of crop rotation is practiced on every farm. A high state of fertility is maintained and high crop returns obtained where a sufficient quantity of legumes are grown and used in part for green manure. Yields have been increased from 30 to 50 per cent by growing and turning under legume crops. The most common rotation is corn for two or three years, followed by oats, and the oats by sweetclover, red clover, or alfalfa. Sweetclover is largely used because of its greater manurial value.

Land values of Marshall silt loam differ widely, depending on location of the farm and condition of the improvements. There are very few poor farms on this soil.

Marshall silt loam readily loses its fertility through lack of suitable rotations, leaching, and washing. On many farms more legumes are needed in the rotation. Where alfalfa is used it can be left from two to four years. Liming is necessary over large areas of Marshall silt loam, especially in the northeastern part of the county, to insure good alfalfa stands. Sweetclover can be grown in any part of the county, liming being necessary in certain sections as with alfalfa. Sweetclover is the most rapid soil builder, owing to its production of larger quantities of organic matter. Local experiments with superphosphate seem to have given good results but are recommended only in an experimental way on a small acreage. Contour plowing is recommended on the rolling areas of this soil to lessen sheet erosion. The soil should be carefully tested before lime is applied, as the range of acidity is wide in the topsoil, ranging from medium acid to neutral and calcareous.

Marshall silt loam, shallow phase.—Marshall silt loam, shallow phase, is an eroded phase of Marshall silt loam, formed on the more steeply eroded slopes along the deeper-cut drainage lines. The surface soil consists of a 4-inch layer of light-brown or dark-brown silt loam which is smooth and mellow and in most places neutral or calcareous. Between depths of 4 and 14 inches is a transitional layer, consisting of light yellowish-brown silt loam which is neutral or calcareous. Below this and continuing to a depth of 48 or more inches is light-yellow pulverulent floury silt loam which is highly calcareous. The incorporated lime particles are so fine that they can

not be differentiated visually from the fine silt particles which make up the subsoil. In places no lime nodules occur in the subsoil, but over the surface are many large lime concretions, which decrease in numbers downward from the surface and disappear entirely at a depth of 12 inches. However, the nodules may be present anywhere throughout the soil profile.

Soil of this phase occurs on the steeper slopes adjacent to the gentler divides on which typical Marshall silt loam is developed. It occupies the eroded slopes usually halfway up to the shoulder. It occurs in narrow strips, following the slopes on both sides of the streams.

This phase of Marshall silt loam is very variable and the color is nowhere uniform, as the land has long been and is constantly subjected to much sheet erosion. Besides the many light-colored spots, showing the exposed subsoil, darker talus slopes are at the bottom of some of the hill slopes where the dark topsoil washed down from above is from 12 to 20 inches deep. In the rougher areas in the western and southwestern parts of the county and along the deeper-cut streams the slopes are very light colored. When extremely dry they appear nearly uniformly grayish brown, but when wet they are darker grayish brown, being slightly lighter than the typical Marshall silt loam lying above them. These lighter slopes are in Union, Boyer, and Willow Townships. It was impossible to show these areas separately on account of the small scale used in mapping.

Small pockets, ranging from 20 to 50 feet across, and narrow strips, from 5 to 15 feet wide and from 100 to several hundred feet long, are exposed on many of the slopes. The drift ranges in color from dark grayish brown to buff or yellow, and in reaction, from acid to neutral or calcareous. Most of the included exposed drift areas are in the southwestern and western parts of the county.

In sections 4, 5, and 6, Jackson Township, the shallow phase has been mapped on the upland to join with similar areas in Sac County. The soil here more nearly corresponds to the light-colored phase of Marshall silt loam as mapped in the western part of Crawford County and that northeast of the town of Denison, but it is slightly darker.

The shallow phase of Marshall silt loam occurs principally in the western half of the county but extends up Boyer River and its tributaries and along tributary streams southeast of Denison and west of Manilla. Soil of this phase is restricted to the sharper stream slopes, and most of it is subject to excessive run-off. Sheet erosion, active over long periods, has cut down these hillsides to their present degree of slope, and many of them are still losing large quantities of soil annually where improperly handled. The hillsides have attained a slope ranging from 5° to 25°.

Forest trees once covered many of the hillsides, but most of the timber has been removed. With the exception of a few scattered trees along Boyer and East Boyer River bottoms and a few of the other larger streams, all the natural forest growth in the county occurs on this phase of Marshall silt loam. Trees consist largely of oak, ash, maple, elm, cottonwood, and other hardwoods.

Most of the land of the shallow phase is in cultivation. The soil seems to have good moisture-holding power, except on the highly

calcareous eroded spots and strips. The darker areas, having more organic matter, are naturally less droughty and give good yields. Gullies are easily formed by the rapid run-off of storm water. Sweetclover, planted in shallow drainage channels leading down the slopes, greatly checks any damage from heavy rainfall; but where no precautions are taken, one heavy rain may form a gully from 2 to 5 feet deep.

The same crops are grown as on typical Marshall silt loam. The soil is well adapted to sweetclover, and much is grown. Corn is grown for one or two years, then the land is seeded to oats, and the oats are usually followed by sweetclover. Considerable alfalfa also is grown.

Oat yields are usually low, ranging from 25 to 40 bushels an acre. Corn yields vary greatly, but good yields, corresponding to the yield on typical Marshall silt loam, are obtained following clover. Clover and alfalfa grow luxuriantly except on the light-colored droughty spots, high in lime content, where organic matter is lacking. Some of the steeper slopes are in permanent pasture.

This land should always be plowed at right angles to the slope, in order to prevent gullying and lessen sheet erosion. Contour plowing and maintenance of organic matter by growing legumes, preferably sweetclover, are the two most important cropping practices to follow. The grass or sweetclover cover should be left in the shallow drainage lines which must carry off the rainfall, and trees or shrubs should be planted in gullies that have been cut too deeply to be controlled by grass or sweetclover.

Marshall silt loam, light-colored phase.—The light-colored phase of Marshall silt loam is intermediate in characteristics between Knox silt loam and Marshall silt loam. The separation is based mainly on the color of the topsoils.

The surface soil to a depth of 7 inches is grayish-brown silt loam. In places, material from the originally darker surface layer is left in the surface soil. To a depth of 15 inches the topsoil is underlain by heavy light-brown silt loam which is uniform in color and usually noncalcareous in reaction. The next layer, between depths of 15 and 24 inches, is buff or pale-yellow smooth silt loam which is lighter in texture than the layer above and neutral or slightly basic in reaction. The lower part of the subsoil is highly calcareous pale-yellow or grayish-yellow fine floury silt loam. The depth to this layer ranges from 2 to more than 3½ feet.

Soil of this phase occupies the narrower interstream divides and the stream slopes, where the drainage ways have carved deep channels close together. It is of small total area and occurs chiefly in the western part of the county and northwest of Dow City. A large area is on the high upland ridges, deeply cut by drainage ways, 1½ miles northeast of Denison. Smaller areas, on narrow rounded eroded ridge tops, occur in the south-central part of the county, where the streams have cut to a depth of 100 or more feet into the original upland plain.

Marshall silt loam, light-colored phase, is practically all farmed to the common crops. Owing to the relatively low organic-matter content, corn yields are lower than on the areas of typical Marshall silt loam, except where the soil has been well manured or green manure has been turned under to enrich it. Small grains and hay

yield almost as high as on the darker Marshall soils. Sweetclover and alfalfa thrive but are reported to be somewhat susceptible to winter killing.

Heavy applications of barnyard manure and more frequent turning under of green manure are needed on this soil to build up the organic-matter content. The use of phosphate fertilizers should be tried experimentally, as similar soils have given excellent response in crop yields, with a profitable return.

This phase, as well as the shallow phase of Marshall silt loam, has a selling value ordinarily below that of typically developed Marshall soil.

KNOX SILT LOAM

The topsoil of Knox silt loam in virgin areas is dark-brown silt loam to a depth of 7 inches, the upper 2 inches containing a dense mat of grass roots. The soil is smooth, pulverulent, and has developed only very faint granulation. Between depths of 7 and 14 inches the material is light-brown or buff heavy silt loam, with some faint organic coloration in fine threadlike lines, probably owing to the decay of fine grass roots. The material in this layer is firm but not compact. The profile in cultivated fields, to a depth of 14 inches, differs only in the lighter color of the topsoil, which is buff or lighter brown, and in having a slightly lighter textured surface layer. The upper two layers are usually leached of all carbonates.

Below a depth of 14 inches the profiles of cultivated and uncultivated areas are identical. Between depths of 14 and 21 inches the subsoil is grayish yellow, uniform in color, and very mealy and smooth. In most places the material in this layer is neutral, but in places carbonates are present in sufficient quantity to cause the soil to effervesce with hydrochloric acid. The next lower layer, between depths of 21 and 34 inches, has the same color as the layer above, but it contains some faint gray mottlings. Below a depth of 34 inches the soil is lighter in color, being pale yellow or grayish yellow, flourlike in texture, and high in lime. The lime particles are very fine and constitute 20 per cent or more of the soil mass, imparting the white or gray color. The material in this layer is soft and structureless, falling apart in irregular-shaped soft clods when cut with a spade. In many places lime splotches occur in the lower part of the subsoil. Where the soil is eroded and thin, the lime nodules, ranging in size from a pea to a hickory nut, occur at the surface. The lower subsoil layer, which is high in lime, lies at a varying depth from the surface, ranging from 2 to more than 5 feet, but in most places it occurs at a depth ranging from 24 to 30 inches. The lower part of the subsoil, below a depth of 30 inches, is identical with the layer above except that it contains more mottlings of yellow and rust-brown iron stains which appear in fine threadlike or in cylindrical shapes.

Knox silt loam in Crawford County is unimportant and comprises only a few small areas. It occurs mostly along the west county line in Willow and Boyer Townhips and in Paradise Township. Areas of this soil occurring as small narrow eroded ridges, too small to indicate on the soil map as Knox silt loam, are included with Marshall silt loam.

131728—33——2

Drainage ranges from good to excessive on the steeper slopes, where erosion does much damage if not carefully watched. The moisture-holding capacity of the soil is good, but the organic-matter content is low.

The land is all under cultivation, mostly to corn, oats, and sweetclover. Yields are somewhat lower than on Marshall silt loam. Small grain, potatoes, vegetables, grapes, and bush and tree fruits are well adapted to this soil.

The greatest need of this soil is organic matter. Sweetclover and alfalfa should be grown more often and turned under. The steeper slopes should be seeded down more often, which would help check erosion. Superphosphate and rock phosphate should be beneficial on this soil.

CARRINGTON LOAM

The topsoil of Carrington loam, to a depth of 6 inches, is loose friable dark grayish-brown silt loam or loam. The material structurally consists of small granules ranging from one-sixteenth inch in diameter to single grains. The next lower layer, between depths of 6 and 14 inches, is dark grayish-brown loam which is slightly lighter in color than the topsoil. The dark color is pronounced and, owing to organic infiltration, presents an almost solid color. Below this an abrupt change takes place, and between depths of 14 and 28 inches the material consists of brown or yellowish-brown gritty sticky silty clay loam which is coarsely granular, the aggregates averaging twice the size of those in the surface layer. Between depths of 28 and 40 inches the material is yellowish-brown gritty clay loam containing a high percentage of sand and some gravel. All the layers, except the lower subsoil layer, are acid. In places the lower subsoil layer contains lime nodules and soft lime splotches and streaks, characteristic of certain layers in the Kansan till of which this soil is largely composed.

A great variety of surface material is exposed in this drift, which varies both in color and texture. In typical areas silt from the higher-lying Marshall silt loam has washed down and intermixed with the drift in such large proportions as to form Carrington loam. Areas of this kind usually occur at the upper part of the drift slope and in narrow strips. Coarse sand, gravel, and a few small bowlders are scattered through the drift, producing small areas of Carrington sandy loam, which on account of their small total area are also included with Carrington loam. The largest development of the sandy loam is in sections 1 and 2, Stockholm Township. Gravel and sand pits occur in many places, but principally along Boyer and East Boyer Rivers, 1 mile southeast of Denison, and between Denison and Deloit. Lighter-colored drift material is also included with the typical soil because of its small total area. Such developments are 1 mile east and southeast of Denison along East Boyer River, and they extend a short distance up some of the shorter tributaries.

A small area of Lindley sandy loam, consisting of only a few acres, occurs in section 33, Milford Township, and is included with this soil. The soil in this area is calcareous in only a few places, principally where the drift has been deeply eroded to the accumulated lime zone of the older calcareous drift.

Carrington loam occurs principally along Boyer River. Some outcrops of the underlying drift are along East Boyer River and the larger streams and their tributaries. Many exposures of drift, ranging from 10 to 50 feet wide, could not be shown separately and were mapped with Marshall silt loam, shallow phase.

Carrington loam is of little agricultural importance, because of its small total acreage in the county. About 50 per cent of the land is farmed, and most of the remainder is used for pasture. A few small areas support a scattered forest growth of scrub trees.

Where Carrington loam is farmed, it is included in fields with Marshall silt loam and produces nearly as high crop yields as that soil. Lighter-colored and thinner soil areas and the sandier exposures are apt to be droughty in dry periods, and they return low yields.

WAUKESHA SILT LOAM

The surface soil of Waukesha silt loam to a depth of 9 inches is very dark grayish-brown silt loam with a fine-granular structure. A higher percentage of silt seems to be present in the upper 4 inches, and the granulation is finer. Below this, between depths of 9 and 17 inches, is medium dark grayish-brown silt loam, similar to the layer above, except that the material is lighter in color. The next lower layer, between depths of 17 and 22 inches, is a transitional layer between the upper and lower subsoils. It consists of grayish-brown heavy silt loam which is heavier than the overlying layer and is discolored with organic infiltrations. There seems to be a much larger percentage of clay in this layer than in any of the overlying layers. The lower part of the subsoil, between depths of 22 and 45 inches, is yellowish-brown tenacious silty clay loam which is very heavy, sticky, and plastic. In places, at a depth ranging from 5 to 6 feet, layers of sandier material are present. Beds of sand and gravel occur in the subsoil of a few small areas. The soil material of the entire profile is noncalcareous.

Included with Waukesha silt loam are a few small areas in sections 15 and 16, Denison Township, which have sandy topsoils and subsoils. They are entirely different from Waukesha silt loam structurally, chemically, and agriculturally, but because they occupy such a small total acreage they have been included with this soil in mapping. An area containing some sand and gravel occurs on a bench 3½ miles northeast of Denison along East Boyer River. Other areas in which some fine sand is mixed with the soil are on high terraces along Boyer River southwest of Dow City. With these exceptions the soil is uniform both in texture and color.

Waukesha silt loam occurs on distinct terraces well above overflow, lying from 10 to 40 feet above the stream channels. It is developed mainly along Boyer, East Boyer, East Soldier, and Soldier Rivers. Fair-sized areas occur along Nishnabotna, West Nishnabotna, and Middle Soldier Rivers, and a few small areas are along some of the larger tributary streams. The relief of these terraces is nearly flat with a gentle slope toward the stream. Streams issuing from the upland dissect the tablelike benches in many places.

Owing to the structure of the soil, internal drainage is good. The slight slope toward the stream allows good surface run-off except in small depressions and sags where some water damage to young

crops may occur. At one time a few trees grew on these benches, but these have all been cut and all the land is now in cultivation to field crops.

The soil is mellow and easy to cultivate. It is good cornland, and yields are high, ranging from 40 to 70 bushels an acre, depending on the condition of the soil and the season. Oats yield from 30 to 60 bushels. Very few alfalfa fields were noticed on this soil, as sweetclover and redclover are the principal legumes grown. On account of the fine physical structure and moisture-holding capacity of the soil, climatic extremes affect it very little.

The selling value of land of this kind differs from place to place, with improvements, location, and condition of the soil. Some other soil is included on most farms having this kind of soil, so that it is difficult to estimate separate values. The current sale price, however, will average as high as that of Marshall silt loam.

The greatest need of Waukesha silt loam is the incorporation of more organic matter through the use of more sweetclover in the rotation. At present too much corn is grown on this soil. On many farms corn is grown for three or four years before the land is seeded to grain and clover. The lighter-colored and sandier areas included with this soil are in particular need of more organic matter. Barnyard manure is used, but the supply is not sufficient to supply the organic matter needed. Some of the areas are acid, and liming and inoculation would be beneficial for better stands of legumes.

JUDSON SILT LOAM

The topsoil of Judson silt loam is very dark grayish-brown pulverulent friable silt loam to a depth of 9 inches. It is underlain by dark grayish-brown heavy silt loam, containing much colloidal clay, which extends to a depth of about 37 inches, where it changes to dark-gray heavy friable silt loam, slightly lighter in color than the layer above. In a few small depressed areas, the topsoil is slightly heavier in texture and the subsoil is more gray, with some deeper-gray mottlings.

Judson silt loam is classed as a terrace soil and consists largely of colluvial material at the outer edge of the bottom lands. It is very dark colored silt loam, high in organic matter and plant food.

It is not extensively developed, and most of it occurs in isolated narrow disconnected strips along all the larger streams of the county. Most of this land lies above overflow, although some of the areas were overflowed occasionally at periods of exceptionally high floods before the river channels were straightened. At the present time the land is largely above all danger of overflow, although a few areas may be partly inundated for a few hours after torrential rainfall.

This soil has been formed by the carrying down of the darker-colored silt loam soils of the upland and upland slopes through sheet erosion and by streams issuing from the upland, forming alluvial fans.

The surface relief is flat, with a perceptible slope toward the bottom land. The soil boundaries between this soil and the lower-lying bottom land are necessarily arbitrary in places, because of a gradual slope the entire distance from the foot of the hill to the stream channel.

Judson silt loam is highly productive and is all under cultivation, except the land in roads that follow along the base of the upland, in

farm sites, and in feed lots. This is an especially strong corn soil and is used largely for corn. It is very retentive of moisture and is very little affected by drought. Crop yields average about the same as on the better Marshall silt loam farms. Practically all the land is under the plow, a little being used for pasture.

This soil is slightly acid, and lime will be of value for growing legumes on some areas. The land responds readily to applications of barnyard and green manures. Applications of phosphate should be tried in a small way to test their economic value, as it is believed they would be profitable. Both raw rock phosphate and superphosphate may be tried.

This soil occurs in such small irregular areas that it is always included with other soils in selling farm land, as it constitutes only a small part of an individual farm. It has a high cropping value and should enhance the value of any farm.

WABASH SILT LOAM

Wabash silt loam, to a depth of 12 inches, consists of very dark grayish-brown friable silt loam. The subsoil, between depths of 12 and 22 inches, is very dark brown or almost black heavy silt loam. The lower subsoil layer, extending from a depth of 22 inches to a depth of 42 inches, is nearly the same in color and texture as the upper subsoil layer but is slightly more gray and heavier. Below a depth of 42 inches, the color changes abruptly, becoming dull gray splotched with lighter gray and yellow and containing a few rust-brown iron stains and streaks. The texture of this layer is silty clay loam or silty clay, which is sticky and tenacious. The depth of the gray subsoil from the surface ranges from 2 to more than 4 feet. The material has been deeply covered along much of the stream bottom with the dark heavy almost black silt carried down from Marshall silt loam of the upland prairies. The entire soil profile, with few exceptions, is noncalcareous.

Wabash silt loam varies considerably in texture and color but much less than most bottom-land soils. Some spots of sandy and light-colored soils occur, principally along Boyer River, but these could not be mapped because they occur in such small irregular areas. Along East Soldier River much of the soil is intensely black and heavy, being almost silty clay loam. The areas of heavier soil, some of them silty clay loam, were so closely intermingled with typical Wabash silt loam, that they could not be indicated on the soil map. In many places along Soldier River the soil is more nearly dark chocolate brown when dry, but the color was not pronounced enough to warrant a separation from the Wabash series. The surface texture of the soil along Soldier River is extremely variable and intricately mixed, and the soil includes many heavy spots containing a high percentage of colloidal clay, in fact these spots are almost silty clay loam in texture. Many small patches, ranging from one-eighth acre to more than an acre, of dark grayish-brown or black silty clay loam occurring along many of the smaller tributary streams, are included with Wabash silt loam, such areas being too small to be shown as a separate soil type.

Wabash silt loam, a bottom-land soil, is extensively developed along all the streams of the county. The widest developments are

along Boyer, East Boyer, East Soldier, Middle Soldier, and Soldier Rivers and some of their larger tributaries. The bottom lands occur in narrow ribbonlike strips along the tributary streams extending well back toward the heads of the streams, and they range from 150 feet to as much as 1½ miles in width.

The greater part of this soil is subject to overflow only at exceptional flood periods. The channel of Boyer River has been straightened for some distance back from the southwest corner of the county, and new channels have been made to some extent along Nishnabotna, Soldier, and Middle Soldier Rivers, and for short distances along some of the larger tributary streams near their confluence with the main streams. A total of 13,098 acres is included in this drainage enterprise which affects most of the Wabash silt loam and Wabash silty clay loam areas in the county. The smaller narrow strips of land along the smaller streams are subject to the most frequent flood damage which, however, is not serious in most places. Pastures are maintained along these narrower bottom-land areas, and they provide good bluegrass and native-grass pasturage. A few trees grow along the banks of these streams.

This soil is very fertile, being high in organic matter and plant foods, and it is mellow, friable, and easy to work. In normal years crop yields are high.

Corn, the principal crop, produces from 45 to 80 bushels an acre, depending on seasonal conditions. Corn is usually grown for three years in succession and on some farms it is grown continuously for long periods without any apparent decrease in yield, owing to the high natural fertility of the soil. Wheat and oats give good yields but are apt to lodge in wet seasons. Alfalfa yields from 3 to 3½ tons an acre. Some wild hay is cut from the lower more poorly drained places. Crop rotation is practiced to a slight extent only. This soil is highly prized as a corn soil.

Most farms include only a small acreage of Wabash silt loam and are sold on the basis of the value of other soil types rather than the value of Wabash silt loam. In the larger areas where the stream channels have been straightened, the value of the land is higher than elsewhere.

Better drainage, for some of the depressed areas, and a more diversified cropping program, including legumes, would be highly beneficial.

Wabash silt loam, colluvial phase.—Wabash silt loam, colluvial phase, is very dark brown friable silt loam, high in organic matter, consisting of colluvial silt washed from the dark-colored upland prairies. The depth of the topsoil varies greatly, from 10 inches to 4 feet, but it averages between 15 and 20 inches. In many small depressions, colluvial clay has accumulated to such an extent that the texture has been changed to silty clay loam, but the areas are so small that it is impossible to separate them on the map. The subsoil, between depths of 18 and 28 inches, is dark-brown silty clay with a gray cast, and the lower part of the subsoil changes to grayish-brown or dull-gray silty clay containing some mottlings of yellow and rust-brown iron stains.

This soil occurs over the entire county at the source of many drainage lines and extends toward the streams for short distances.

No sharp boundary lines can be drawn between soil of the colluvial phase and typical Wabash silt loam, as they grade from one into the other.

Drainage is good for the most part, although water stands for some time in some of the basinlike areas and tiling is necessary to enable cropping. The greater part of the soil of this phase is left in native grasses to prevent gullying and washing, especially on the narrow strips extending up the hill slopes. Most of the land is rather flat, with a gentle slope toward the stream channel and a sharper slope downstream.

This soil is farmed in conjunction with Marshall silt loam and ordinarily produces higher yields of corn where naturally well drained or where proper drainage has been artificially provided. Small grains are likely to lodge.

Wabash silt loam, colluvial phase, is mellow, easy to farm, and very fertile. Drought causes little decrease in crop returns, as the soil retains moisture well even in prolonged dry periods. In reaction the soil ranges from slightly alkaline to slightly acid.

Land of this kind is farmed and sold with Marshall silt loam and ordinarily comprises less than 5 per cent of any one farm. The total acreage of the phase is much less than that of typical Wabash silt loam.

WABASH SILTY CLAY LOAM

The topsoil of Wabash silty clay loam, to a depth of 10 inches, is dark grayish-brown or black silty clay loam. It is underlain by dark grayish-brown or black clay loam or silty clay which is sticky and plastic. The subsoil, between depths of 24 and 44 inches, is dark grayish-brown or grayish-brown silty clay containing a few iron stains. The lower part of the subsoil, where dark, has a gray cast and is slightly lighter than the upper subsoil layer. In many places the lower subsoil layer is dull-gray heavy silty clay, mottled with lighter gray and brown at a depth of about 30 inches. In places, usually at a depth ranging from 15 to 20 inches from the surface, thin layers of lighter-textured and lighter-colored material, mostly silt, occur.

The texture of Wabash silty clay loam, as mapped in Crawford County, ranges from heavy silt loam to heavy silty clay loam because of the gradation from the silty clay loam to the closely associated and predominating Wabash silt loam, particularly near the boundary lines between the two soils.

Wabash silty clay loam occurs mainly along Boyer River, extending from below Deloit to the county line. Some areas lie along East Boyer River, and other areas are along the smaller streams. Some of the areas along the small streams are too small to map separately and are included with Wabash silt loam.

The surface relief of Wabash silty clay loam is almost level, and most of the land lies from 10 to 12 feet above the stream channel. Natural drainage is poor, owing to the flat surface relief and heavy subsoil, but artificial channels along the larger streams and open laterals carrying the water from the small upland drainage courses have greatly improved drainage conditions. Some crop damage occurs occasionally by water standing on these areas, but the water remains only a short time.

The soil is high in natural fertility, and crop yields are limited only by drainage conditions. Few or no trees grow on this land, most of which is in cultivation, only a small proportion being used for pasture. Wild hay is cut from some of the more poorly drained areas, and yields average about 2 tons an acre.

Corn is the main crop grown on this soil, and acre yields ranging from 40 to 50 bushels are common in favorable seasons. Small grains (wheat and oats) are grown only to a small extent, as such crops tend to grow rank and lodge in wet seasons. Alfalfa does well where the soil is well drained, but it is grown on only a very small acreage.

On account of the heavy clay texture, this soil must be carefully handled to obtain best results, and care should be taken in plowing and subsequent cultivation to prevent clodding and baking. The growing of sweetclover would greatly increase the downward movement of water. Better drainage is needed on many areas of this soil.

Some barnyard manure is used. Superphosphate or raw rock phosphate should be tried in an experimental way. Results from applications on similar soils having high nitrogenous content indicate its profitable use on this soil which ranges from neutral to slightly acid.

RAY SILT LOAM

To a depth of 7 inches the surface soil of Ray silt loam, a bottomland soil, is grayish-brown or yellowish-brown smooth silt loam. To a depth ranging from 15 to 22 inches it is underlain by grayish-brown silt loam containing some fine sand washed from the upland drift slopes. The lower subsoil layer is very dark grayish-brown or almost black silty clay loam or heavy silt loam. The light-colored surface and subsurface layers vary greatly in texture, ranging from buff fine powdery silt loam to almost silty clay loam.

This is an unimportant soil because of its small extent. A few small areas, ranging in size from 5 to 30 acres, occur along the lower course of Boyer River. A small area is 3½ miles northeast of Denison along East Boyer River.

This soil is formed by colluvial wash from the eroded hill slopes carried out into the bottoms by tributary streams cutting into and through the wider bottoms of the master streams. The soil is deposited in layers in the lower spots and depressions and along the smaller lateral drainage lines over the darker Wabash soils of the main bottoms.

Most of the land is under cultivation and is farmed with the surrounding Wabash soil areas. Drainage is good in the silt surface layer but may be restricted in the dark heavy silty clay subsoil. The topsoil is low in organic matter and needs applications of barnyard manure or the turning under of green-manure crops to increase the fertility. The soil is productive, but crop yields are lower than on Wabash silt loam.

SOILS AND THEIR INTERPRETATION

In this report the soils of Crawford County have been grouped in a number of series and types on the basis of their physical characteristics and their chemical constituents, as far as these could be readily ascertained in the field. The soils of any region are the

result of a great number of factors among which are the following: (1) The character of the parent material from which the soils have developed; (2) the processes—physical, chemical, and biological—to which the soils have been subjected during their development; and (3) the time during which the soil materials have been subjected to the soil-forming processes. The character of the soil-forming processes and the rapidity with which they have acted are determined to a large degree by climatic conditions. In this county the soils have developed under the influence of a mean annual temperature of 47.8° F. and a mean annual precipitation of about 30 inches. The precipitation indicates that the county is within the region where lime is being entirely removed from the soil by leaching. The county, however, is near the western edge of that region and is within a short distance of the region where lime is removed only from the surface layers and actually accumulates in the subsoil. Although precipitation is not sufficiently low to prevent the growth of trees, other conditions, probably the smooth surface relief combined with a moderately low rainfall, have operated to keep this a treeless region, to favor the growth of a thick grass cover, and to provide the proper conditions under which the organic matter supplied by the grass vegetation could be preserved in the upper part of the soil.

Where all the factors of soil formation of a given region act on the soil for a long time without interruption, the soil attains a uniform profile which may be regarded as normal for that region, or, as it is called, the regional profile. Such a profile can only be developed on a smooth, flat, or gently rolling surface where all the rainfall is retained and all the soil-forming processes can act without interruption. On areas where erosion proceeds with greater or less rapidity, the upper layer of soil is constantly being removed and newer material is being brought near the surface. On such soil areas sufficient time has not elapsed for the development of the regional profile.

The most mature soils of the county, or those which have been left undisturbed and subjected to weathering for the longest time, are on the smooth well-drained uplands and terraces. These soils have developed a very dark grayish-brown surface layer, as a result of the accumulation of a large quantity of black well-decomposed organic material, composed mainly of partly decayed grass roots, intimately combined with the mineral part of the soil.

The surface layer has a single-grained or finely granular structure, being almost everywhere silt loam in texture. On the more nearly level or rolling areas this surface layer averages about 12 inches thick. The color of the heavier-textured layer below, which extends to a depth ranging from 18 to 24 inches, is dark brown, but it grades downward into brown. The dark color is imparted by organic matter which has been carried downward from the layer above, following shrinkage cracks, root holes, and worm and insect burrows. In place the material of this transitional layer is slightly more firm and compact than that of the topsoil, but it is very granular when broken up. The next lower layer may be brown or yellowish brown in color and heavy silt loam or silty clay loam in texture. It is rather compact, but the material is easily broken up

and pulverized. Granulation is very indistinct, and in many places this layer is not present. At a depth ranging from 45 to 60 inches this layer merges with the parent material which has been little altered by weathering, is yellowish brown or grayish yellow, and, in most of the loess areas, has a heavy silt loam texture. In texture and structure the material in this layer does not differ greatly from that in the layer above.

The lime carbonate has been removed from the upper layers of the soil but is normally present in the originally calcareous parent material. On the smooth well-drained upland, where the surface has not been lowered by erosion, leaching of the carbonates has proceeded in most places to a depth of about 60 inches. Below this depth the loess contains sufficient lime carbonate to effervesce when treated with acid. On the slopes below the flat divides lime carbonate is present near the surface, the thickness of the overlying leached layers depending on the rapidity and extent of erosion. On eroded slopes and tops of hills the leached material is thin, and the light-colored calcareous loess is exposed at the surface in small areas.

The principal characteristics considered in the foregoing paragraphs are those imparted to the soil by the soil-forming processes. In the differentiation of soils into series, consideration has also been given to the source, process of accumulation, and composition of the material from which the soils have developed. A soil series, therefore, includes soils that are similar in color, origin, and structural characteristics. The soil types composing a series differ from each other mainly in the texture, or the coarseness and fineness, of the surface soil. The soil type is the unit of soil mapping. The general characteristics described are best shown in this county by the Marshall soils which have developed on the upland over the silty parent material known as loess. This loess is the surface covering of the entire upland, except in small areas where it has been removed by erosion. The original loess sheet was evidently of such thickness that deep erosion might take place before the underlying rock would be exposed.

A less perfect soil development occurs in small areas where the underlying drift is exposed. The Kansan drift, which consists of beds of light-gray or blue clay interspersed with beds of sandy clay, presumably underlies the uplands, but it is buried so deeply by the loess that only small areas along the steeper stream slopes have been exposed to weathering. At a depth of several feet large quantities of lime remain in the drift material and indicate the calcareous character of the original deposit, but in this county the upper weathered layers of the soil are thoroughly leached, and lime in few places, if anywhere, occurs within 3 feet of the surface. Other drift sheets underlie the Kansan drift and contribute materials which modify the soils in small areas, but the exposures are in no place of sufficient size to produce considerable areas of distinctive soils. In Crawford County only one type of soil, Carrington loam, has developed over the Kansan drift. It has a very dark grayish-brown loam surface soil, a transitional layer of dark-brown silty clay, and a subsoil of yellowish-brown silty clay loam material. The

parent material, at a depth ranging from 24 to 30 inches, is brown sandy or gravelly clay.

The Judson soils, developed over deep colluvial or slope deposits, also belong to the group of soils which have dark surface layers and well-drained and well-oxidized lower layers. These are young soils and owe their dark color to organic matter brought down in sediments from other dark-colored upland soils.

The parent material of the alluvial soils of the county consists of sediments brought down from the uplands and deposited on the flood plains of streams. The greater part of the Missouri River alluvium is composed of reworked drift and loess materials similar to the soil materials of the upland areas, and the alluvial deposits along the shorter streams, which have their sources within the county, consist of sediments derived entirely from local materials. The older alluvial deposits left as terraces by the lowering of the stream beds have undergone the same processes of weathering as the upland soils and have developed similar characteristics. Thus, Waukesha silt loam, which has developed under conditions of good drainage, has reached the same stage of development as Marshall silt loam of the uplands.

A light-colored soil occurs on eroded slopes in the western part of the county. In these areas erosion has prevented the accumulation of large quantities of organic matter in the surface soil. A forest growth covered the eroded slopes, so that soils characteristic of forested areas have resulted. The soils in these forested areas are thinner and lighter in color than the soils of the smooth upland. In most areas the surface layer is light grayish brown, the texture is silt loam, and the structure is single grained. The depth to which the surface soil has accumulated depends on the rapidity of erosion and ranges from a very thin covering on the steep slopes and tops of knolls to about 8 inches on the more level areas. The surface soil is underlain by a slightly more compact heavier brown or yellowish-brown layer which in most places reaches a depth not greater than 18 inches and in many places is very thin and not distinctly developed and the surface soil apparently rests on the parent material. Where this layer is thick, the structure may be granular, but in many other places the granular structure is not distinctly developed. The next lower horizon is the parent material, which, in Knox silt loam, the only representative of this group in the county, is loess. The material of this horizon is yellowish-brown silt similar to that of the lower horizon of Marshall silt loam. It shows no granulation but is soft and structureless. Lime is present in abundance and in eroded areas occurs very near the surface.

The soils of the first bottoms of the larger streams were developed under conditions of restricted drainage. The silt loam and silty clay loam of the Wabash series have black surface soils, with a fine-granular structure, and gray or mottled gray and yellow subsoils which are heavier in texture than the surface soils. The profiles of these soils differ considerably, depending on the character of the alluvium from which they have developed and the depth to which oxidation has taken place. Ray silt loam was formerly a dark-colored heavy Wabash soil which has been covered by a light-colored silty layer.

SUMMARY

Crawford County is located in the western part of Iowa, midway between the northern and southern State boundary lines and one county removed from Missouri River which forms the western boundary of the State. The total area is 715 square miles, or 457,600 acres.

The county lies on a once smooth gently rolling prairie which has been slightly to deeply carved by an intricate system of drainage ways, affording good or excessive drainage to all parts of the uplands.

The surface relief ranges from gently rolling in the northeastern corner and north-central part of the county to sharply rolling in the southwestern part.

The bottom lands are well developed along Boyer River and East Boyer River, the master streams. The alluvial lands are mostly flat, with a gentle slope toward the streams. Drainage is slow in some low flat depressions along Boyer River.

The county ranges in elevation from 1,369 feet above sea level on the uplands at the eastern side to 1,092 feet above sea level in the valley of Boyer River in the southwestern corner.

According to the 1930 Federal census, the population of the county is 21,028. Denison is the county seat and main distributing and shipping center. Many smaller towns are important trading centers and afford excellent shipping facilities.

The climate is characterized by cold winters and warm summers. The mean annual temperature is 47.8° F., the mean annual rainfall is 29.44 inches, and the frost-free season averages 146 days.

The county is well served by railroads, main and branch lines of the Chicago & North Western, the Illinois Central, and the Chicago, Milwaukee, St. Paul & Pacific systems traversing the county. Omaha and Sioux City are the principal markets. Many miles of paved and graveled roads are in the county, and dirt roads are graded and well kept.

An excellent school system, rural mail routes, and telephone service cover the entire county.

Agriculture consists principally of grain and hay farming and livestock raising and feeding.

The soils of the county have good natural productivity, are nearly all of loessial origin, are retentive of moisture, are easily tilled, and are highly productive. Reworked loessial silts and clays cover the bottom lands.

Land values range from $65 an acre to more than $200, depending on the soils, location of the farm, and improvements.

Eight soil types and three phases of types are mapped in Crawford County. Marshall silt loam is the predominating soil and, with its phases, constitutes 73.7 per cent of the area of the county.

Marshall silt loam is very dark grayish-brown silt loam of loessial origin. It is of excellent physical structure, well drained, and highly productive. Alfalfa and sweetclover produce high yields on this soil, and oats do well. The surface soil on the gently rolling areas is deeper. No artificial drainage is necessary on this soil.

Marshall silt loam, shallow phase, is characteristically developed on the more abrupt hill slopes. Eroded spots and small drift pock-

ets occur within areas of this shallow soil, but these are too small to differentiate as a different soil type. This soil must be carefully handled to prevent serious damage by erosion. A small part of it is covered with scrub trees. Where properly handled, crop yields are only slightly lower than on typical Marshall silt loam.

Marshall silt loam, light-colored phase, is a lighter-colored soil than typical Marshall silt loam, being medium grayish brown. The producing power of the land is slightly less than of typical Marshall silt loam.

Knox silt loam consists of buff or yellowish-brown upland loess. It is low in organic matter and less productive than Marshall silt loam.

Carrington loam is an inextensive soil in this county. It produces nearly as high crop yields as Marshall silt loam, with which it is associated.

Waukesha silt loam is a terrace soil similar to Marshall silt loam.

Judson silt loam is a deep black silt loam occurring at the base of upland slopes, normally above overflow. It is well drained and highly productive.

Wabash silt loam is an alluvial soil occurring on the bottom lands throughout the county. The larger bodies are rarely subject to overflow, owing to artificial straightening of the stream channels, but some narrow areas suffer from flood waters. The soil is highly productive and prized for growing corn.

Wabash silt loam, colluvial phase, is a colluvial soil washed from the uplands into narrow drainage channels at the heads of many drainage ways. It is rich and highly productive where well drained, but in places it is poorly drained and is left largely in pasture.

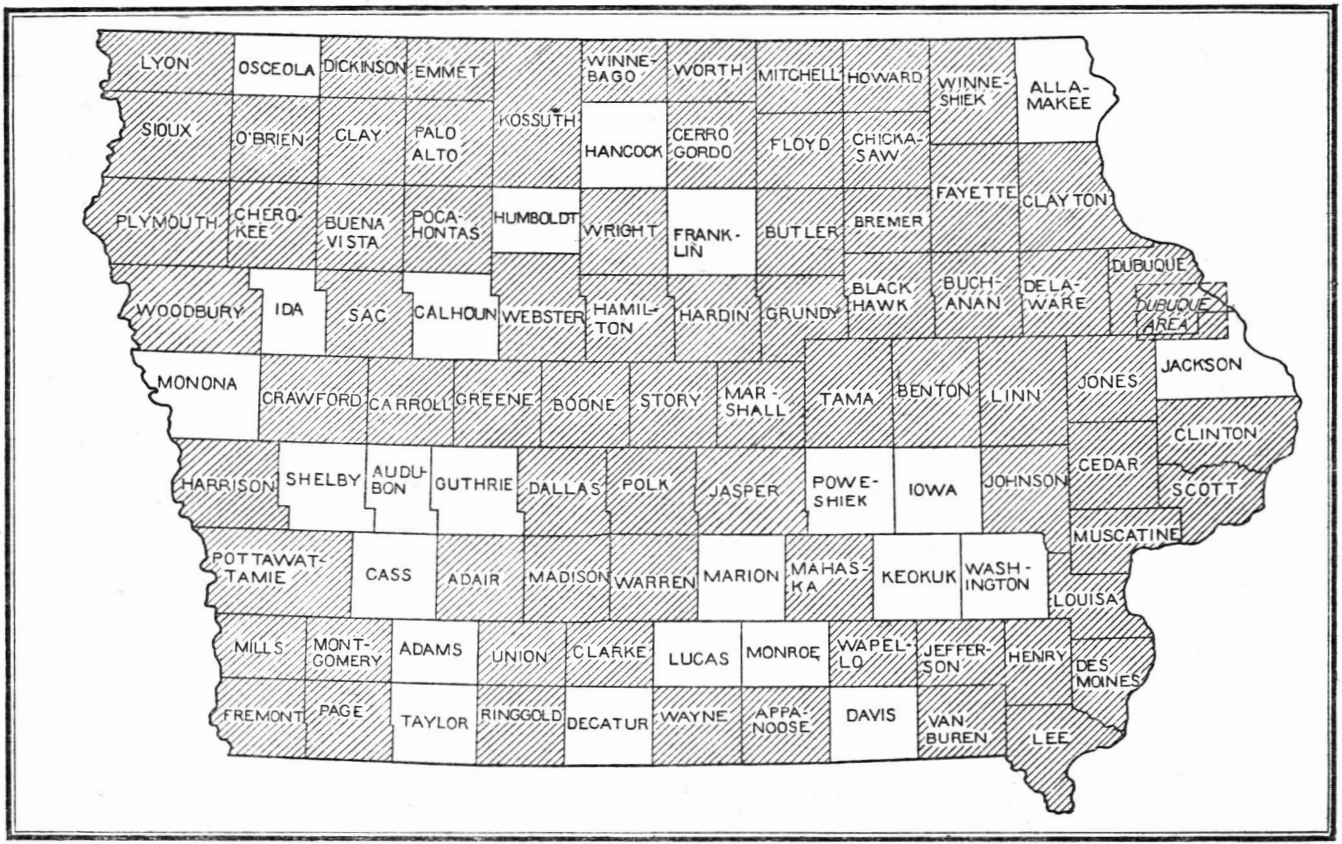
Wabash silty clay loam is almost black and resembles Wabash silt loam, but it is heavier in texture. It is normally highly productive and has good drainage. Some of it has rather restricted drainage, and crops suffer in wet seasons.

Ray silt loam is a light-yellow or buff colluvial soil, from 10 to 24 inches thick, deposited on alluvial fans on the bottom lands over the almost black Wabash soils. The topsoils are low in organic matter but are moderately productive.

O

Authority for printing soil survey reports in this form is carried in Public Act No. 269, Seventy-second Congress, second session, making appropriations for the Department of Agriculture, as follows:

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 soil area surveyed by the Bureau of Chemistry and Soils, Department of Agriculture, in the form of advance sheets bound in paper covers, of which not more than two hundred and fifty copies shall be for the use of each Senator from the State and not more than one thousand copies for the use of each Representative for the congressional district or districts in which a survey is made, the actual number to be determined on inquiry by the Secretary of Agriculture made to the aforesaid Senators and Representatives, and as many copies for the use of the Department of Agriculture as in the judgment of the Secretary of Agriculture are deemed necessary.



Areas surveyed in Iowa, shown by shading. Detailed surveys shown by northeast-southwest hatching

Accessibility Statement

This document is not accessible by screen-reader software. The U.S. Department of Agriculture is committed to making its electronic and information technologies accessible to individuals with disabilities by meeting or exceeding the requirements of Section 508 of the Rehabilitation Act (29 U.S.C. 794d), as amended in 1998. Section 508 is a federal law that requires agencies to provide individuals with disabilities equal access to electronic information and data comparable to those who do not have disabilities, unless an undue burden would be imposed on the agency. The Section 508 standards are the technical requirements and criteria that are used to measure conformance within this law. More information on Section 508 and the technical standards can be found at www.section508.gov.

If you require assistance or wish to report an issue related to the accessibility of any content on this website, please email Section508@oc.usda.gov. If applicable, please include the web address or URL and the specific problems you have encountered. You may also contact a representative from the USDA Section 508 Coordination Team.

Nondiscrimination Statement

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the

Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at http://www.ascr.usda.gov/complaint_filing_cust.html and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by:

(1) mail: U.S. Department of Agriculture
Office of the Assistant Secretary for Civil Rights
1400 Independence Avenue, SW
Washington, D.C. 20250-9410;

(2) fax: (202) 690-7442; or

(3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.