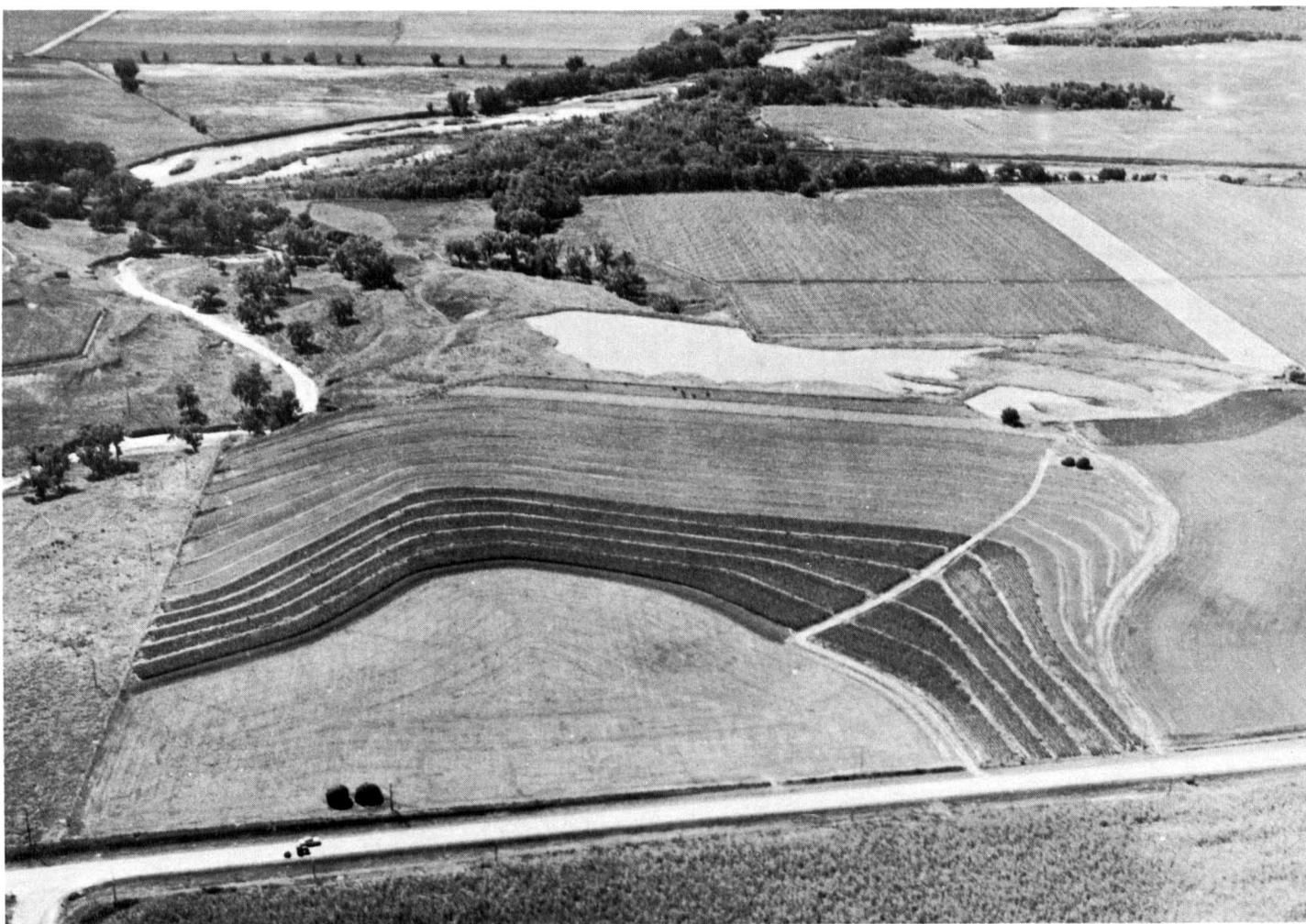


Issued February 1960

# SOIL SURVEY

## Geary County, Kansas



UNITED STATES DEPARTMENT OF AGRICULTURE  
Soil Conservation Service  
in Cooperation with  
KANSAS AGRICULTURAL EXPERIMENT STATION

## HOW TO USE THE SOIL SURVEY REPORT

**T**HIS REPORT on Geary County, Kans., will serve several groups of readers. It will help farmers in planning the kind of management that will protect their soils and provide good yields; assist engineers in selecting sites for roads, ponds, buildings, and other structures; aid ranchers in managing their range; and add to the soil scientist's fund of knowledge.

In making this survey, soil scientists walked over the land. They dug holes and examined surface soils and subsoils; measured slopes with a hand level; noticed differences in growth of crops, weeds, and brush; and, in fact, recorded all the things that they believed might affect the suitability of the soils for farming, grazing, and related uses.

The scientists plotted the boundaries of the soils on aerial photographs. Then, cartographers prepared from the photographs the detailed soil map in the back of this report. Fields, roads, rivers, and many other landmarks can be seen on the map.

### Locating the soils

Use the index to the map sheets to locate areas on the large map. The index is a small map of the county on which numbered rectangles have been drawn to show where each sheet of the large map is located. When the correct sheet of the large map is found, it will be seen that the boundaries of the soils are

outlined and that there is a symbol for each kind of soil. All areas marked with the same symbol have the same kind of soil. Suppose, for example, an area located on the map has a symbol La. The legend for the detailed map shows that this symbol represents Ladysmith silty clay loam, 0 to 1 percent slopes. This soil, and all the others mapped in the county, are described in the section, Descriptions of the Soils.

### Finding information

Few readers will be interested in all of the soil survey report, for it has special sections for different groups.

*Farmers and ranchers* can learn about their soils from the section, Descriptions of the Soils, and how to manage them and what yields to expect in the section, Use and Management of Soils.

*Soil scientists* will find information about how the soils were formed and how they are classified in the section, Formation and Classification of Soils.

*Students, teachers, and other users* will find information about soils and their management in various parts of the report, depending on their particular interest.

*Persons not familiar with the county* will find information on its history, natural resources, climate, and agriculture in the last part of the report.

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# SOIL SURVEY OF GEARY COUNTY, KANSAS

SURVEY BY RALPH G. DUNMIRE, SOIL CONSERVATION SERVICE, AND O. W. BIDWELL, KANSAS AGRICULTURAL EXPERIMENT STATION

REPORT BY O. W. BIDWELL

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UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH KANSAS AGRICULTURAL EXPERIMENT STATION

**G**EARY COUNTY is in the northeastern quarter of Kansas. It is L-shaped, and its greatest dimensions are 24 miles from north to south and 25 miles from east to west. Its area is approximately 400 square miles. Of the 105 counties in Kansas, only Doniphan and Wyandotte Counties are smaller (fig. 1).

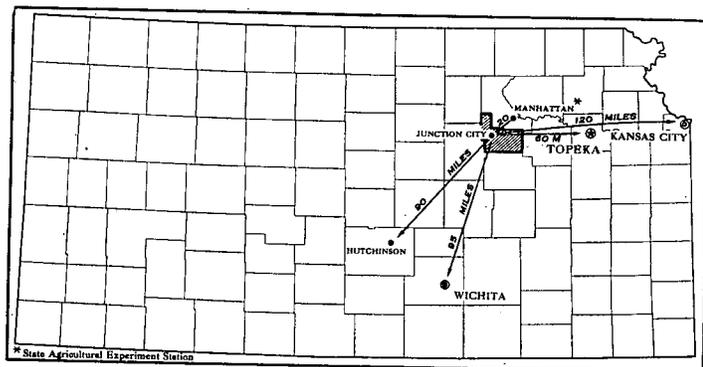


Figure 1.—Location of Geary County in Kansas.

This survey was made as part of the technical assistance furnished by the Soil Conservation Service to the Geary County Soil Conservation District. The district was organized in 1939, the fourth to be organized in Kansas. By 1957, about 80 percent of the farmers in the county had conservation plans for their farms.

Fieldwork for this survey was completed in 1955. Unless otherwise indicated, all statements in the report refer to conditions in the county at that time.

The soils mapped in this county are described individually in the section, Descriptions of the Soils. They are also discussed in interpretive groups. These are the capability groups and range sites, which are based on use and management; and the higher categories of soil classification.

## Soil Associations of Geary County

The soils in Geary County occur in rather definite patterns, which are related to the topography, or lay of the land. There are 10 main soil areas, or soil associations, each of which has a distinctive topography and arrange-

ment of soils. These general soil areas are shown on the colored map in the back of this report.

### 1. Humbarger-Muir Soil Association

This association covers about 11,400 acres on the flood plains and second bottoms of the Smoky Hill River. It is flooded occasionally. At times of major floods the river changes its course, leaving old meanders and oxbows.

Besides the Humbarger and Muir soils, this association includes areas of Solomon and Sutphen soils. The Humbarger and Solomon soils, which constitute about 75 percent of the total area, are on the first bottoms. The Muir and Sutphen soils are on the second bottoms. The Solomon soil occurs in depressions and old stream channels. The Sutphen is in depressions and nearly level backwater areas near the outer edges of the valley.

Most of the acreage is used for cultivated crops, chiefly corn, small grains, sorghum, and alfalfa. Trees grow mainly along the river channels and around farmsteads. Maintaining fertility is the main problem on these soils.

### 2. Cass-Sarpy Soil Association

This association, about 11,700 acres in extent, is on the flood plains and second bottoms of the Republican and Kansas Rivers. Most of this area is nearly level, but a small part is sloping, and there are small depressions. There is less difference in the levels of the stream terraces in these areas than there is along the Smoky Hill River.

Besides the Cass and Sarpy soils, which are on the flood plains, this association includes areas of Riverwash on the flood plains and of Muir soils, Sutphen soils, and Sand dunes, Sarpy material, on the second bottoms. As a whole, these soils are sandier than those in the Humbarger-Muir soil association.

These soils are used mainly for corn, small grains, alfalfa, and sorghum. Truck crops are also grown, but much less extensively. Trees grow along the river channels and old stream meanders and around farmsteads. If these soils are cultivated, maintaining fertility and supplying organic matter are the main problems.

### 3. Tully-Muir-Hobbs Soil Association

This association covers about 38,000 acres on the nearly level flood plains and second bottoms of the

secondary streams and their tributaries. The first bottoms are about a third as wide as the second bottoms.

The Hobbs soil is along the upper reaches of the large creeks and on the flood plains of the smaller streams. The Muir soils are on the second bottoms, which slope slightly toward the streams. The Tully soils are on the more strongly sloping fans on the second bottoms at the base of the valley slopes. The association also includes areas of Humbarger soils, which are on the flood plains of the large creeks near their junction with the main rivers.

Most of this area is used for corn, small grains, sorghum, and alfalfa. Trees grow along the stream channels. Maintaining fertility and supplying organic matter are the main problems on these soils. Erosion control is needed on the stronger slopes.

#### 4. Shellabarger-Farnum-Derby Soil Association

This soil association covers about 6,800 acres. It occupies two areas of gently undulating to rolling relief just north of the valley of the Smoky Hill River.

This association includes areas of Hastings soils, as well as Shellabarger, Farnum, and Derby soils. The Shellabarger and Farnum are the most extensive. The Shellabarger soils occur mainly near the bluffs along the Smoky Hill River. The Hastings soils occupy the highest areas, which are generally those farthest from the river. The Farnum soils lie between the Shellabarger and Hastings soils. The Derby soil occupies a small dunelike area about 2 miles southwest of Junction City.

These soils are used mostly for wheat, sorghum, and alfalfa. The steeper areas and most of the Derby soil are in native grass pasture. Practices to improve fertility and control erosion are needed on these soils.

#### 5. Hastings-Geary Soil Association

This soil association occurs extensively along the bluffs of the Republican River and to a lesser extent along the Smoky Hill and Kansas Rivers. It covers about 17,100 acres. The relief is undulating to very strongly sloping.

Besides the Hastings and Geary soils, this association includes areas of Shellabarger, Sogn, Monona, Hobbs, and Farnum soils. The Shellabarger and Farnum soils occur near Alida, in the upland north and east of the great bend of the Republican River. The Monona soil is on the steeper bluffs bordering the valley. The Hastings soils lie on more gentle slopes above the Monona soil. The Geary soils occur throughout the area but are most extensive east of the Smoky Hill River, where areas of an old reddish-brown loess are exposed. The Sogn soils are in narrow, steeply sloping areas where limestone and shale bedrock outcrop along the valley sides. The Hobbs soil is on the flood plains of the small streams.

About 52 percent of the gently sloping Hastings and Geary soils is in cultivation. Corn, small grains, sorghum, and alfalfa are the chief crops. About 45 percent of these soils is in native pasture, and about 3 percent is in forest. Of the steeply sloping Monona soil, about 75 percent is in trees, about 19 percent is in native pasture, and about 6 percent is cultivated. Controlling erosion and increasing soil fertility are the chief problems in the cultivated areas.

#### 6. Crete Soil Association

This soil association covers about 29,300 acres. It occurs mainly in two large areas, one east and one west of the Republican River. The slopes range from nearly level on the divides to steep along the entrenched streams.

Although the Crete soils are by far the most extensive, there are small areas of the Sogn, Irwin, Hobbs, Geary, and Hastings soils in this association. The Crete soils occur on the broad divides and gentle slopes. The Sogn soils are on steep slopes where limestone and shale bedrock outcrop. The Irwin soils occur mostly on gentle slopes between the Crete and Sogn soils. The Hastings and Geary soils are on slopes along the boundaries between this association and the Hastings-Geary soil association. The Hobbs soil is on the nearly level flood plains of small streams.

Corn, small grains, sorghum, alfalfa, and sweetclover are grown on the soils of this association. Native grass pastures cover many of the steeper slopes, especially on the Sogn soils. Trees grow along the streams, on some of the steep slopes, and around the farmsteads. If these soils are cultivated, erosion and low fertility are the principal limitations.

#### 7. Sogn-Florence Soil Association

This association of about 90,000 acres occupies the area called the Flint Hills or the Bluestem Hills (fig. 2). The area consists of ridgetops, side slopes, and small valleys that have steeply sloping sides.

Besides the Sogn and Florence soils, this association includes some areas of Dwight, Irwin, and Hobbs soils. The Sogn and Florence soils are on the narrow ridges and the valley slopes. The Dwight soil is chiefly on nearly level ridgetops that are more than 300 feet wide. The Irwin soils occur on some of the gently sloping ridges. The Hobbs soil is on narrow bottoms in some of the small valleys.

The area is in native grass, and most of it is used for grazing. Along the streams, some of the pastures are combined with cropland to form farming units. The main management problem in this area is maintaining a vigorous stand of native grasses.

#### 8. Dwight Soil Association

The total extent of this soil association is about 9,000 acres. It occurs mostly in the eastern part of the county on nearly level ridgetops that are 300 to 500 feet wide. It is surrounded by the Sogn-Florence soil association.

The Dwight soil is dominant, but small areas of the Irwin and Sogn soils are included, mostly near the outer edges of the ridgetops.

More than 70 percent of this association is in native grass. Crops are grown in some of the larger individual areas and in some areas that are surrounded by other cultivated soils. Wheat, alfalfa, and sweetclover are the main crops produced.

Practices for controlling erosion and maintaining good tilth are necessary in cultivated areas. The main problem in managing the areas in native grass is maintaining a vigorous stand.



Figure 2.—Typical Flint Hills topography of ridgetops, strong sideslopes, and small stream valleys. Sogn-Florence soil association.

## 9. Irwin Soil Association

This soil association of about 27,100 acres occupies the gently sloping uplands in the southern part of the county.

Although the Irwin soils are the most extensive in this association, Ladysmith soils occur in small depressions and Sogn soils occur on the steeper slopes along the drainageways where limestone and shale are close to the surface. In areas of Sogn soils, there are outcrops of limestone.

Most of the acreage is cropped to wheat. Alfalfa, sweetclover, and a little corn and sorghum are also grown. Controlling erosion and maintaining fertility are the chief management problems.

## 10. Ladysmith-Irwin Soil Association

This soil association covers about 11,500 acres in southeastern Geary County. The area is composed of broad level ridges and gentle slopes.

The Ladysmith soils occupy the nearly level areas, and the Irwin soils, the gentle slopes. Also in this association are small areas of Dwight, Florence, and Sogn soils.

Small grains, sorghum, alfalfa, and sweetclover are grown on these soils, but wheat is the principal crop. A small acreage is still in native grasses. Trees grow mainly around the farmsteads. The main problems of management are controlling erosion and maintaining tilth and fertility.

## Use and Management of Soils

In this section you will find an explanation of the nationwide system of classifying soils according to their capability for farming and other uses; a classification of the soils of Geary County according to this system; and suggestions that will help you to get good yields of cultivated crops, to keep good stands of native plants on the range, and to make use of trees to protect cropland and rangeland.

## Capability Groups of Soils

Capability grouping is a system of classification used to show the relative suitability of soils for crops, grazing, forestry, and wildlife. It is a practical grouping based on the needs and limitations of the soils, the risks of damage to them, and also their response to management. There are three levels above the soil mapping unit in this grouping. They are the capability unit, subclass, and class.

The capability unit, which may also be called a management group of soils, is the lowest level of soil capability grouping. A capability unit is made up of soils similar in management needs, in risk of damage, and in general suitability for use.

The next broader grouping, the subclass, is used to indicate the dominant kind of limitation. The letter symbol "e" indicates that the main limiting factor is risk of erosion if the plant cover is not maintained; "w" means that excess water retards plant growth or interferes with cultivation; and "s" shows that the soils are shallow, droughty, or generally low in fertility.

The broadest grouping, the capability class, is identified by Roman numerals. All the soils in one class have limitations and management problems of about the same degree, but of different kinds, as shown by the subclass. All of the classes except class I may have one or more subclasses.

Soils that are suitable for annual or periodic cultivation of annual or short-lived crops are in classes I, II, and III.

Class I soils are those that have the widest range of use and the least risk of damage. They are level or nearly level, productive, well drained, and easy to work. They can be cultivated with almost no risk of erosion and will remain productive if managed with normal care.

Class II soils can be cultivated regularly but do not have quite so wide a range of suitability as class I soils. Some class II soils are gently sloping; consequently, they need moderate care to prevent erosion. Other soils in class II may be slightly droughty, or slightly wet, or somewhat limited in depth.

Class III soils can be cropped regularly, but they have a narrower range of use than class II soils and need even more careful management.

Class IV soils have greater natural limitations than those in class III, but they can be cultivated for some crops under very careful management.

The soils in classes V, VI, and VII normally should not be cultivated for annual or short-lived crops, but they can be used for pasture or range, for woodland, or for wildlife.

Class V soils are nearly level or gently sloping but are droughty, wet, low in fertility, or otherwise unsuitable for cultivation. There are no class V soils in Geary County.

Class VI soils are not suitable for cultivated crops, because they are steep, or droughty, or otherwise limited, but they give fair yields of forage or forest products. Some soils in class VI can, without damage, be cultivated enough so that fruit trees or forest trees can be set out or pasture crops seeded.

Class VII soils provide only poor to fair yields of forage or forest products. They have characteristics that limit them severely for these uses.

The soils in class VIII have practically no agricultural use. Some of them have value as watersheds, wildlife habitats, or recreational areas.

The soils of Geary County have been grouped in the following capability classes, subclasses, and units:

Class I.—Soils that are very good for crops and have few limitations that restrict their use.

Unit I-1.—Soils that are deep, dark colored, nearly level, and well drained.

Unit I-2.—Soils that are deep, dark colored, nearly level, and normally well drained.

Class II.—Soils that have some limitations that reduce the choice of plants or necessitate some conservation practices.

Subclass IIe.—Soils that are likely to erode if not protected.

Unit IIe-1.—Deep, dark-colored, well-drained silty clay loams.

Subclass IIw.—Soils that have moderate limitations because of excess water.

Unit IIw-1.—Deep, dark-colored, somewhat poorly drained silty clay.

Subclass IIs.—Soils that have moderate limitations of tilth and fertility.

Unit IIs-1.—Deep, dark-colored silty clay loams.

Unit IIs-2.—Deep, moderately dark colored fine sandy loam.

Unit IIs-3.—Deep, moderately dark colored alluvial soils.

Class III.—Soils that have severe limitations that reduce the choice of plants or necessitate special conservation practices, or both.

Subclass IIIe.—Soils that are severely limited by erosion if tilled.

Unit IIIe-1.—Deep, dark-colored silty clay loams over a dense, compact clay subsoil.

Unit IIIe-2.—Deep, dark-colored silt loam and silty clay loams.

Unit IIIe-3.—Deep and moderately deep, dark-colored fine sandy loam and sandy loam.

Unit IIIe-4.—Deep, dark-colored silty clay loam.

Subclass IIIw.—Soils that are severely limited by excess water.

Unit IIIw-1.—Nearly level clayey soils.

Subclass IIIs.—Soils that are severely limited by low fertility and little capacity for holding available water.

Unit IIIs-1.—Deep, light-colored, nearly level sand.

Class IV.—Soils that have very severe limitations that restrict the choice of plants or necessitate very careful management, or both.

Subclass IVe.—Soils that are very severely eroded and subject to further erosion if not protected.

Unit IVe-1.—Deep, dark-colored silty clay loam.

Unit IVe-2.—Deep silt loam and silty clay loam.

Unit IVe-3.—Deep, severely eroded silty clay loam.

Unit IVe-4.—Deep sandy loam that is low in fertility.

Subclass IVs.—Soils that are very severely limited.

Unit IVs-1.—Silty clay loam over claypan.

Class VI.—Soils that have severe limitations that make them generally unsuitable for cultivation and limit their use largely to permanent cover.

Subclass VIe.—Soils subject to rapid erosion if not protected.

Unit VIe-1.—Strongly sloping or severely eroded silty clay loam.

Unit VIe-2.—Nearly level to steeply sloping loamy soils.

Unit VIe-3.—Sandy soils with low fertility.

Unit VIe-4.—Very shallow to deep, steeply sloping soils over limestone and shale.

Class VII.—Soils that are unsuitable for cultivation and have very severe limitations for pasture and trees.

Subclass VIIs.—Soils that are very shallow to bedrock.

Unit VIIs-1.—Very shallow rocky clay loam over limestone.

Class VIII.—Soils not suitable for crops, grasses, or woody plants.

Unit VIIIs-1.—Sand deposits.

In the following pages, the soils of Geary County are placed in capability units, and suggestions are given for the use and management of the soils in each unit.

#### CAPABILITY UNIT I-1

#### SOILS THAT ARE DEEP, DARK COLORED, NEARLY LEVEL, AND WELL DRAINED

These soils are easy to work. They take in water, store it, and give it up readily to crops. Erosion is not a problem. Crop yields are high. The soils are—

Muir loam.

Muir silty clay loam.

Hastings silty clay loam, 0 to 1 percent slopes.

Suitable crops for these soils are corn, oats, wheat, sorghum, alfalfa, and sweetclover. The Muir soils, which are in the valleys and are less exposed to hot dry winds, produce better corn than the Hastings soil, which is on the uplands. In some years wind erosion may be a slight hazard. The smaller streams occasionally flood Muir silty clay loam.

To supply organic matter and maintain fertility, include a legume in the cropping sequence and return all crop residues to the soil. Grow alfalfa for about 2 or 3 years and follow it with 4 to 6 years of row crops or small grains. Apply fertilizer and lime according to need, as indicated by soil tests.

**CAPABILITY UNIT I-2****SOILS THAT ARE DEEP, DARK COLORED, NEARLY LEVEL, AND NORMALLY WELL DRAINED**

The soils in this unit occur on first bottoms. They are—

Hobbs silt loam.  
Humbarger clay loam and loam.

Corn, wheat, oats, sorghum, alfalfa, and sweetclover do well on these soils. The soils probably will be less harmed by continuous row cropping than others in the county. Nevertheless, it is advisable to grow a legume crop every 5 or 6 years to aid in maintaining good soil tilth, structure, and permeability.

Trees that grow at the edges of fields compete with the crops and reduce crop yields. They do, however, give the crops some protection against the hot winds.

The chief hazard of these soils is flooding. The Hobbs soil, which lies along the smaller streams, is subject to occasional flash floods. The fields are hard to manage because they are cut up by streams, valley walls, and terrace edges. Soils of this unit are suitable for irrigation. Apply fertilizer according to need, as indicated by soil tests.

**CAPABILITY UNIT IIe-1****DEEP, DARK-COLORED, WELL-DRAINED SILTY CLAY LOAMS**

The soils in this unit occur on the uplands and on colluvial slopes. They are—

Crete silty clay loam, 1 to 4 percent slopes.  
Hastings silty clay loam, 1 to 4 percent slopes.  
Tully silty clay loam, 1 to 4 percent slopes.

Suitable crops for these soils are oats, wheat, sorghum, alfalfa, and sweetclover. Corn is suitable for the Hastings soil.

Grow legumes in the cropping sequence to improve soil structure and add organic matter. Return all crop residues to the soil. Alfalfa stands should remain 2 to 3 years. Follow alfalfa with 3 to 5 years of row crops and small grains. Smooth brome grass or native grasses can be used to seed waterways.

Contour tillage will help to conserve moisture and reduce erosion. Terraces may be needed on long slopes. Diversion terraces may be needed to protect the Tully soil from water that runs off higher slopes. Apply fertilizer and lime according to need, as indicated by soil tests.

**CAPABILITY UNIT IIw-1****DEEP, DARK-COLORED, SOMEWHAT POORLY DRAINED SILTY CLAY**

Sutphen silty clay is the only soil in this unit. It occurs on nearly level terraces. It has a clayey subsoil.

Suitable crops for this soil are wheat, oats, sorghum, alfalfa, and sweetclover. Wheat is the main crop; however, corn is grown in years of adequate moisture and legumes in years of moisture deficiency.

Follow legume crops with 3 to 5 years of small grains and row crops. A brome grass-alfalfa mixture will improve the moisture-absorbing capacity.

Water erosion is not a problem on this soil. Wind erosion may occur in spring if the soil is left unprotected. The chief problem is wetness, which, in years of high rainfall, hinders tillage and harvesting. During dry years this soil tends to be droughty and difficult to work. Timely tillage and growing legumes and grasses in the rotation will improve the tilth. Apply fertilizer and lime according to need, as indicated by soil tests.

**CAPABILITY UNIT IIe-1****DEEP, DARK-COLORED SILTY CLAY LOAMS**

The soils in this unit have clayey subsoils. They are—

Crete silty clay loam, 0 to 1 percent slopes.  
Irwin silty clay loam, 0 to 1 percent slopes.  
Ladysmith silty clay loam, 0 to 1 percent slopes.

Suitable crops are wheat, oats, sorghum, alfalfa, and sweetclover. Corn may be grown on the Crete soil.

Include legumes in the rotation to increase fertility, add organic matter, and make the subsoil more permeable. Grow alfalfa for 2 or 3 years. Follow it with 3 to 4 years of small grains or row crops. For the Ladysmith and Irwin soils, a suitable sequence consists of sweetclover followed by 2 to 4 years of wheat.

There is little danger of water erosion. In the spring of some years, wind erosion may occur on unprotected land—especially if the soil has been fall plowed. Small depressions in broad, flat areas may be wet during years of high rainfall. These spots may hinder tillage or harvesting.

Apply fertilizer and lime according to need, as indicated by soil tests.

**CAPABILITY UNIT IIe-2****DEEP, MODERATELY DARK COLORED FINE SANDY LOAM**

The only soil in this unit is Farnum fine sandy loam, 0 to 1 percent slopes. It occurs on the uplands. It has a clayey subsoil.

Suitable crops for this soil are small grains, sorghum, alfalfa, and sweetclover. Corn does poorly because this soil is droughty, especially during July and August, when corn needs large amounts of water.

Grow legumes and follow with 3 to 5 years of wheat and sorghum. Protect the soil from wind erosion by keeping it covered at all times. Leave the wheat and sorghum stubble on the soil after harvest. Return all crop residues to the soil. Water erosion is not a problem.

This soil is moderately low in nitrogen and phosphorus. It is slightly acid. To improve crop yields, apply fertilizer and lime according to need, as indicated by soil tests. A good supply of organic matter in the surface soil will furnish plant nutrients and help improve the moisture-holding properties of the soil.

**CAPABILITY UNIT IIe-3****DEEP, MODERATELY DARK COLORED ALLUVIAL SOILS**

This unit consists of nearly level alluvial soils. They are—

Cass fine sandy loam.  
Cass loam.  
Humbarger loamy fine sand.

Corn, wheat, oats, sorghum, alfalfa, and sweetclover are suitable crops for these soils. Alfalfa grows particularly well because its roots reach the water table. The sandy soils are generally more productive in dry years, and the loam more productive in years of average or more than average rainfall.

Grow small grains or row crops 3 to 6 years, and follow with alfalfa. Because alfalfa roots can reach the water table, stands will last longer on these soils than on the upland soils. Work crop residues into the soil to supply organic matter. Prevent wind erosion in spring by keeping stubble or a growing crop on the soil.

These soils are suitable for irrigation. Because the soils

are porous, a sprinkler system is the best means of irrigating.

Crops on these soils respond well to nitrogen and phosphate fertilizer. Apply fertilizer according to need, as determined by soil tests.

**CAPABILITY UNIT IIIe-1**

**DEEP, DARK-COLORED SILTY CLAY LOAMS OVER DENSE, COMPACT CLAY SUBSOIL**

The soils in this unit occur on the uplands. The soils are—

Irwin silty clay loam, 1 to 4 percent slopes.  
Ladysmith silty clay loam, 1 to 4 percent slopes.

Wheat, oats, sorghum, alfalfa, and sweetclover are suitable crops for these soils. Warm-season native grasses are good for seeding waterways. Western wheatgrass can also be used. Grow legumes in rotation with 3 or 4 years of a small grain or sorghum. Alfalfa stands should remain 3 or 4 years. A crop sequence often used is 1 year of sweetclover, 2 years of wheat, and 1 year of sorghum.

These soils have slow internal drainage and are droughty in dry years. Because they absorb water slowly, water erosion is a hazard. To prevent erosion, farm on the contour and terrace long slopes. Apply fertilizer and lime according to need, as indicated by soil tests.

**CAPABILITY UNIT IIIe-2**

**DEEP, DARK-COLORED SILT LOAM AND SILTY CLAY LOAMS**

The soils in this unit are sloping and have clayey subsoils. They are—

Crete silty clay loam, 4 to 8 percent slopes.  
Geary silt loam, 4 to 8 percent slopes.  
Hastings silty clay loam, 4 to 8 percent slopes.  
Tully silty clay loam, 4 to 8 percent slopes.

Wheat, oats, sorghum, alfalfa, and sweetclover are suitable crops. Either bromegrass or the native grasses are suitable for waterways or pastures. A good crop sequence is sweetclover for 1 year or alfalfa for 3 or 4 years; row crop for 1 year; 2 or 3 years of small grains.

Controlling runoff to reduce erosion and conserve moisture is the biggest problem. Contour cultivation, terraces, and waterways will help. Diversion terraces may be needed to protect the Tully soil from water that runs off higher lying, steeper land. Return crop residues to the soil to improve tilth and permeability and to reduce runoff and erosion. Apply nitrogen fertilizer when excess straw and other crop residues cause a nitrogen deficiency. Apply fertilizer and lime according to need, as indicated by soil tests.

**CAPABILITY UNIT IIIe-3**

**DEEP AND MODERATELY DEEP, DARK-COLORED FINE SANDY LOAM AND SANDY LOAM**

These are deep soils of the uplands. They have sandy clay loam to clay subsoils. The soils of this unit are—

Farnum fine sandy loam, 1 to 4 percent slopes.  
Shellabarger sandy loam, 1 to 4 percent slopes.

Wheat, sorghum, alfalfa, and sweetclover are the crops best suited to these soils. In most years corn fails to mature, because of insufficient moisture. Grow cultivated crops for 2 to 4 years after 1 year of sweetclover or 3 or 4 years of alfalfa. Use native grasses for seeding pastures and waterways.

These soils are susceptible to erosion by both wind and water. Stubble-mulch tillage and good use of crop residues

will help to control wind and water erosion. Terracing and contour cultivation are essential in cultivated areas. Maintaining grassed terrace outlets and waterways is difficult because of the tendency of the soil to gully. Mechanical structures may be needed to stabilize waterways.

These soils are acid and low in fertility. Good yields of wheat and sorghum can be expected if nitrogen and phosphate fertilizers are used and organic matter is supplied in the form of manure and plant residues. Apply fertilizer and lime according to need, as indicated by soil tests.

**CAPABILITY UNIT IIIw-1**

**NEARLY LEVEL CLAYEY SOILS**

These soils are deep and somewhat poorly drained to poorly drained. They occur in backwater areas and nearly level old stream channels on the first bottoms. They are clayey to considerable depths. The soils in this unit are—

Solomon silty clay.  
Sutphen clay, moderately deep over sand.

Surface drainage will improve these soils for cultivated crops, provided there are adequate outlets. Wheat, sorghum, and sweetclover are suitable crops for areas that are drained. Reed canarygrass does well on undrained areas.

The Sutphen soil has a high water table in wet seasons or when the Republican River is near flood stage. Floods and long periods of wetness limit the use of this soil.

The Solomon soil occurs in long, narrow strips that are difficult to manage separately. If drained, it can be used in the same way as the surrounding soil.

Growing legumes and grasses will help to keep these soils in good tilth. Generally, these soils are high in fertility, but they may need nitrogen, especially if the weather in spring is cold and wet. Apply fertilizer according to need, as indicated by soil tests.

**CAPABILITY UNIT IIIs-1**

**DEEP, LIGHT-COLORED, NEARLY LEVEL SAND**

Sarpy loamy fine sand is the only soil in this unit. It is an alluvial soil on nearly level first bottoms.

Corn, small grains, sorghum, alfalfa, and sweetclover are suitable crops for this soil. In most years crop yields vary from place to place because of the variable nature of the soil. Yields are not usually reduced by the occasional floods, because the soil absorbs the water rapidly. Good stands of alfalfa may remain for several years. Grow alfalfa or sweetclover and follow it with 3 to 5 years of row crops and small grains.

Low fertility, low moisture-holding capacity, and wind erosion are the chief limitations. Phosphorus and nitrogen are needed. Stubble-mulch tillage, winter cover crops, and crop residues will help prevent wind erosion. Apply fertilizer according to need, as indicated by soil tests.

**CAPABILITY UNIT IVe-1**

**DEEP, DARK-COLORED SILTY CLAY LOAM**

Irwin silty clay loam, 4 to 8 percent slopes, is the only soil in this unit. It has a clayey, slowly permeable subsoil. It occurs on rolling uplands.

This soil is best left in native grasses. However, if cultivated crops are needed or if the soil is already in cultivation, grow alfalfa, wheat, and only an occasional crop of sorghum and use adequate erosion control measures at all times.

Plant a perennial legume, and plow it under only when the stand becomes poor and needs to be re-established. Then plant a small grain or sorghum. Wheat should not be grown continuously, because when it is grown the soil is exposed to the beating rains of July, August, and September. Establish native grasses in pastures and waterways.

The erosion hazard is high. Cultivated areas should be farmed on the contour and protected by terraces with waterways. Return the crop residues to the soil. Apply fertilizer and lime according to need, as indicated by soil tests.

**CAPABILITY UNIT IVe-2**

**DEEP SILT LOAM AND SILTY CLAY LOAM**

The soils in this unit occur on uplands. They are—

Geary silt loam, 8 to 12 percent slopes.

Hastings silty clay loam, 8 to 12 percent slopes.

Small grains, sorghum, alfalfa, and sweetclover are suitable crops for these soils. Either bromegrass or native grasses are suitable for seeding pastures or waterways.

Grow legumes or bromegrass to check erosion and to supply nitrogen and organic matter. Follow with 2 to 4 years of cultivated crops, but grow a row crop only occasionally.

Controlling runoff to reduce erosion and conserve moisture is the most serious management problem. Cultivated areas should be farmed on the contour and protected by terraces and waterways. All crop residues should be returned to the soil. Apply fertilizer and lime according to need, as indicated by soil tests.

**CAPABILITY UNIT IVe-3**

**DEEP, SEVERELY ERODED SILTY CLAY LOAMS**

The soils in this unit occur on moderately sloping upland and colluvial slopes. They are—

Crete soils, severely eroded.

Geary soils, severely eroded.

Hastings soils, severely eroded.

Tully soils, severely eroded.

Small grains, sorghum, alfalfa, and sweetclover are suitable crops for these soils. Native grasses are suitable for seeding pastures and waterways. These soils should be in grasses and legumes most of the time. Small grains and row crops may be grown for 2 or 3 years in the cropping sequence, if the soils are protected from erosion.

Most of the surface soil has been lost through erosion. Preventing further soil loss and conserving moisture are the biggest problems. Diversion terraces may be needed to protect the Tully soils from water that runs off higher lying, steeper slopes. To conserve soil and water, cultivate on the contour and protect the fields with terraces and waterways. Do everything possible to improve the tilth and to increase the supply of organic matter. Apply fertilizer and lime according to need, as indicated by soil tests.

**CAPABILITY UNIT IVe-4**

**DEEP SANDY LOAM THAT IS LOW IN FERTILITY**

Shellabarger sandy loam, 4 to 8 percent slopes, is the only soil in this unit. It is an upland soil that has a sandy clay loam subsoil. It is subject to wind and water erosion.

Wheat, sorghum, alfalfa, and sweetclover are the cultivated crops best suited to this soil. Native grasses

are best for pastures and waterways. Grow bromegrass and alfalfa most of the time. Small grains and row crops can be grown for 1 or 2 years in rotation with grasses and legumes.

Wind and water will erode this soil if it is unprotected. Protect cultivated fields with terraces and waterways. Farm on the contour, and keep vegetation on the soil at all times. Grade-stabilizing structures may be needed to prevent gullying at the end of grassed waterways.

This soil is low in nitrogen, phosphorus, lime, and organic matter. You can correct these deficiencies by growing legumes, utilizing crop residues, and applying lime and fertilizer. Apply fertilizer and lime according to need, as indicated by soil tests.

**CAPABILITY UNIT IVs-1**

**SILTY CLAY LOAM OVER CLAYPAN**

Dwight silty clay loam is the only soil in this unit. It is deep and dark colored. It has a thin surface soil over a claypan. This soil occurs on nearly level upland ridges that are 300 to 500 feet wide.

Most of this soil is in grass. A small part is cropped. The native grasses are best suited to this soil. Wheat and sweetclover are suitable crops. Some sorghum and alfalfa may be grown. This soil is normally too droughty for corn. A suitable crop sequence consists of sweetclover followed by 1 to 3 years of wheat. Sorghum can be grown for 1 year in place of wheat.

Good management of crop residues, including stubble-mulch tillage, will help to control wind erosion and increase the intake of water. Areas steep enough to be susceptible to water erosion should be cultivated on the contour and protected by terraces and waterways. Apply fertilizer and lime according to need, as indicated by soil tests.

**CAPABILITY UNIT VIe-1**

**STRONGLY SLOPING OR SEVERELY ERODED SILTY CLAY LOAMS**

The soils in this unit are deep and have a dense, compact clay subsoil. They are—

Irwin silty clay loam, 8 to 12 percent slopes.

Irwin soils, severely eroded.

These soils are best suited to native grasses for pasture or hay. Their management is discussed in the section on range sites, under the Clayey upland site.

**CAPABILITY UNIT VIe-2**

**NEARLY LEVEL TO STEEPLY SLOPING LOAMY SOILS**

The soils in this unit are—

Florence cherty clay loam.

Monona silt loam.

Shellabarger sandy loam, 8 to 20 percent slopes.

Tully silty clay loam, 8 to 20 percent slopes.

Because of steepness, rockiness, or erodibility, these soils are best suited to native grasses. Their management is discussed in the section on range sites, under the Loamy upland site.

**CAPABILITY UNIT VIe-3**

**SANDY SOILS THAT ARE LOW IN FERTILITY**

The soils in this unit are gently undulating to rolling. They are—

Derby loamy sand.

Sand dunes, Sarpy material.

Because these soils are not very productive and are susceptible to wind erosion, they are best suited to native grasses for hay or pasture. Their management is discussed in the section on range sites, under the Sands site.

**CAPABILITY UNIT VIc-4**

**VERY SHALLOW TO DEEP, STEEPLY SLOPING SOILS OVER LIMESTONE AND SHALE**

This unit is composed of the Sogn complex, a group of very shallow to deep soils on gentle to steep slopes. The soils occur in such an intricate pattern that the use of the whole unit is limited by the shallow and steep areas.

As a whole, this unit is not suitable for cultivation. It is now in native grass pasture. Its management is discussed in the section on range sites, under the Limestone breaks site.

**CAPABILITY UNIT VIIb-1**

**VERY SHALLOW ROCKY CLAY LOAM OVER LIMESTONE**

Sogn rocky clay loam is the only soil in this unit. It is too shallow to be suitable for cultivation. It is best used for native grasses. Its management is discussed in the section on range sites, under the Shallow site.

**CAPABILITY UNIT VIIIb-1**

**SAND DEPOSITS**

The only mapping unit in this capability class is Riverwash, a miscellaneous land type. It occurs on islands and sandbars in present stream channels or in old meanders of the major streams. It is composed of deep deposits of sand. It has practically no agricultural value. Some areas support stands of willows or cottonwoods and are useful for wildlife habitats.

## Management of Cultivated Soils

Soils used for cultivated crops need management practices that will maintain or improve their natural fertility, protect them from erosion, and keep them in good tilth.

*Fertility management.*—Some of the soils in this county do not have enough available phosphorus to produce high yields of crops. Those most likely to be deficient in available phosphorus are the sandy soils—Derby, Farnum, and Shellabarger. The calcareous soils of the first bottoms—Cass, Humbarger, Sarpy, and Solomon—have less available phosphorus than the more acid alluvial soils. To get high yields from these soils, you will need to apply phosphatic fertilizers.

The soils most likely to be deficient in nitrogen are the eroded upland soils, the sandy soils, and the soils that have been cropped continuously to small grains or corn. Especially in years of more-than-average rainfall, you can improve yields of most crops by applying nitrogenous fertilizers. Growing legumes frequently in the conservation cropping system will supply a part of the nitrogen needed by other crops.

Deep-rooted legumes such as alfalfa or sweetclover may be used in the cropping sequence to improve soil structure, increase moisture penetration, and add organic matter and nitrogen. Alfalfa is grown commonly for pasture, for seed, and for hay. The hay may be for use on the farm or for sale. Usually it is more profitable as part of a livestock enterprise than as a cash crop. For pasture, an alfalfa-brome grass mixture should be planted; for hay or for seed, alfalfa should be planted alone.

Sweetclover may be seeded with oats in spring. It may

be used in the cropping sequence in several ways. As a green-manure crop, it may be plowed down the second spring before corn or sorghum is planted, or it may be plowed down early in summer before wheat is planted (fig. 3). If left to mature, it may be harvested for seed



Figure 3.—Plowing down sweetclover on a Ladysmith soil.

in the second summer. If grazed carefully, it may be grazed late in fall and again early in spring of the succeeding year. One year of income is lost when sweetclover is plowed under late in spring or in summer of the second year.

Legumes often deplete moisture reserves and may affect the production of crops that follow. The soils of the uplands are commonly too acid to produce good yields of legumes. Most of them need 1 or 2 tons of agricultural limestone per acre. The limestone should be worked into the soil well in advance of seeding the legumes.

Use all available manure. Gardens should receive first priority, waterways second, and other areas third. Manure is especially valuable in establishing grass in waterways and on eroded areas. Besides supplying nutrients, manure acts as a mulch and improves the physical condition of the soil.

Do not burn crop residues. This practice destroys organic material that, if returned to the soil, would improve the fertility and tilth, help to maintain the structure, and keep the soil porous and permeable.

Have the soils tested to determine their fertility status. Consult your county agent or Soil Conservation Service technician about taking samples for testing and about applying fertilizer and lime.

*Erosion control.*—Erosion by water and wind is a serious problem in many places in Geary County. The loss of any of the surface soil reduces the supply of organic matter and plant nutrients. It also makes the soil less absorbent; consequently, more water runs off, the rate of erosion increases, and the supply of available moisture decreases.

Water may cause either sheet or gully erosion. The degree of erosion depends on the length and steepness of the slopes; the texture, structure, and permeability of the soil; and the vegetation.

Practices that will control water erosion include the following: (1) Terracing cropland if the slope does not exceed 6 percent; (2) establishing suitable native and tame grasses in waterways and outlets; (3) diverting water that runs off higher areas; (4) tilling and planting on the contour or parallel to the terraces; (5) utilizing crop residues; (6) installing dams, grade stabilization structures, or other structures if they are needed.

The damage done by wind erosion is most easily recognized on some of the sandy soils. The silt and clay particles have been blown away, and the sand grains are left. The soils on the north-south ridges have been most severely affected because they are exposed to the prevailing south winds. On the silty soils, it is more difficult to distinguish between the damage done by wind erosion and that done by water erosion because either will remove the surface soil and expose the clayey subsoil.

To control wind erosion, keep vegetation on the soil at all times. This may be a growing crop or crop residues, such as wheat stubble. If wind erosion starts on an unprotected field, emergency tillage to roughen the surface may be necessary to hold the soil until a crop can be established.

*Tillage practices.*—Frequent tillage destroys the structure of the soil. It produces a powdery surface layer, which will not absorb water readily and is easily eroded by wind. It also destroys organic matter. Ordinarily, till only enough to prepare a good seedbed and to control weeds and volunteer growth. If you use chemicals to control weeds, you may not need to till so often.

A tillage pan forms below the plow layer in some of the Geary County soils. It is most common in the fine sandy loams but is also found in finer textured soils. A pan develops because of a combination of factors. If a soil is always tilled at the same depth, the bottom of the plow layer may acquire a sheared, slick surface. Tractor wheels are apt to compress the plow layer, particularly if the soil is moist. Clay that moves down through the loose plowed layer may fill the fine pores of the slick, compressed surface of the pan. The combination of these factors results in a platy structure in the soil just below the plow layer. This platy layer is usually so dense that it restricts root development and water movement.

To prevent a pan from forming, vary the depth of plowing and other tillage operations, and do not till when the soil is too moist. Growing deep-rooted legumes may help to prevent or correct tillage pans.

*Irrigation.*—The extent of irrigation in Geary County is limited and fluctuates with weather cycles. There is no organized irrigation district, and irrigation is on a single-farm basis. Ordinarily one or two fields on a farm are irrigated and the rest of the farm is not. Water is obtained from wells or running streams. The irrigable areas appear to be limited to soils on the bottoms and terraces of the rivers and larger creeks. Nowhere else in the county is enough water available for proper irrigation.

Each field must be considered separately for irrigation. The layout of the field must be such that water can be used economically. To plan layout, leveling, and management of fields to be irrigated, get help from the local technicians of the Soil Conservation Service or from the county agent.

**Estimated yields**

Table 1 lists the estimated average acre yields of wheat and corn for each soil. The estimates were based on work done by Pine<sup>1</sup> and Cotner<sup>2</sup> of the Department of Eco-

<sup>1</sup> PINE, W. H. METHODS OF CLASSIFYING KANSAS LAND ACCORDING TO ECONOMIC PRODUCTIVITY. Ph. D. Thesis. Univ. Minn. 1948.

<sup>2</sup> COTNER, M. L. EFFECTS OF VARIATIONS IN INPUTS AND PRICE RELATIONSHIPS ON THE VALUE OF CROPLAND, GEARY COUNTY, KANSAS. M. S. Thesis. Kansas State College. 1955.

nomics and Sociology, Kansas State College, and on the experiences and judgment of agricultural workers in the Extension Service, the Soil Conservation Service, and the Agronomy Department of Kansas State College.

TABLE 1.—Estimated average acre yields of wheat and corn under two levels of management

[Yields in columns A are those obtained when grain crops are grown most of the time in no systematic rotation; legumes are grown less often than once in 8 years; and little or no lime or fertilizer is used. Yields in columns B are those obtained when crops are rotated and erosion is controlled according to the needs of the soil; lime and fertilizers are applied in kinds and amounts indicated by soil tests; legumes are grown at least once every 5 years; suitable crops are selected; seedbeds are properly prepared; and weeds, insects, and diseases are controlled.]

Soil	Wheat		Corn	
	A	B	A	B
	Bu.	Bu.	Bu.	Bu.
Cass fine sandy loam.....	26	30	40	45
Cass loam.....	27	28	35	38
Crete silty clay loam, 0 to 1 percent slopes.....	23	35	20	25
Crete silty clay loam, 1 to 4 percent slopes.....	23	32	18	23
Crete silty clay loam, 4 to 8 percent slopes.....	15	25	(1)	(1)
Crete soils, severely eroded.....	10	25	(2)	(2)
Derby loamy sand.....	(2)	(2)	(2)	(2)
Dwight silty clay loam.....	12	25	(2)	(2)
Farnum fine sandy loam, 0 to 1 percent slopes.....	15	30	(2)	(2)
Farnum fine sandy loam, 1 to 4 percent slopes.....	15	28	(2)	(2)
Florence cherty clay loam.....	(2)	(2)	(2)	(2)
Geary silt loam, 4 to 8 percent slopes.....	20	25	(1)	(1)
Geary silt loam, 8 to 12 percent slopes.....	15	20	(2)	(2)
Geary soils, severely eroded.....	13	18	(2)	(2)
Hobbs silt loam.....	27	27	45	50
Humbarger clay loam and loam.....	27	35	30	50
Humbarger loamy fine sand.....	20	25	25	50
Irwin silty clay loam, 0 to 1 percent slopes.....	15	25	(1)	(1)
Irwin silty clay loam, 1 to 4 percent slopes.....	15	25	(1)	(1)
Irwin silty clay loam, 4 to 8 percent slopes.....	15	20	(1)	(1)
Irwin silty clay loam, 8 to 12 percent slopes.....	(2)	(2)	(2)	(2)
Irwin soils, severely eroded.....	12	18	(2)	(2)
Ladysmith silty clay loam, 0 to 1 percent slopes.....	20	30	(1)	(1)
Ladysmith silty clay loam, 1 to 4 percent slopes.....	18	30	(1)	(1)
Monona silt loam.....	(2)	(2)	(2)	(2)
Muir loam.....	22	30	25	35
Muir silty clay loam.....	23	38	40	43
Riverwash.....	(2)	(2)	(2)	(2)
Sand dunes, Sarpy material.....	(2)	(2)	(2)	(2)
Sarpy loamy fine sand.....	17	20	30	35
Shellabarger sandy loam, 1 to 4 percent slopes.....	18	22	(1)	(1)
Shellabarger sandy loam, 4 to 8 percent slopes.....	17	21	(1)	(1)
Shellabarger sandy loam, 8 to 20 percent slopes.....	(2)	(2)	(2)	(2)
Sogn rocky clay loam.....	(2)	(2)	(2)	(2)
Sogn complex.....	(2)	(2)	(2)	(2)
Solomon silty clay.....	18	18	(1)	(1)
Sutphen silty clay.....	24	28	(1)	(1)
Sutphen clay, moderately deep over sand.....	24	26	(1)	(1)
Tully silty clay loam, 1 to 4 percent slopes.....	23	25	15	18
Tully silty clay loam, 4 to 8 percent slopes.....	20	20	13	18
Tully silty clay loam, 8 to 20 percent slopes.....	(2)	(2)	(2)	(2)
Tully soils, severely eroded.....	15	18	(2)	(2)
Hastings silty clay loam, 0 to 1 percent slopes.....	24	32	30	45
Hastings silty clay loam, 1 to 4 percent slopes.....	23	32	30	45
Hastings silty clay loam, 4 to 8 percent slopes.....	23	30	(1)	(1)
Hastings silty clay loam, 8 to 12 percent slopes.....	20	25	(2)	(2)
Hastings soils, severely eroded.....	17	25	(2)	(2)

<sup>1</sup> The crop is not grown to any extent on this soil.

<sup>2</sup> The crop is not suitable for this soil.

## Management of Rangeland<sup>3</sup>

The eastern half of Geary County is part of the Flint Hills bluestem prairie. This is the largest remaining tract of virgin prairie in the United States. It extends from the Nebraska-Kansas border into Oklahoma and has an area of 3,800,000 acres.

Too steep and rocky to be cultivated, the Flint Hills are well suited to grass. The original stands consisted principally of summer-growing tall and mid grasses. Deep-rooted forbs were mixed with the grasses. Prairie cordgrass grew on the wet bottom lands, and mixtures of mid and short grasses on the droughty ridgetops.

As long as the prairie was grazed lightly, the composition of the stands remained essentially unchanged. Many parts of the range, however, have been overstocked and the plants have been literally eaten to the ground. The most palatable plants were the first to disappear. They were replaced by annual grasses, drought-resistant grasses, and other less palatable plants.

Because reseeding is impractical, if not impossible, maintenance of the native vegetation is imperative, not only to assure continued high yields of forage but also to protect the watershed and prevent erosion. Control of grazing is the key to continued productivity of the native prairie vegetation.

To regulate grazing effectively, stock the range with the kind of livestock best suited to the climate and the type of forage; limit the size of the herds and the length of time a particular range is used; use the range lightly during the season when it is most likely to be damaged by heavy grazing; and keep the stock distributed over the range.

Each season, the forage plants must be allowed to accumulate adequate reserves of carbohydrates. This is possible only if enough green leafy top growth remains undisturbed for a long enough time to build up the reserve. The number of animals and the length of time the range is used should be limited so that no more than half of each year's growth will be grazed off. If more than that is removed, the better forage plants will weaken and die, and weeds and brush will replace them.

Bluestem pastures should have only light use during the early part of the growing season. The plants are most susceptible to damage by overgrazing at that time, because they are not large enough to manufacture enough carbohydrates for both current growth and storage.

Keeping the range evenly grazed is difficult because of variations in terrain and in the location of salt and water. Fencing and providing salt and water at separate locations will help to keep the stock distributed over the range.

Cattle are better suited to this range than any other kind of livestock. Sheep have never been raised in any considerable numbers.

### Range condition and stocking rates

The condition of a range can be judged by comparing the present vegetation with the climax vegetation.

The climax vegetation is the combination of plants that grew on a range before it was disturbed by grazing. As a rule, it is the most productive combination of native

plants that will grow on a given site. It also gives the best protection against erosion.

The climax vegetation consists mainly of two classes of plants: decreasers and increasers. Decreasers are the most heavily grazed and are consequently the first to be destroyed by overgrazing. Increasers withstand grazing better or are less palatable to the livestock; they increase under grazing and replace the decreasers. Invaders are plants that become established after the climax vegetation has been reduced by grazing.

A range is described as in excellent condition if 76 to 100 percent of the stand is of the same composition as the original stand. It is in good condition if the percentage is between 51 and 75, in fair condition if the percentage is between 26 and 50, and in poor condition if the percentage is less than 25.

A proper stocking rate is one that will permit keeping the range in excellent condition or improving it if it has deteriorated. The rate will depend chiefly on the present condition of the range but will vary according to the weather. The rates suggested in the discussions of the individual range sites are those used by the ranchers whose ranges seemed to be in the best condition. These rates should be decreased somewhat in dry years and may be increased slightly in wet years.

### Range sites

There are eight range sites in Geary County. Six of the sites are illustrated in figure 4. Range sites are determined by climate, topography, and kinds of soils. These factors affect the composition and production of the native vegetation. Descriptions of the individual sites and suggestions for management of each site are given in the following pages. All of the soils are grouped into range sites according to their capacity to support native plants, even though many are not now being used for range.

Additional advice on range management can be obtained from the Agricultural Extension Service, the Soil Conservation Service, or the Kansas Agricultural Experiment Station.

#### CLAY LOWLAND SITE

This range site consists of nearly level, poorly drained, frequently flooded lowlands. Nearly all of it is used for crops, hence it is not available for grazing. The soils in this range site are—

Solomon silty clay.  
Sutphen clay, moderately deep over sand.  
Sutphen silty clay.

These are deep, very dark colored soils that have clay textures to depths of 2 to 5 feet. They are very firm when moist, very plastic when wet, and very hard when dry. They may be ponded in wet seasons. During droughts, the vegetation is uneven because dry spots and cracks develop on small hummocks.

This is potentially one of the most productive of the range sites in the county. However, because of its location and its usefulness for cultivated crops, all of this site has been broken from range and converted to cropland.

#### LOAMY LOWLAND SITE

This extensive range site consists of nearly level to rolling, well-drained bottom lands that receive water from floods and from runoff from the adjoining uplands.

<sup>3</sup> Prepared with the assistance of K. L. Anderson, Kansas State College; and C. M. Schumacher and J. T. Neill, Soil Conservation Service.

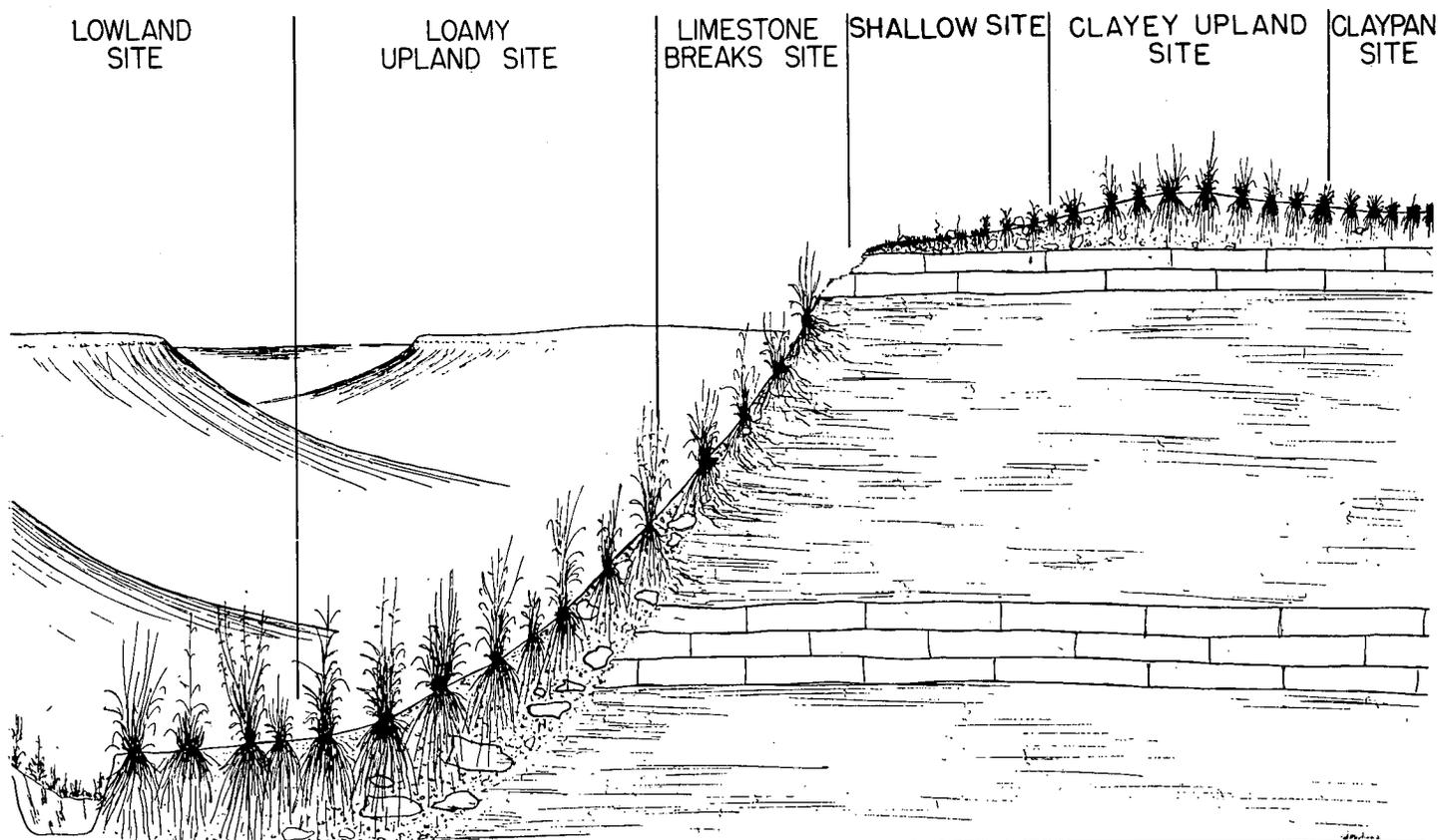


Figure 4.—Diagram showing the major range sites in the Flint Hills.

In the northern and western parts of the county, this site covers rather large areas along major streams, and most of it is cultivated. In the part of the county that is used mostly for range, it occurs in narrow strips along drainageways and has been left in native vegetation. The soils in this range site are—

Cass fine sandy loam.  
Cass loam.  
Hobbs silt loam.  
Humbarger clay loam and loam.  
Humbarger loamy fine sand.  
Muir loam.  
Muir silty clay loam.

These are deep friable soils that have moderately permeable subsoils. They absorb water readily and hold it well. Their general fertility level is high.

The climax vegetation is predominantly big bluestem, Indiangrass, and switchgrass. Little bluestem is also abundant. The amount of prairie cordgrass, gamagrass, switchgrass, and wildrye varies according to the degree of wetness of the soils. The forbs, though only about 5 percent of the cover, are conspicuous. The most common forbs are goldenrod, compassplant, sawtooth sunflower, and dotted gayfeather.

Tall dropseed and side-oats grama are the principal increasing grasses. Ironweed, vervain, Kentucky bluegrass, and various woody plants are the invaders.

*Suggested stocking rate.*—Except for the parts that have been invaded by weeds, brush, trees, or bluegrass, this is the most productive range site in the county. If it is in excellent condition, it should produce about 1.4 animal-

unit-months of grazing per acre. Based on a 5-month grazing season,  $3\frac{1}{2}$  to 5 acres in excellent condition will support one cow. If the range condition is good, 5 to 7 acres per head is needed; if the condition is fair, 7 to 14 acres; and, if the condition is poor, at least 14 to 15 acres.

A pasture may have in it several range sites; therefore, it is necessary to consider the acreage and the condition of each to determine the overall carrying capacity.

#### SANDS SITE

This range site is composed of grasslands on rolling, dunelike, deep sands. It occurs on the high terraces of the Republican River and in an upland area between the Republican and Smoky Hill Rivers. The soils in this range site are—

Derby loamy sand.  
Sand dunes, Sarpy material.  
Sarpy loamy fine sand.

These are deep, dark colored to moderately light colored soils. They have a low water-holding capacity. Water moves rapidly through the permeable subsoil.

The climax vegetation is a mixture of tall and mid grasses, principally big and little bluestem, Indiangrass, and switchgrass. There is also a considerable amount of leadplant amorphia, tephrosia, and prairieclover. Sand dropseed, hairy grama, purple lovegrass, fall witchgrass, and rosette panicums are the typical grass increasers. Chickasaw plum is one of the chief woody increasers. Windmillgrass, sandbur, sand paspalum, and western ragweed are the principal invaders.

This site is normally productive, but it may deteriorate rapidly if closely grazed. If the plant cover is destroyed by overgrazing and trampling, blowouts may form.

*Suggested stocking rate.*—In excellent condition, this range should produce about 1.2 animal-unit-months of grazing per acre. Based on a 5-month grazing season, 4 to 5½ acres per head is needed. If the range is in good condition, 5½ to 8½ acres per head is needed; if it is in fair condition, 8½ to 17 acres; and if it is in poor condition, not less than 17 acres is needed.

#### LOAMY UPLAND SITE

In this site (locally called "ordinary upland") are the productive soils of the nearly level to rolling uplands. Included are several potentially arable soils. The soils in this range site are—

Florence cherty clay loam.  
Geary silt loam, 4 to 8 percent slopes.  
Geary silt loam, 8 to 12 percent slopes.  
Geary soils, severely eroded.  
Monona silt loam.  
Shellabarger sandy loam, 1 to 4 percent slopes.  
Shellabarger sandy loam, 4 to 8 percent slopes.  
Shellabarger sandy loam, 8 to 20 percent slopes.  
Tully silty clay loam, 1 to 4 percent slopes.  
Tully silty clay loam, 4 to 8 percent slopes.  
Tully silty clay loam, 8 to 20 percent slopes.  
Hastings silty clay loam, 0 to 1 percent slopes.  
Hastings silty clay loam, 1 to 4 percent slopes.  
Hastings silty clay loam, 4 to 8 percent slopes.  
Hastings silty clay loam, 8 to 12 percent slopes.  
Hastings soils, severely eroded.

Most of these soils are deep or moderately deep. They have permeable subsoils that range in texture from silt loam to clay. These soils catch and hold sufficient water to support a luxuriant growth of prairie grasses (fig. 5).



Figure 5.—Hereford cattle grazing well-managed native grassland on Loamy upland range site.

The climax cover is a mixture of the tall and mid grasses characteristic of the true prairie. Big bluestem is dominant on the lower slopes, and little bluestem is dominant on the upper slopes. About 85 percent of the original cover consisted of the bluestems, Indiangrass, switchgrass, and prairie dropseed. The rest was largely deep-rooted legumes and other forbs.

Side-oats grama and tall dropseed are usually the first grasses to increase under grazing. The principal invaders are woody plants, ironweed, Kentucky bluegrass,

vervain, windmillgrass, tumblegrass, and annuals—depending upon the available moisture. Woody plants are most likely to invade sites on north slopes, in seep areas, and in rocky areas.

Badly overgrazed pastures on Geary, Monona, Hastings, and Tully soils may be seeded to brome grass or other tame, cool-season pasture grasses or reseeded to native grasses.

*Suggested stocking rate.*—According to the Agricultural Experiment Station at Manhattan, this range site has produced an average of 2,052 pounds of air-dry forage per acre for the past 23 years. If the range is in excellent condition, about 1.2 animal-unit-months of grazing per acre can be expected. Based on a 5-month grazing season, 4 to 5½ acres per head is needed. If the range is in good condition, 5½ to 8½ acres per head is needed; if it is in fair condition, 8½ to 17 acres; if it is in poor condition, not less than 17 acres.

#### LIMESTONE BREAKS SITE

This range site consists of the steep breaks where resistant limestone strata outcrop. There is only one mapping unit—the Sogn complex—in this site, and only that part of the complex that occurs on slopes of more than 30 percent. The surface soil is clay loam and silty clay loam. There are many large stones on the surface and throughout the profile.

The climax vegetation is a mixture of the tall and mid grasses characteristic of the true prairie. The principal grasses are big and little bluestem, Indiangrass, and side-oats grama. The shrubby decreaseers such as inland ceanothus and leadplant *amorpha* are plentiful in some places. Sumac, coralberry (buckbrush), dogwood, and other woody increaseers now make up about 5 percent of the vegetation.

Side-oats grama and tall dropseed are usually the first grasses to increase. Woody plants, particularly on north-facing slopes, are undesirable increaseers. Short grasses, weedy forbs, and annuals may invade if the site is heavily grazed for long periods.

This site is normally productive, but cattle do not graze it so readily as the other range sites, because it is steep and rocky.

*Suggested stocking rate.*—If this range is in excellent condition, it can be expected to produce about 1 animal-unit-month of grazing per acre. Based on a 5-month grazing season, 5 to 7 acres per head is needed if the range is in excellent condition. If the range is in good condition, 7 to 10 acres is needed; if it is in fair condition, 10 to 20 acres; and if it is in poor condition, 20 or more acres.

#### CLAYEY UPLAND SITE

This site consists of grasslands on nearly level to rolling uplands. It is made up of the following soils—

Crete silty clay loam, 0 to 1 percent slopes.  
Crete silty clay loam, 1 to 4 percent slopes.  
Crete silty clay loam, 4 to 8 percent slopes.  
Farnum fine sandy loam, 0 to 1 percent slopes.  
Farnum fine sandy loam, 1 to 4 percent slopes.  
Irwin silty clay loam, 0 to 1 percent slopes.  
Irwin silty clay loam, 1 to 4 percent slopes.  
Irwin silty clay loam, 4 to 8 percent slopes.  
Irwin silty clay loam, 8 to 12 percent slopes.  
Ladysmith silty clay loam, 0 to 1 percent slopes.  
Ladysmith silty clay loam, 1 to 4 percent slopes.  
Tully soils, severely eroded.

These soils have 8- to 16-inch surface layers over clay and silty clay subsoils. They are moderately droughty.

The climax vegetation is a mixture of the tall and mid grasses characteristic of the true prairie. Little bluestem is the principal grass, and big bluestem is next in importance. The stands also include side-oats grama, prairie dropseed, Indiangrass, switchgrass, and short grasses. Conspicuous legumes are leadplant *amorpha*, scurfpea, and prairieclover. Goldenrod, dotted gayfeather, sagewort, and other forbs also grow on this site.

Side-oats grama and tall dropseed are the first grasses to increase if the range is overused. Under continued heavy grazing, this site becomes droughty, and short grasses, rather than tall weeds and brush, become dominant. Annual bromes, broomweed, and other annuals may invade following close use and drought.

This site is slightly less productive than others that receive about the same amount of rainfall.

Much of this site is now in cultivated crops. If a farmer wishes to return his cropland to range, he should seed it with a mixture of the native grass species.

*Suggested stocking rate.*—In excellent condition, this range can be expected to produce about 1 animal-unit-month of grazing per acre. Based on a 5-month grazing season, 5 to 7 acres per head is needed if the range is in excellent condition. If the range is in good condition, 7 to 10 acres is needed; if it is in fair condition, 10 to 20 acres; and if it is in poor condition, 20 or more acres.

#### SHALLOW SITE

This site consists of nearly level to gently sloping ridge crests. It includes only one mapping unit, Sogn rocky clay loam. This soil is less than 10 inches deep over limestone bedrock.

The climax vegetation consists chiefly of mid grasses. There are some short grasses and forbs, but the stands are not so dense as those on the Loamy upland site. Little bluestem is the principal grass, but prairie dropseed and side-oats grama are common. The tall grasses—big bluestem, Indiangrass, and switchgrass—are less common. Common legumes are prairieclover, leadplant *amorpha*, and scurfpea. Common forbs are stiff sunflower and blacksamson *echinacea*.

Sumac, coralberry (buckbrush), dogwood, and other woody increasers may make up as much as 5 percent of the vegetation. Side-oats grama and hairy grama are the first grasses to increase. Where the soil is shallowest, the tall and mid grasses tend to decrease and short grasses to increase. The principal invaders are annual and perennial forbs and annual grasses.

*Suggested stocking rate.*—In excellent condition, this range should produce about 1.0 animal-unit-month of grazing per acre. Based on a 5-month grazing season, 5 to 7 acres will support one cow. If the range is in good condition, 7 to 10 acres is needed; if it is in fair condition, 10 to 20 acres; and if it is in poor condition, not less than 20 acres.

#### CLAYPAN SITE

This range site consists of claypan soils on nearly level uplands and eroded clayey soils. It consists of the following soils—

Crete soils, severely eroded.  
Dwight silty clay loam.  
Irwin soils, severely eroded.

All of these soils have a dense, compact clay subsoil. The Dwight soil has a thin surface soil. The others have lost their surface soil through erosion. Few roots penetrate the subsoil, and many become distorted at the abrupt boundary between the surface soil and subsoil. Generally, these soils are droughty.

The climax vegetation consists chiefly of mid grasses—little bluestem, side-oats grama, and tall dropseed—and short grasses. The principal legume is scurfpea. Heath aster, dotted gayfeather, sagewort, and other forbs are common. Hardly any shrubby plants grow here.

The short grasses—blue grama and buffalograss—increase if the range is overgrazed. In some places western wheatgrass increases rapidly. Continued overuse will cause buffalograss to predominate. The soils will then absorb less water, and yields of forage will decline.

The invading plants are windmillgrass, tumblegrass, and annual grasses, chiefly little barley.

This range site is on ridge crests where the cattle congregate. Ranchers say that the cattle gather on the windswept crests because the flies are not so numerous as in more protected areas. As a consequence, this site is often overgrazed. It should be reseeded to native grasses, chiefly little bluestem and side-oats grama.

*Suggested stocking rate.*—In excellent condition, this site can be expected to produce about 0.8 animal-unit-month of grazing per acre. Based on a 5-month grazing season, 6½ to 8 acres is needed to support one cow or steer. If the range is in good condition, 8 to 12½ acres is needed; if it is in fair condition, 12½ to 25 acres; if it is in poor condition, not less than 25 acres.

## Woodland Management<sup>4</sup>

There are no extensive areas of woodland in Geary County. Few of the native trees have commercial value. Some of the stands would produce sawtimber if well managed, but most have been poorly managed. Effective windbreaks and shelterbelts can be established by planting trees and shrubs suitable for the particular soils in which they are to be grown. Both the native woodlands and the plantings should be protected from fire and grazing and cleared of cull trees and wolf trees.

### *Native woodlands*

The native woodlands occur generally as narrow bands and patches of trees along the creeks and rivers and on some of the steep slopes. Many of these steep slopes border the stream valleys. The dominant species vary from one location to another, depending on the amount of available moisture and on past use and management.

There are four broad groupings of native woodland, each having a characteristic topography. These groupings are discussed as "sites."

*Site 1.*—This site is composed of lowland areas adjacent to the Kansas, Republican, and Smoky Hill Rivers. The soils are mainly Sarpy loamy fine sand and Riverwash. The dominant trees are cottonwood and willow.

Some cottonwoods grow to sawtimber size, but most of the trees are of no commercial value. They do, however, help to stabilize streambanks by reducing bank cutting and channel changes.

<sup>4</sup> Prepared with the help of Roy M. Davis and F. D. Abbott of the Soil Conservation Service.

*Site 2.*—This site is on the flood plains of the rivers and large streams. The soils are mainly the Muir, Hobbs, and Humbarger. The dominant trees are bur oak, black walnut, cottonwood, green ash, American elm, red elm, and hackberry.

The black walnut trees are the most valuable commercially, but most of them have been harvested. Some of the other trees can be cut for sawtimber. Because of poor management, the present stand is of poor quality. Under good management, commercially valuable trees of medium height probably could be grown.

*Site 3.*—This site is along small streams. The soils are alluvial and colluvial deposits of silt, clay, shale, and cherty material. The dominant trees are bur oak, green ash, American elm, red elm, and hackberry. The bur oak trees are the most valuable commercially, but most of them have been harvested. Some of the remaining trees can be used for sawtimber. Because of poor management, the present stand is of poor quality. Commercially valuable trees of medium height probably can be grown under good management.

*Site 4.*—This site is on the steep and very steep sides of deep valleys. Most of it is on north- and northeast-facing slopes, but some is on west- and northwest-facing slopes. The soils are composed of colluvial materials that contain fragments of limestone, shale, and chert. The dominant trees are green ash, eastern redcedar, American elm, and chinkapin oak.

Site 4 will not produce trees of commercial value. The trees do, however, protect the watershed and provide food and shelter for wildlife. Most of this site adjoins pastures and is grazed.

### **Windbreaks and shelterbelts**

Farmsteads exposed to cold winter and hot summer winds need the protection of windbreaks. Trees and shrubs for windbreaks should be selected according to their suitability for the soils.

For moderately deep and deep silty soils, clay loams, and fine sandy loams, the following trees and shrubs are suitable: eastern redcedar, Austrian pine, ponderosa pine, Siberian elm (known generally in this area as Chinese elm), hackberry, green ash, bur oak, mulberry, Russian-olive, honeylocust, wild plum, lilac, bush-honeysuckle, tamarisk, multiflora rose, and western chokecherry.

For moderately deep and deep clay soils and severely eroded silt loams and silty clay loams, the following are suitable: eastern redcedar, Austrian pine, ponderosa pine, American elm, honeylocust, mulberry, wild plum, and roughleaf dogwood.

For shallow, rocky soils and complex mixtures of shallow to moderately deep clay, silt, shale, chert, and limestone, the following are suitable: eastern redcedar, American elm, ponderosa pine, wild plum, roughleaf dogwood, and skunkbush sumac.

For loose, sandy soils, the suitable trees and shrubs are eastern redcedar, ponderosa pine, cottonwood, Siberian elm, green ash, sandplum, Russian-olive, mulberry, and tamarisk.

Field shelterbelts help to control wind erosion on cultivated fields. They are needed especially where the soil is loose and sandy, but they will reduce wind erosion wherever fields are bare. Trees for shelterbelts should be selected to suit the soil.

The local soil conservation technician or the county agent will help plan farmstead windbreaks or field shelterbelts.

## **Descriptions of the Soils**

The scientist who makes a soil survey examines the soils in the field, classifies them in accordance with facts that he observes, maps their boundaries on an aerial photograph or other map, and describes them in his report.

The soil scientist digs many holes to observe the soil characteristics. The holes are not dug at regular intervals but are spaced as indicated by differences in topography, vegetation, and other features that suggest differences in the soil. Each hole reveals layers within the soil, which are called horizons. These horizons generally differ in one or more of the following characteristics: thickness, color, texture, structure, and consistence. Collectively these horizons are known as the soil profile (fig. 6). Each kind of soil has a particular organization of horizons and soil characteristics that is not the same as that of another kind of soil.

The surface layer, called the A horizon, is the one from which soluble minerals and clay have been removed by water percolating downward. The subsoil, or B horizon, is a layer that has been enriched by clay and other materials and has developed a distinctive color and structure. The material below the B horizon, if it appears to be the material from which the soil developed, is called the C horizon.

The characteristics by which the horizons are set apart are the following:

*Color*, which is generally described in two ways: verbally, as, for example, dark brown or reddish brown, and by use of a Munsell color notation, which is a more precise method of designating gradations in color.

*Texture*, which refers to the relative proportions of the different sizes of mineral grains (sand, silt, and clay) that make up the soil mass. A loamy sand, for example, is mostly sand and contains only a little finer material. A clay soil contains enough fine material to make it plastic and sticky when wet.

*Structure*, which refers to the arrangement of the soil particles into lumps, granules, blocks, or other aggregates. The aggregates are described as to strength, or grade (weak, moderate, or strong); size (very fine, fine, medium, coarse, or very coarse); and shape (platy, prismatic, columnar, blocky, subangular blocky, granular, or crumb). Some soils have no definite structure and are described as single grain (sandy soils) or massive (clay soils).

*Consistence*, which indicates the ease with which a lump of the soil can be crushed. When the soil is moist, consistence is described as loose, very friable, friable, firm, very firm, and extremely firm; when the soil is dry, the terms used are loose, soft, slightly hard, hard, very hard, and extremely hard.

The soil scientist maps the soils on aerial photographs, using the soil characteristics to identify each soil and observing external features, such as relief and vegetation, to determine the extent of each.

Each of the soils mapped in Geary County is described in detail in the following pages. The approximate acreage

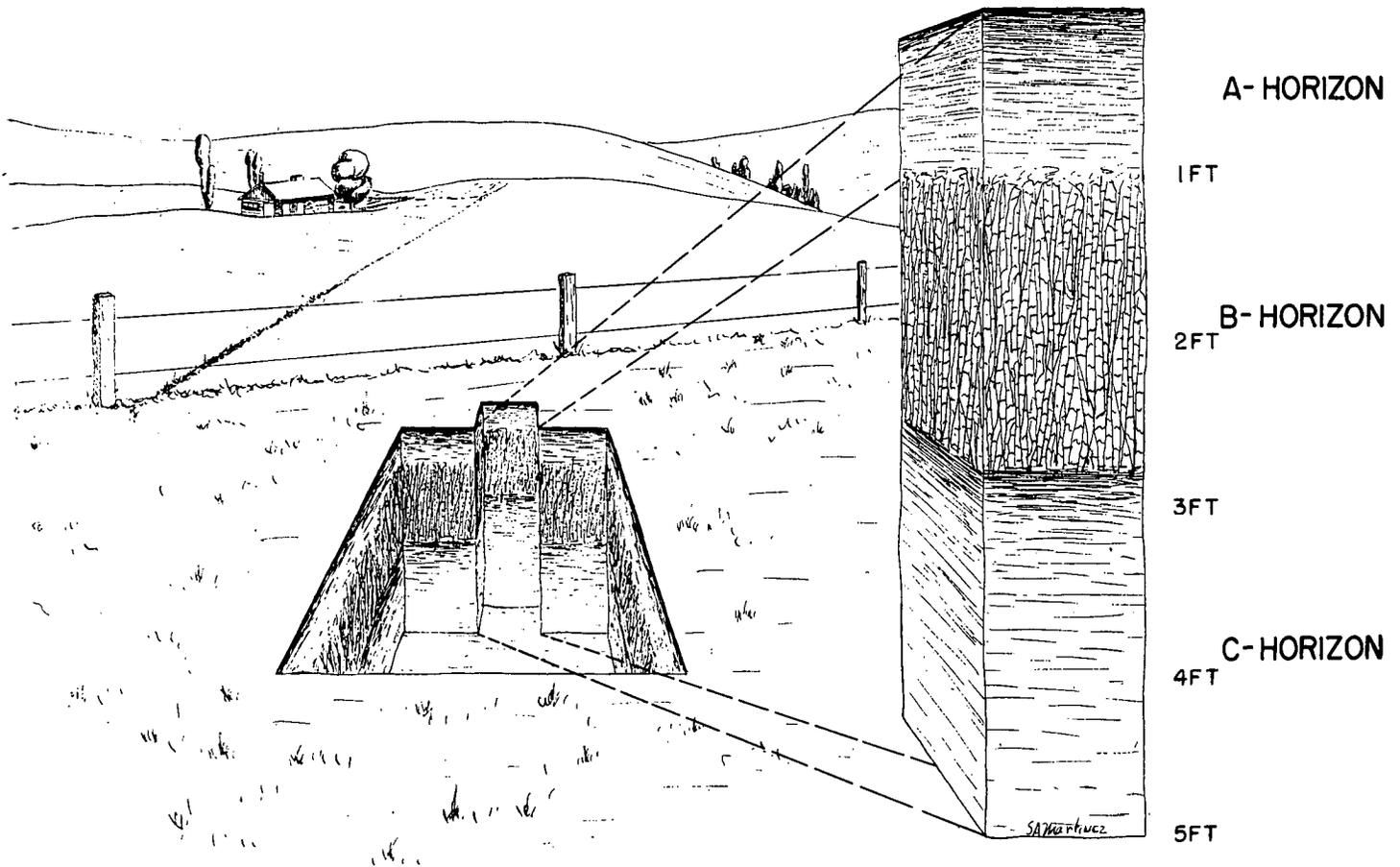


Figure 6.—Schematic soil profile.

and proportionate extent of each soil are given in table 2. Some of the important characteristics of each soil series are given in table 3.

If there are several mapping units of one type, the type is described in detail, and the mapping units are described briefly. But, if there is only one mapping unit of the type, that mapping unit is described in detail, and it is assumed to be representative of the soil type.

**CASS FINE SANDY LOAM**

**Cass fine sandy loam (Ca).**—This is a well-drained, moderately dark colored, stratified alluvial soil. It occurs on the nearly level first bottoms of the Kansas and Republican Rivers. It is darker colored and finer textured than the nearby Sarpy loamy fine sand.

This soil is no coarser than a fine sandy loam to depths of 5 feet or more. Although it is normally well drained, it is sometimes flooded after heavy rains. The entire profile is calcareous.

Typical profile (located 500 feet north of railroad and 200 feet west of road in SW¼ sec. 27, T. 11 S., R. 5 E., in a cultivated field on a 1 percent slope):

- A<sub>1p</sub> 0 to 6 inches, grayish-brown (10YR 5.5/2, dry) to dark grayish-brown (10YR 4/2, moist) fine sandy loam; soft when dry, very friable when moist; massive; calcareous, pH 7.4; abrupt lower boundary.
- A<sub>1</sub> 6 to 20 inches, grayish-brown (10YR 5/1.5, dry) to very dark grayish-brown (10YR 3/1.5, moist) fine sandy

loam; soft when dry, friable when moist; moderate thin platy structure in upper part to weak granular structure in lower part; calcareous, pH 7.6; gradual lower boundary.

- AC 20 to 27 inches, light brownish-gray (10YR 6/2, dry) to grayish-brown (10YR 5/2, moist) fine sandy loam; soft when dry, friable when moist; massive; calcareous, pH 7.6; abrupt lower boundary.
- C 27 to 60 inches+, very pale brown (10YR 7/3, dry) to pale brown (10YR 6/3, moist) fine sandy loam; soft when dry, friable when moist; massive; calcareous, pH 7.6.

In some places there are thin layers of sand or of sand mixed with clay. The surface soil is 20 to 36 inches thick. In some places it is slightly darker colored than the typical surface soil, depending upon the content of organic matter in the soil.

This soil is moderately fertile. It is friable and easily worked. Most of it is used continuously for cultivated crops.

This soil is occasionally flooded, but water does not stand long on the surface. In spring some wind erosion may occur on unprotected fields. Capability unit IIs-3; range site, Loamy lowland.

**CASS LOAM**

**Cass loam (Cb).**—This is a well-drained, moderately dark colored, stratified soil that occurs on the nearly level first bottoms of the Republican and Kansas Rivers. It

TABLE 2.—*The approximate acreage and proportionate extent of the soils*

Soil	Acres	Percent
Cass fine sandy loam.....	4,060	1.6
Cass loam.....	3,220	1.3
Crete silty clay loam, 0 to 1 percent slopes.....	3,180	1.2
Crete silty clay loam, 1 to 4 percent slopes.....	12,530	5.0
Crete silty clay loam, 4 to 8 percent slopes.....	4,720	1.8
Crete soils, severely eroded.....	4,410	1.7
Derby loamy sand.....	360	.1
Dwight silty clay loam.....	13,150	5.1
Farnum fine sandy loam, 0 to 1 percent slopes.....	300	.1
Farnum fine sandy loam, 1 to 4 percent slopes.....	1,890	.7
Florence cherty clay loam.....	8,390	3.3
Geary silt loam, 4 to 8 percent slopes.....	2,460	1.0
Geary silt loam, 8 to 12 percent slopes.....	1,560	.6
Geary soils, severely eroded.....	760	.3
Hobbs silt loam.....	9,380	3.7
Humbarger clay loam and loam.....	9,670	3.8
Humbarger loamy fine sand.....	310	.1
Irwin silty clay loam, 0 to 1 percent slopes.....	1,450	.6
Irwin silty clay loam, 1 to 4 percent slopes.....	10,660	4.2
Irwin silty clay loam, 4 to 8 percent slopes.....	9,450	3.7
Irwin silty clay loam, 8 to 12 percent slopes.....	770	.3
Irwin soils, severely eroded.....	6,730	2.6
Ladysmith silty clay loam, 0 to 1 percent slopes.....	2,100	.8
Ladysmith silty clay loam, 1 to 4 percent slopes.....	4,480	1.8
Monona silt loam.....	590	.2
Muir loam.....	270	.1
Muir silty clay loam.....	15,070	5.9
Riverwash.....	1,120	.4
Sand dunes, Sarpy material.....	400	.2
Sarpy loamy fine sand.....	1,640	.6
Shellabarger sandy loam, 1 to 4 percent slopes.....	1,950	.8
Shellabarger sandy loam, 4 to 8 percent slopes.....	1,810	.7
Shellabarger sandy loam, 8 to 20 percent slopes.....	1,300	.5
Sogn rocky clay loam.....	21,180	8.3
Sogn complex.....	59,610	23.3
Solomon silty clay.....	1,660	.7
Sutphen clay, moderately deep over sand.....	690	.3
Sutphen silty clay.....	1,040	.4
Tully silty clay loam, 1 to 4 percent slopes.....	6,390	2.5
Tully silty clay loam, 4 to 8 percent slopes.....	6,300	2.5
Tully silty clay loam, 8 to 20 percent slopes.....	4,330	1.7
Tully soils, severely eroded.....	850	.3
Hastings silty clay loam, 0 to 1 percent slopes.....	410	.2
Hastings silty clay loam, 1 to 4 percent slopes.....	2,590	1.0
Hastings silty clay loam, 4 to 8 percent slopes.....	3,830	1.5
Hastings silty clay loam, 8 to 12 percent slopes.....	2,430	1.0
Hastings soils, severely eroded.....	490	.2
Miscellaneous areas:		
Water areas.....	1,730	.7
Quarries.....	50	( <sup>1</sup> )
Military reservation.....	1,640	.6
Total acreage.....	255,360	100.0

<sup>1</sup> Less than 0.1 percent.

is darker colored and finer textured than Sarpy loamy fine sand or Cass fine sandy loam.

Typical profile (located 75 feet west of driveway and 200 feet north of railroad in NE¼SW¼ sec. 20, T. 11 S., R. 5 E., in a cultivated field that has a 1 percent slope):

- A<sub>10</sub> 0 to 7 inches, grayish-brown (10YR 5/2, dry) to very dark grayish-brown (10YR 3/2, moist) loam; slightly hard when dry, friable when moist; weak granular structure; noncalcareous, pH 6.8; abrupt lower boundary.
- A<sub>1</sub> 7 to 15 inches, light brownish-gray (10YR 6/2, dry) to very dark grayish-brown (10YR 3/2, moist) loam; hard when dry, firm when moist; massive; noncalcareous, pH 7.1; clear lower boundary.

- AC 15 to 30 inches, dark grayish-brown (10YR 4/2, dry) to very dark grayish-brown (10YR 3/2, moist) silt loam; hard when dry, firm when moist; massive; noncalcareous, pH 7.1; clear lower boundary.
- C<sub>1</sub> 30 to 60 inches, brown (10YR 5/3, dry) to dark grayish-brown (10YR 4/2, moist) loam; hard when dry, firm when moist; massive; noncalcareous, pH 7.6.

The surface soil ranges from 20 to 38 inches in thickness. In places its color is slightly darker than that described because the amount of organic matter is greater than normal. Its texture ranges from silt loam to fine sandy loam. In some places there are layers of fine sandy loam, and in others a buried soil lies within 5 feet of the surface.

This soil is friable and easily worked. It is moderately fertile and is well suited to many crops. Occasionally, planting may be delayed or a crop lost because of floods.

This soil is suitable for irrigation. Because water is absorbed rapidly, sprinkling is the best way to irrigate. Capability unit IIs-3; range site, Loamy lowland.

#### CRETE SILTY CLAY LOAMS

These are dark-colored soils that have a fine-textured subsoil. They have developed from loess on the uplands in the northwestern part of the county. Runoff is slow to rapid, depending upon the slope gradient. In hot dry summers these soils tend to be somewhat droughty.

The Crete soils resemble the Hastings soils but have a more clayey subsoil that has a coarser blocky structure. They occur on slopes ranging up to 8 percent.

Typical profile (located 400 feet south of E¼ corner of sec. 3, T. 10 S., R. 5 E., in a native grass meadow on a 1 percent slope):

- A<sub>10</sub> 0 to 5 inches, dark grayish-brown (10YR 4/2, dry) to very dark grayish-brown (10YR 3/2, moist) silty clay loam; slightly hard when dry, friable when moist; moderate medium granular structure; contains many roots; noncalcareous, pH 5.8; abrupt lower boundary.
- A<sub>1</sub> 5 to 9 inches, dark grayish-brown (10YR 4/2, dry) to very dark grayish-brown (10YR 3/2, moist) silty clay loam; hard when dry, firm when moist; moderate medium blocky structure; many roots; noncalcareous, pH 5.6; clear lower boundary.
- AB 9 to 16 inches, grayish-brown (10YR 5/2, dry) to very dark grayish-brown (10YR 3/2, moist) silty clay loam; very hard when dry, very firm when moist; moderate medium blocky structure; few roots; noncalcareous, pH 5.6; clear lower boundary.
- B<sub>21</sub> 16 to 26 inches, brown (10YR 5/3, dry) to dark-brown (10YR 4/3, moist) silty clay; very hard when dry, very firm when moist; strong coarse blocky structure; few roots; noncalcareous, pH 5.5; clear lower boundary.
- B<sub>22</sub> 26 to 35 inches, brown (10YR 5/3, dry) to dark-brown (10YR 4/3, moist) silty clay; very hard when dry, very firm when moist; strong medium blocky structure; few roots; noncalcareous, pH 5.9; abrupt lower boundary.
- B<sub>30a</sub> 35 to 50 inches, pale-brown (10YR 6/3, dry) to dark grayish-brown (10YR 4/2, moist) silty clay; few, fine, faint mottles of yellowish red (5YR 4/6, moist); very hard when dry, very firm when moist; moderate medium blocky structure; numerous calcium carbonate concretions; soil mass is noncalcareous, pH 7.1; clear lower boundary.
- B<sub>2b</sub> 50 to 60 inches+, dark-brown (7.5YR 4/4, dry) to grayish-brown (10YR 5/2, moist) silty clay; common, medium, distinct, yellowish-red (5YR 5/6, moist) mottles; very hard when dry, very firm when moist; moderate fine blocky structure; a few small calcium carbonate concretions; soil mass is noncalcareous, pH 7.1.

These soils are browner and have more friable subsoils on the steeper slopes. The Crete soils in this county may

TABLE 3.—Some important characteristics of the soil series

Soil series	Topographic position	Slope range	Color of surface soil and texture of dominant mapping unit	Color, consistence, and texture of subsoil <sup>1 2</sup>
Cass	First bottoms	Nearly level	Grayish-brown fine sandy loam.	Light brownish-gray friable fine sandy loam. <sup>3</sup>
Crete	Uplands	Nearly level to undulating.	Dark grayish-brown silty clay loam.	Brown very firm silty clay.
Derby	Dunelike uplands	Undulating to rolling	Grayish-brown loamy sand.	Reddish-brown very friable fine sandy loam.
Dwight	Uplands	Nearly level	Dark-gray silty clay loam.	Dark grayish-brown very firm clay.
Farnum	Uplands	Nearly level to gently sloping.	Dark grayish-brown fine sandy loam.	Brown very firm clay.
Florence	Uplands	Nearly level to moderately steep.	Brown silty clay loam	25 percent fine earth; 75 percent fragments.
Geary	Uplands	Gently sloping to sloping.	Dark grayish-brown silt loam.	Brown firm silty clay loam.
Hobbs	First bottoms	Nearly level	Dark grayish-brown silt loam.	Dark grayish-brown friable silt loam. <sup>3</sup>
Humbarger	First bottoms	Nearly level	Dark grayish-brown loam.	Light brownish-gray firm clay loam. <sup>3</sup>
Irwin	Uplands	Nearly level to rolling	Very dark grayish-brown silty clay loam.	Dark grayish-brown very firm clay.
Ladysmith	Uplands	Nearly level to gently sloping.	Dark-gray silty clay loam.	Dark-gray very firm clay.
Monona	Uplands	Hilly to steep	Dark grayish-brown silt loam.	Grayish-brown friable silt loam. <sup>3</sup>
Muir	Second bottoms	Nearly level	Dark grayish-brown silty clay loam.	Dark-brown firm silty clay loam.
Riverwash	Old stream channels	Nearly level	Light-gray fine sand and sand.	Light-gray loose fine sand and sand. <sup>3</sup>
Sand dunes, Sarpy material.	Dunelike second bottoms.	Rolling to hilly	Grayish-brown loamy fine sand.	Very pale brown loose loamy fine sand. <sup>3</sup>
Sarpy	First bottoms	Nearly level	Grayish-brown loamy fine sand.	Pale-brown friable loamy fine sand. <sup>3</sup>
Shellabarger	Uplands	Nearly level to hilly	Dark grayish-brown sandy loam.	Brown friable sandy clay loam.
Sogn	Uplands	Undulating to steep.	Nearly black clay loam	Limestone bedrock.
Solomon	First-bottom depressions.	Nearly level (concave)	Dark-gray silty clay	Dark-gray very firm clay. <sup>3</sup>
Sutphen	Second bottoms	Nearly level	Very dark gray silty clay.	Very dark gray very firm clay. <sup>3</sup>
Tully	Foot slopes	Nearly level to moderately steep.	Dark grayish-brown silty clay loam.	Dark-brown very firm silty clay.
Hastings	Uplands	Level to rolling	Dark grayish-brown silty clay loam.	Brown firm silty clay loam.

<sup>1</sup> Color when dry; consistence when moist.

<sup>2</sup> Unless otherwise specified (see footnote 3), the subsoil is the B<sub>2</sub> horizon, that is, the horizon that is highest in clay.

<sup>3</sup> No B<sub>1</sub> horizon. A layer beginning at a depth of 7 inches and extending to a depth of 36 inches is arbitrarily designated as the subsoil.

have bedrock, moderately fine textured loess, or the remnants of an older, reddish-colored soil lying beneath the B horizon. The presence of these different substrata materials is not predictable. The description is of a profile overlying a buried soil.

**Crete silty clay loam, 0 to 1 percent slopes (Cc).**—The profile of this soil is the one described for the Crete series. The soil has slow runoff and is slowly permeable in the subsoil; consequently, wetness is a problem in periods of excess moisture. This soil is suited to most crops grown in the county. Capability unit IIs-1; range site, Clayey upland.

**Crete silty clay loam, 1 to 4 percent slopes (Cd).**—This soil occurs on gently sloping uplands, mostly west of Junction City. The darkened surface layer is 10 to 14 inches thick. The subsoil generally is slightly browner and contains a little less clay than that of Crete silty clay loam, 0 to 1 percent slopes. Runoff is medium, and permeability is slow. The hazard of water erosion is moderate to severe unless the soil is properly protected. This soil is well

suited to terracing and contour cultivation (fig. 7). Capability unit IIe-1; range site, Clayey upland.

**Crete silty clay loam, 4 to 8 percent slopes (Ce).**—This unit has a thinner darkened surface layer than Crete silty clay loam, 0 to 1 percent slopes. It has a less clayey and generally more friable B horizon. Runoff is rapid, and in most years the soil is droughty. Because of its steeper slopes, this soil is more susceptible to erosion than the Crete soils on milder slopes. Capability unit IIIe-2; range site, Clayey upland.

**CRETE SOILS, SEVERELY ERODED**

**Crete soils, severely eroded (Cf).**—This unit occurs on slopes of 2 to 8 percent. The dominant slopes are 4 to 6 percent. Except in a few small areas, all of the original surface soil has been removed by erosion, and the lighter colored clayey subsoil is exposed. The plow layer is in the clayey subsoil. Infiltration has been reduced, and runoff has increased; consequently, these soils are droughty and susceptible to further erosion. Capability unit IVe-3; range site, Claypan.



Figure 7.—Contour-listed cornfield on Crete soil.

#### DERBY LOAMY SAND

**Derby loamy sand (Da).**—This soil occurs in an upland area of stabilized sand dunes 2 miles southwest of Junction City. The topography is undulating to rolling. The dunes have slopes of more than 8 percent, and the relief is more than 20 feet.

This soil is sandy to depths of more than 5 feet. It differs from Sand dunes, Sarpy material, in occurring on the uplands, in being redder, and in containing more silts and clays. It is coarser textured than the Shellabarger soils. It does not have the clayey subsoil of the Farnum. The profile is slightly acid throughout.

Typical profile (located 1,000 feet north and 500 feet west of SE corner sec. 9, T. 12 S., R. 5 E., in a native pasture on an 8 percent slope):

- A<sub>1</sub> 0 to 7 inches, grayish-brown (10YR 5/2.5, dry) to dark-brown (10YR 3/3, moist) loamy sand; hard when dry, very friable when moist; massive; contains many roots; noncalcareous, pH 6.5; gradual lower boundary.
- AB 7 to 10 inches, brown (7.5YR 5/3, dry) to dark-brown (7.5YR 3/3, moist) light sandy loam; hard when dry, very friable when moist; almost structureless; contains many roots; noncalcareous, pH 6.2; gradual lower boundary.
- B 10 to 18 inches, reddish-brown (5YR 5/4, dry) to dark reddish-brown (5YR 3/4, moist) sandy loam; hard when dry, friable when moist; almost structureless; slightly more clayey than the overlying layers; clay films coat some sand grains but do not fill interstices; noncalcareous, pH 6.1; gradual lower boundary.
- C 18 to 50 inches+, yellowish-red (5YR 5/6, dry; 4/6, moist) loamy fine sand; hard when dry, friable when moist; massive; contains layers of fine sandy loam ½ to 1 inch thick; size of sand grains is at limit between fine and medium sand; noncalcareous, pH 6.0.

The surface soil varies in color from grayish brown on the ridges of the dunes to dark grayish brown in the low areas. A buried soil is commonly found below depths of 4 feet.

This soil is well drained. It is permeable, and little water runs off. Internal drainage is rapid. Because this soil is low in fertility, has a low water-holding capacity, and is likely to be eroded by wind if cultivated, it is not suitable for cultivation. Except where the pastures have been overgrazed, native grasses are abundant. Capability unit VIe-3; range site, Sands.

#### DWIGHT SILTY CLAY LOAM

**Dwight silty clay loam (Db).**—This soil occurs on nearly level ridgetops in the Flint Hills. Some of it has developed directly over shale, and some in a thin mantle of loess deposited over the shale. Slick spots—small depressions in which water sometimes stands—are common.

This soil differs from the Ladysmith soils in having a thinner surface soil, an abrupt boundary between the surface soil and the subsoil, and a thinner profile. It occurs on narrow ridgetops, and the Ladysmith soils occur on broad tablelands.

This soil has a thin, acid surface layer. The subsoil is clay; it is noncalcareous, although in some places the lower part contains lime concretions.

Typical profile (located 300 feet northeast of gate on south side of SE¼ sec. 10, T. 12 S., R. 8 E., in a native grass pasture on a 1 percent slope):

- A<sub>1</sub> 0 to 5 inches, dark gray (10YR 4/1, dry) to very dark gray (10YR 3/1, moist) silty clay loam; slightly hard when dry, friable when moist; moderate thin platy structure in uppermost 2 inches and weak medium granular structure below; contains many roots; noncalcareous, pH 5.5; abrupt lower boundary.
- B<sub>21</sub> 5 to 17 inches, dark grayish-brown (10YR 4/2, dry) to very dark grayish-brown (10YR 3/2, moist) clay; a few, fine, distinct mottles; very hard when dry, very firm when moist; moderate coarse columns that break into a moderate medium blocky structure; few roots at this depth or below; noncalcareous, pH 6.3; clear lower boundary.
- B<sub>22</sub> 17 to 22 inches, dark grayish-brown (10YR 4.5/2, dry) to very dark grayish-brown (10YR 3/2, moist) clay a few, fine, indistinct mottles; very hard when dry, very firm when moist; moderate medium blocky structure; noncalcareous, pH 7.3; gradual lower boundary.
- B<sub>3ca</sub> 22 to 32 inches, pale-brown (10YR 6/3, dry) to brown (10YR 4/3, moist) clay; some fine, indistinct mottles; very hard when dry, very firm when moist; moderate fine blocky structure; soil mass is noncalcareous, pH 7.8, but contains many small calcium carbonate concretions; gradual lower boundary.
- C<sub>1ca</sub> 32 to 45 inches, light-gray and pale-brown (10YR 7/2 and 6/3, dry) to pale-brown and dark yellowish-brown (10YR 6/3 and 4/4, moist) silty clay loam; many fine, distinct mottles; hard when dry, friable when moist; weak subangular blocky structure to massive; soil mass is noncalcareous, pH 7.7, but contains many small calcium carbonate concretions; gradual lower boundary.
- C<sub>2</sub> 45 to 56 inches, light-gray and very pale brown (10YR 7/2 and 7/4, dry) to yellowish-brown and pale-brown (10YR 5/4 and 6/3, moist) silty clay loam; hard when dry, friable when moist; weak subangular blocky structure to massive; calcareous, pH 7.7; gradual transition to layer below.
- D<sub>1</sub> 56 inches+, weathered cherty limestone and shale.

The thickness of the surface soil ranges from 3 to 6 inches, and the depth to the chert or consolidated rock is variable.

The slight slope provides moderate runoff and good surface drainage, but sometimes water stands in the small depressions for a considerable time after rainy periods. The subsoil is very slowly permeable.

The surface soil is so shallow that plowing mixes subsoil with the surface soil. Tilt is poor, and it is difficult to prepare a good seedbed. The thin surface soil and dense, compact clay subsoil limit the number of crops suited to this soil. Capability unit IVs-1; range site, Claypan.

#### FARNUM FINE SANDY LOAMS

These are deep soils that have a dark grayish-brown loamy surface layer that grades to the clayey subsoil at a depth of about 20 inches. They developed from eolian sands on the upland ridge crests. They resemble the Shellabarger soils but have a more clayey subsoil.

Typical profile (located 900 feet north and 100 feet east of the SW corner sec. 10, T. 12 S., R. 5 E., in a cultivated field on a 3 percent slope):

- A<sub>1</sub> 0 to 10 inches, dark grayish-brown (10YR 4/2, dry) to very dark grayish-brown (10YR 2.5/2, moist) fine sandy loam; soft when dry, friable when moist; weak granular structure; noncalcareous, pH 6.0; gradual lower boundary.
- B<sub>1</sub> 10 to 14 inches, dark grayish-brown (10YR 4/2, dry) to very dark grayish-brown (10YR 2.5/2, moist) sandy clay loam; dark brown (10YR 3/3, moist) when crushed; hard when dry, friable when moist; weak granular structure; clay films; noncalcareous, pH 6.0; gradual lower boundary.
- B<sub>21</sub> 14 to 20 inches, brown (7.5YR 4/2, dry) to dark-brown (7.5YR 3/2, moist) sandy clay; hard when dry, firm when moist; moderate medium subangular blocky structure; clay films; noncalcareous, pH 5.5; gradual lower boundary.
- B<sub>22</sub> 20 to 32 inches, brown (10YR 5/3, dry) to dark-brown (10YR 4/3, moist) clay; very hard when dry, very firm when moist; strong medium subangular blocky grading to blocky structure; distinct clay films; noncalcareous, pH 5.6; gradual lower boundary.
- B<sub>3</sub> 32 to 36 inches, brown (7.5YR 5/3, dry) to dark-brown (7.5YR 4/3, moist) sandy clay loam; very hard when dry, very firm when moist; weak subangular blocky structure; noncalcareous, pH 5.6; clear lower boundary.
- C<sub>1</sub> 36 to 48 inches, strong-brown (7.5YR 5/6, dry; 4/6, moist) sandy clay loam; soft when dry, very friable when moist; massive; noncalcareous; gradual lower boundary.

The A horizon is 8 to 14 inches thick. The surface soil is a fine sandy loam and has a few small inclusions of winnowed loamy fine sand. The B<sub>2</sub> horizon varies in texture from sandy clay to clay.

**Farnum fine sandy loam, 0 to 1 percent slopes (Fa).**—This soil has a somewhat darker colored surface soil than Farnum fine sandy loam, 1 to 4 percent slopes. Runoff and permeability are slower, and wetness is more of a problem during years of above average rainfall. This soil is subject to wind erosion when unprotected. Capability unit IIs-2; range site, Clayey upland.

**Farnum fine sandy loam, 1 to 4 percent slopes (Fb).**—This soil has the profile described as typical. Although moderately well drained, it drains slowly in unusually wet years. It is susceptible to sheet, gully, and wind erosion. Capability unit IIIe-3; range site, Clayey upland.

#### FLORENCE CHERTY CLAY LOAM

**Florence cherty clay loam (Fc).**—This is a dark-colored upland soil that has a subsoil of very cherty clay. It occurs on nearly level to moderately sloping areas. It has developed from Florence, Schroyer, and Threemile limestones, which are cherty.

Typical profile (located at the W¼ corner of sec. 28, T. 11 S., R. 8 E., in a native pasture on a 1 percent slope):

- A<sub>11</sub> 0 to 8 inches, brown (7.5YR 4/2, dry) to dark-brown (7.5YR 3/2, moist) silty clay loam; slightly hard when dry, friable when moist; moderate fine granular structure; contains many roots; noncalcareous, pH 5.5; gradual lower boundary.
- A<sub>12</sub> 8 to 14 inches, brown (7.5YR 4/2, dry) to dark-brown (7.5YR 3/2, moist), very cherty silty clay loam; hard when dry, firm when moist; moderate medium blocky structure; chert fragments ½ to 3 inches long; noncalcareous, pH 5.8; clear lower boundary.
- B<sub>2</sub> 14 to 24 inches, yellowish-red (5YR 5/6, dry; 4/6, moist) very cherty clay; very hard when dry, very firm when moist; massive; yellowish-brown spots in lower half of horizon; noncalcareous.

The surface soil is clay loam and silty clay loam. It contains various percentages of chert fragments.

The profile below a depth of 24 inches consists of reddish very cherty clay, which may be several feet thick. Loose cherty rubble is encountered in some places and nonconforming materials in others. The depth of the solum is variable. It depends upon the thickness and the content of chert of the Florence, Schroyer, and Threemile limestones in the locality.

This soil cannot be cultivated, because of the chert. The native vegetation consists of tall and mid grasses. Capability unit VIe-2; range site, Loamy upland.

#### GEARY SILT LOAMS

These are deep soils that have developed in the uplands, dominantly from loess. They occur in gently sloping to sloping areas near major streams. They are browner than the Hastings soils.

The dark grayish-brown surface soil is about 10 inches thick and has a medium granular structure. The subsoil, about 24 inches thick, is brown and clayey and has a fine subangular blocky structure.

Typical profile (located 500 feet north of cemetery, NE¼SE¼ sec. 27, T. 11 S., R. 6 E., in a native grass meadow on a 4 percent slope)

- A<sub>11</sub> 0 to 6 inches, dark grayish-brown (10YR 4/2, dry) to very dark grayish-brown (10YR 3/2, moist) silt loam; slightly hard when dry, friable when moist; moderate medium granular structure; contains many roots; noncalcareous, pH 5.6; abrupt lower boundary.
- A<sub>12</sub> 6 to 11 inches, dark grayish-brown (10YR 4/2, dry) to very dark grayish-brown (10YR 3/2, moist) silt loam; slightly hard when dry, firm when moist; weak prisms that break to moderate medium granular structure; contains many roots; noncalcareous, pH 5.6; gradual lower boundary.
- B<sub>1</sub> 11 to 18 inches, brown (10YR 5/3, dry) to dark grayish-brown (10YR 4/2, moist) silty clay loam; hard when dry, firm when moist; weak prisms that break to a moderate fine subangular blocky structure; few roots; noncalcareous, pH 5.7; gradual lower boundary.
- B<sub>2</sub> 18 to 36 inches, brown (7.5YR 5/4, dry) to dark-brown (7.5YR 3/2, moist) silty clay loam; hard when dry, firm when moist; weak prisms that break to a moderate fine subangular blocky structure; noncalcareous, pH 5.6; gradual lower boundary.
- C 36 to 60 inches+, brown (7.5YR 5/5, dry) to dark-brown (7.5YR 4/4, moist) silty clay loam; hard when dry, firm when moist; weak prismatic structure; noncalcareous, pH 6.0.

The color of the B and C horizons varies from brown to reddish brown. The texture of the subsoil ranges from silty clay loam to light silty clay.

These soils are suited to the crops grown in the area. If they are cultivated, water erosion is the most serious hazard.

## HUMBARGER CLAY LOAM AND LOAM

**Geary silt loam, 4 to 8 percent slopes (Ga).**—This unit includes more than half of the Geary acreage in the county. Its profile is the one described as typical of the Crete series. Capability unit IIIe-2; range site, Loamy upland.

**Geary silt loam, 8 to 12 percent slopes (Gb).**—This soil has an A horizon that is generally 6 to 8 inches thick. The subsoil is generally less clayey than that of Geary silt loam, 4 to 8 percent slopes.

This soil is best left in native grasses; however, it may be used for cultivated crops if adequate conservation measures are used. Capability unit IVE-2; range site, Loamy upland.

## GEARY SOILS, SEVERELY ERODED

**Geary soils, severely eroded (Gc).**—The soils in this unit are similar to Geary silt loam, 4 to 8 percent slopes, but have lost their original surface layer through sheet erosion. The plow layer is in the subsoil, and gullies are common.

These severely eroded soils produce poor yields of cultivated crops. If the cultivated areas are returned to grass, the pastures are poor unless they are properly managed and fertilized. Capability unit IVE-3; range site, Loamy upland.

## HOBBS SILT LOAM

**Hobbs silt loam (Ha).**—This is a dark-colored, weakly developed soil that occurs on the first bottoms of the secondary streams. The profile is silty and noncalcareous throughout. The uppermost 20 to 30 inches is dark grayish-brown, and the lower part is slightly lighter colored.

Typical profile (located 100 feet south and 150 feet east of the NW corner of sec. 18, T. 12 S., R. 5 E., in a native grass pasture on a 1 percent slope):

- A<sub>1</sub> 0 to 10 inches, dark grayish-brown (10YR 4/2, dry) to very dark grayish-brown (10YR 3/2, moist) silt loam; slightly hard when dry, firm when moist; moderate medium granular structure; noncalcareous, pH 6.2; clear lower boundary.
- AC 10 to 20 inches, dark grayish-brown (10YR 4.5/2, dry) to very dark grayish-brown (10YR 3/2, moist) silt loam; hard when dry, friable when moist; weak granular structure; noncalcareous, pH 6.2; gradual lower boundary.
- C<sub>1</sub> 20 to 44 inches, grayish-brown (10YR 5/2, dry) to very dark grayish-brown (10YR 3/2, moist) silt loam; a few, fine, faint mottles of brown (10YR 5/3, dry) to dark brown (10YR 4/3, moist); hard when dry, friable when moist; massive; noncalcareous, pH 6.2; clear lower boundary.
- C<sub>2</sub> 44 to 60 inches+, grayish-brown (10YR 5/2, dry) to very dark grayish-brown (10YR 3/2, moist) silt loam; many, medium, distinct mottles of brown (10YR 5/3, dry) to dark brown (10YR 4/3, moist); hard when dry, firm when moist; massive; noncalcareous, pH 6.7.

Strata of silty clay loam occur in some profiles. Generally, the profile is darker colored in the eastern part of the county where this soil is associated with the Sogn and Tully soils. Faint mottling is not uncommon where this soil receives additional water from the upland.

Except for a few depressions where water ponds for short periods, this soil is well drained and has medium runoff. It is moderately permeable.

This soil is suitable for irrigation. It can be used for crops, pasture, or woods. It is suitable for all the crops grown in the area, but frequent spring floods may damage crops or delay planting. Capability unit I-2; range site, Loamy lowland.

**Humbarger clay loam and loam (Hb).**—These are moderately dark colored soils on the bottom lands. They are normally well drained. They are flooded occasionally. They occur on the nearly level flood plains of the Smoky Hill River and some of the larger creeks. The texture varies from loam to clay loam within short distances and in such an intricate pattern that the soils could not be mapped separately.

This mapping unit is darker colored and less sandy than the Sarpy soils. The profile is loamy and calcareous throughout.

Typical profile of Humbarger loam (located near center of the island in NW¼ sec. 27, T. 12 S., R. 5 E., in a nearly level cultivated field):

- A<sub>1p</sub> 0 to 7 inches, dark grayish-brown (10YR 4/2, dry) to dark-brown (10YR 3/3, moist) loam; slightly hard when dry, friable when moist; weak fine granular structure; calcareous; roots abundant; abrupt smooth boundary.
- A<sub>12</sub> 7 to 19 inches, very dark grayish-brown (10YR 3/2, dry) to black (10YR 2/1, moist) clay loam; hard when dry, firm when moist; moderate to strong medium and fine blocky structure; calcareous; gradual smooth boundary.
- AC 19 to 25 inches, grayish-brown (10YR 5/2, dry) to dark grayish-brown (10YR 4/2, moist) clay loam; hard when dry, firm when moist; moderate medium subangular blocky structure; calcareous; gradual smooth boundary.
- C 25 to 54 inches+, light brownish-gray (10YR 6/2, dry) to brown (10YR 4/3, moist) stratified clay loam and loam; weak medium subangular blocky structure to massive; calcareous.

In some places the profile is weakly stratified with slightly more sandy or more clayey layers. Because of deposition of material by flowing water, the characteristics of these soils vary within short distances.

All crops commonly grown in the county are well suited to these soils (fig. 8). The chief management problems are conserving fertility and maintaining the supply of organic matter. Occasionally a crop is destroyed by a flood. It is easier to work these soils soon after the harvest than after they have become dry. Capability unit I-2; range site, Loamy lowland.



Figure 8.—Harvesting wheat on Humbarger soils.

## HUMBARGER LOAMY FINE SAND

**Humbarger loamy fine sand (Hc).**—This unit consists of areas formerly of Humbarger loam on which a 12- to 36-inch layer of very pale brown fine sand and loamy fine sand was deposited by the flood of 1951 (fig. 9). This

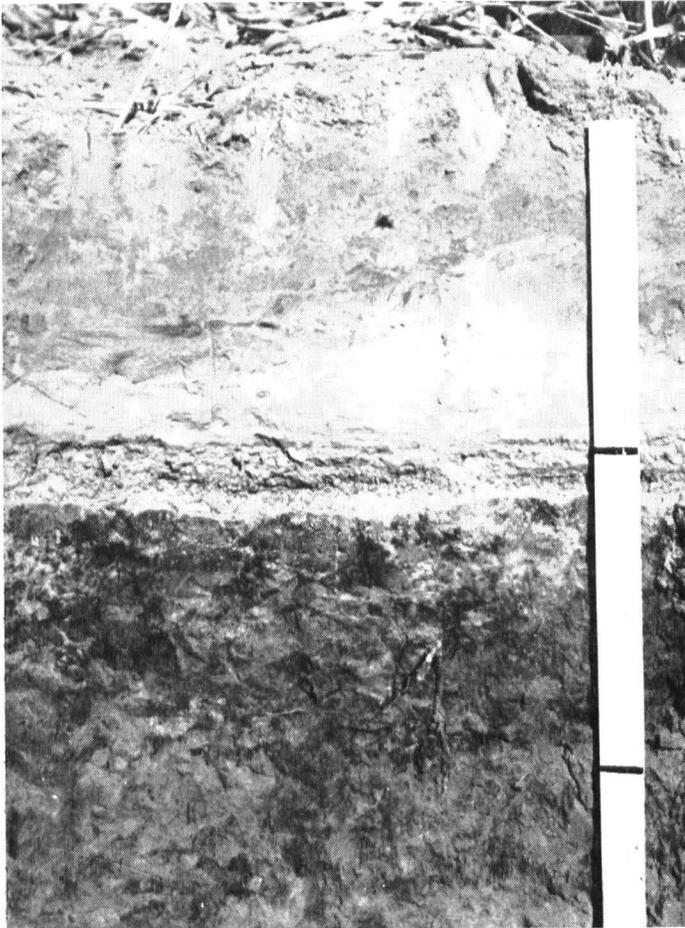


Figure 9.—Humbarger soils overlain with about 14 inches of sandy material deposited by the flood of 1951.

deposit varies in thickness and composition, depending on its location in relation to the stream current at the time of the flood. In addition, efforts to reclaim the flooded areas have altered the material. Numerous areas have been deep-plowed to bring the underlying loam to the top. Capability unit IIs-3; range site, Loamy lowland.

## IRWIN SILTY CLAY LOAMS

These are deep, dark-colored soils that have developed from fine-textured materials of undetermined origin over shales and limestones. They are browner than the Lady-smith soils and may have a thicker transition layer between the A and B horizons. They have a thicker A horizon than Dwight silty clay loam and a less abrupt boundary between the A and B horizons.

The A horizon is very dark grayish-brown and is about 10 inches thick. The subsoil is dense, compact, dark grayish-brown, blocky clay.

Typical profile (located 490 feet north and 1,670 feet east of the W $\frac{1}{4}$  corner of sec. 5, T. 13 S., R. 6 E., in a native grass pasture on a 1 percent slope):

- A<sub>1</sub> 0 to 11 inches, very dark grayish-brown (10YR 3/2, dry) to very dark brown (10YR 2/2, moist) silty clay loam; hard when dry, moderately friable when moist; fine granular structure; contains many roots; noncalcareous; gradual lower boundary.
- B<sub>21</sub> 11 to 21 inches, dark grayish-brown (10YR 4/2, dry) to dark-brown (7.5YR 3/2, moist) clay; extremely hard when dry, extremely firm when moist; weak coarse blocky breaking to weak fine blocky structure; very dark grayish-brown coatings on peds; continuous, distinct clay films; some rootlet channels clogged; many roots; noncalcareous; diffuse, smooth lower boundary.
- B<sub>22</sub> 21 to 28 inches, dark grayish-brown (10YR 4.5/2, dry) to very dark grayish-brown (10YR 3/2, moist) clay; extremely hard when dry, extremely firm when moist; weak blocky structure to massive; few-roots; noncalcareous; diffuse, smooth lower boundary.
- B<sub>3</sub> 28 to 38 inches, dark grayish-brown (10YR 4.5/2, dry; 4/2, moist) clay; extremely hard when dry, extremely firm when moist; weak coarse blocky structure to massive; a few hard calcium carbonate concretions up to three-eighths inch in diameter, noncalcareous mass; diffuse, smooth lower boundary.
- C 38 to 54 inches, brown (10YR 5/3, dry) to dark yellowish-brown (10YR 4/4, moist) silty clay; a few, coarse, distinct mottles of light brownish gray in upper part and common, fine, faint mottles of brown and light brownish gray in lower part; very hard when dry, very firm when moist; massive; a few fine, soft, calcareous concretions, noncalcareous mass; diffuse, smooth lower boundary.
- D 54 to 60 inches+, brown (10YR 5/3, dry) to dark-brown (7.5YR 4/3, moist) silty clay; very hard when dry, very firm when moist; massive; noncalcareous.

In some places, shale or limestone bedrock occurs at depths of 3 to 6 feet. Where the soil is underlain by limestone, the lower horizons are commonly more reddish than the upper horizons. In areas under native grass, the A horizon is 8 to 14 inches thick. Lime concretions occur within 3 feet of the surface in many places. In a few places the C horizon is not mottled.

These soils occur dominantly on slopes of 3 to 6 percent, but the slopes range from  $\frac{1}{2}$  to 12 percent. The native grasses are best suited to the steep slopes; wheat, sorghum, legumes, and grasses are well suited to the more gentle slopes.

**Irwin silty clay loam, 0 to 1 percent slopes (1a2).**—This soil has the profile described as typical. It has slow runoff and slow permeability in the subsoil; consequently, wetness is a problem in periods of excessive rainfall. Capability unit IIs-1; range site, Clayey upland.

**Irwin silty clay loam, 1 to 4 percent slopes (1a).**—The depth to the clay subsoil varies from 8 to 14 inches, but is generally thicker than in Irwin silty clay loam, 0 to 1 percent slopes. The color of the surface soil and the upper part of the B<sub>2</sub> horizon is browner than in the more level areas. Runoff is medium to rapid. Permeability is slow, although less so than on Irwin silty clay loam, 0 to 1 percent slopes. This soil is susceptible to erosion. Capability unit IIc-1; range site, Clayey upland.

**Irwin silty clay loam, 4 to 8 percent slopes (1b).**—This soil occurs on the steeper slopes. Nearly all of this soil is in native prairie grasses. Its surface soil and solum are genetically thinner than those in the profile described. In places bedrock is within 3 or 4 feet of the surface. Runoff is rapid, and permeability is slow. Capability unit IVe-1; range site, Clayey upland.

**Irwin silty clay loam, 8 to 12 percent slopes (lc).**—Most of this soil occurs in small areas. The surface soil is thinner and the profile generally shallower than those of the Irwin soils on milder slopes. Most of this soil is in native bluestem grasses. Capability unit VIe-1; range site, Clayey upland.

#### IRWIN SOILS, SEVERELY ERODED

**Irwin soils, severely eroded (ld).**—Most of this unit is on slopes of 4 to 8 percent. The original surface soil has been lost through erosion. The present surface layer is clay or silty clay and lacks the good tilth and productivity of the less eroded Irwin soils. Capability unit VIe-1; range site, Claypan.

#### LADYSMITH SILTY CLAY LOAMS

These soils occur in the uplands in the southeastern part of the county. They are deep, dark colored, and strongly developed. They have a grayer surface soil and a grayer, more clayey subsoil than the Crete soils. They have a thicker A horizon than the Dwight soil and a less abrupt transition from surface soil to subsoil.

The dark-gray surface soil is about 10 inches thick. The subsoil is dense, compact, nearly black clay, which is about 24 inches thick. The underlying material is shaly.

Typical profile (located 150 feet south of the W $\frac{1}{4}$  corner of sec. 27, T. 13 S., R. 8 E., in a native grass pasture on a 1 percent convex slope):

- A<sub>1</sub> 0 to 9 inches, dark-gray (10YR 4/1, dry) or very dark gray (10YR 2.5/1, moist) silty clay loam; slightly hard when dry, firm when moist; moderate fine and medium granular structure; many roots; noncalcareous, pH 5.6; clear lower boundary.
- B<sub>21</sub> 9 to 18 inches, dark-gray (10YR 4/1, dry) or very dark gray (10YR 2.5/1, moist) clay; very hard when dry, very firm when moist; moderate coarse prisms that break to a moderate medium blocky structure; contains a few roots; noncalcareous, pH 5.5; gradual lower boundary.
- B<sub>22</sub> 18 to 27 inches, gray (10YR 5/1, dry) to very dark gray (10YR 3/1, moist) clay; a few yellowish-red, fine, distinct mottles; very hard when dry, very firm when moist; moderate medium blocky structure; many black shotlike concretions; noncalcareous, pH 6.5; gradual lower boundary.
- B<sub>3</sub> 27 to 34 inches, light brownish-gray and pale-brown (10YR 6/2-6/3, dry) to grayish-brown (10YR 5/2, moist) clay; a few yellowish-red, fine, distinct mottles; very hard when dry, very firm when moist; weak blocky structure; many black shotlike pellets and concretions of calcium carbonate, but soil mass noncalcareous, pH 7.2; gradual lower boundary.
- C<sub>1</sub> 34 to 48 inches, light-gray (10YR 7/2, dry) to light brownish-gray (10YR 6/2, moist) heavy silty clay loam; many light yellowish-brown, coarse, prominent mottles; hard when dry, firm when moist; weak blocky structure; a few calcium carbonate concretions, but soil mass noncalcareous, pH 7.4; abrupt lower boundary.
- C<sub>2</sub> 48 to 60 inches+, clay shale residuum.

The thickness of the A horizon ranges from 8 to 10 inches.

The claypan keeps these soils wet in years of above average rainfall and makes them droughty in years of little rainfall. The slopes are dominantly 1 percent but range up to 4 percent.

**Ladysmith silty clay loam, 0 to 1 percent slopes (La).**—This soil has the profile described as typical. It has slow to very slow runoff and slow subsoil permeability; conse-

quently, wetness is a problem during wet periods. Capability unit IIs-1; range site, Clayey upland.

**Ladysmith silty clay loam, 1 to 4 percent slopes (Lb).**—This soil has a somewhat thinner A horizon than Ladysmith silty clay loam, 0 to 1 percent slopes, and is not so dark colored. The upper part of the B<sub>2</sub> horizon may be lighter colored, and the lower part may be brownish instead of grayish. Runoff is medium to rapid, and the erosion hazard is moderate to high. Capability unit IIIe-1; range site, Clayey upland.

#### MONONA SILT LOAM

**Monona silt loam (Ma).**—This is a weakly developed soil formed from silty loess. In many places it is underlain by a buried soil at depths of 3 to 5 feet. The slopes are hilly to steep. This soil differs from the Hastings soils in being medium textured throughout and lacking a strongly developed profile.

Typical profile (located 800 feet south of north section line and 170 feet east of road in NE $\frac{1}{4}$ NE $\frac{1}{4}$  sec. 36, T. 10 S., R. 4 E., in a wooded area of elm, oak, and walnut trees on a 30 percent slope):

- A<sub>11</sub> 0 to 5 inches, dark grayish-brown (10YR 4/2, dry) to very dark grayish-brown (10YR 3/2, moist) silt loam; soft when dry, friable when moist; weak granular structure; many roots; noncalcareous, pH 6.7; abrupt lower boundary.
- A<sub>12</sub> 5 to 15 inches, grayish-brown (10YR 5/2, dry) to very dark grayish-brown (10YR 3/2, moist) silt loam; soft when dry, friable when moist; medium prisms that break to a weak subangular blocky structure; many roots; noncalcareous, pH 5.7; diffuse lower boundary.
- AC<sub>1</sub> 15 to 26 inches, grayish-brown (10YR 5/2.5, dry) to dark grayish-brown (10YR 4/2, moist) silt loam; slightly hard when dry, friable when moist; weak medium prisms that break to a weak subangular blocky structure; noncalcareous, pH 5.2; gradual lower boundary.
- AC<sub>2</sub> 26 to 34 inches, brown (10YR 5.5/3, dry; 4.5/3, moist) silt loam; slightly hard when dry, firm when moist; weak medium prisms that break to a weak subangular blocky structure; noncalcareous, pH 5.7; abrupt lower boundary.
- A<sub>1b</sub> 34 to 60 inches+, strong-brown (7.5YR 5/6, dry) to brown (7.5YR 4/4, moist) silt loam; slightly hard when dry, firm when moist; weak subangular blocky structure; noncalcareous, pH 6.2; underlain by lighter colored silt loam.

On the valley walls south and west of the Republican River the profile is dominantly silt loam. On the bluffs east and north of the river, it is loam to very fine sandy loam. Buried soils are common (fig. 10). Where this soil is under native grass, the A horizon is thicker and slightly darker colored than where it is under trees. Strata of fine sandy loam occur in some profiles.

Elm and walnut trees and several kinds of oak trees grow on the steepest bluffs. Tall grasses grow on the milder slopes. Capability unit VIe-2; range site, Loamy upland.

#### MUIR LOAM

**Muir loam (Mb).**—This is a dark colored, medium textured to moderately fine textured alluvial soil. It is sandier throughout the profile than the Hobbs soil. Drainage is good. Runoff is medium, and the subsoil is moderately permeable.

The surface soil is dark grayish-brown loam about 8 inches thick. It is underlain by brown sandy clay loam, which extends to depths of more than 5 feet.

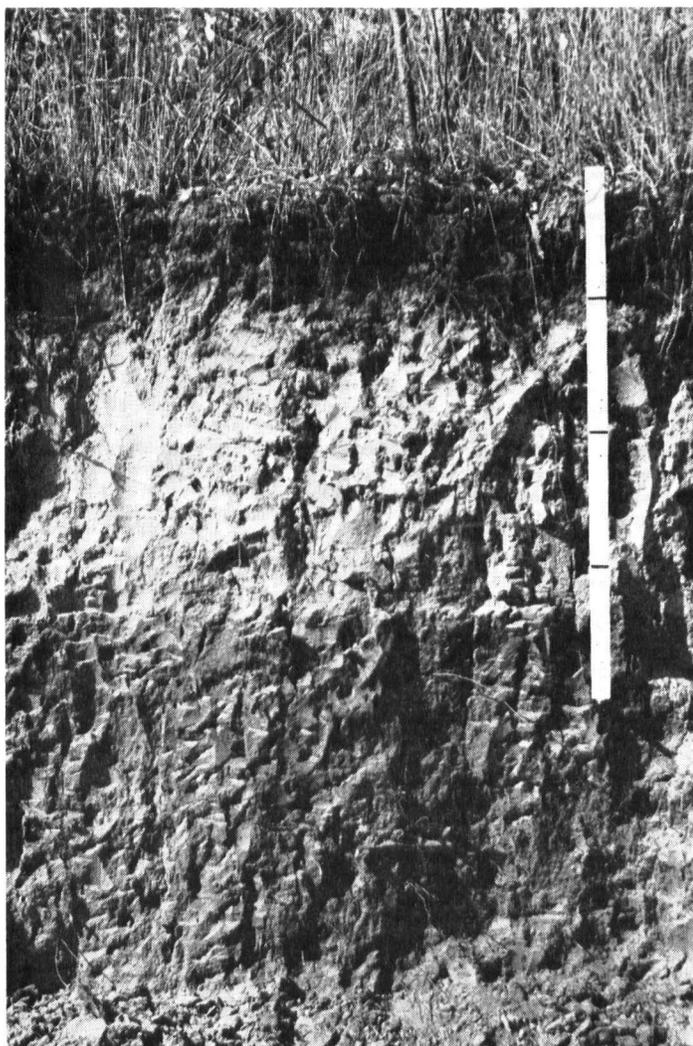


Figure 10.—Profile of Monona silt loam showing a buried soil at a depth of about 3½ feet.

Typical profile (located 125 feet west and 250 feet north of highway intersection in sec. 23, T. 12 S., R. 4 E., in a cultivated area on a ½ percent slope):

- A<sub>1p</sub> 0 to 7 inches, dark grayish-brown (10YR 4/1.5, dry) to very dark grayish-brown (10YR 3/2, moist) loam; slightly hard when dry, very friable when moist; weak granular structure; noncalcareous, pH 5.9; abrupt lower boundary.
- B 7 to 30 inches, dark grayish-brown and brown (10YR 4/2 and 5/3, dry) to very dark grayish-brown (10YR 3/2, moist) sandy clay loam; very hard when dry, very firm when moist; weak blocky structure to massive; noncalcareous, pH 6.2; clear lower boundary.
- C 30 to 60 inches+, brown and pale-brown (10YR 5/3 and 6/3, dry) to dark grayish-brown and brown (10YR 4/2 and 5/3, moist) sandy clay loam; very hard when dry, very firm when moist; massive; noncalcareous, pH 6.6.

The texture of the B horizon varies from clay loam to loam.

This soil is suited to all crops commonly grown in the county. It is likely to be damaged by water flowing from the uplands. Capability unit I-1; range site, Loamy lowland.

#### MUIR SILTY CLAY LOAM

**Muir silty clay loam (Mc).**—This is a dark-colored, well-drained alluvial soil. In Geary County it occurs on the nearly level second bottoms of the Republican, Kansas, and Smoky Hill Rivers and their major tributaries.

More than 90 percent of this soil has a gradient of less than 2 percent. The slopes are stronger at the edges of the high bottoms or in drainageways that cut through the large, nearly level areas.

This soil is darker colored than the Humbarger soils and is noncalcareous. It has a silty clay loam texture throughout the profile. Runoff is medium, and the subsoil is moderately permeable.

Typical profile (located 250 feet west of the east section line and 100 feet north of the highway in sec. 26, T. 11 S., R. 6 E., in a cultivated area on a 1 percent slope):

- A<sub>1</sub> 0 to 23 inches, dark grayish-brown (10YR 4/2, dry) to very dark grayish-brown (10YR 3/2, moist) silty clay loam; hard when dry, friable when moist; moderate to strong medium granular structure; noncalcareous, pH 6.2; gradual lower boundary.
- AC 23 to 38 inches, dark-brown (10YR 4/3, dry; 3/3, moist) silty clay loam; hard when dry, firm when moist; strong medium subangular blocky structure; noncalcareous, pH 6.0; gradual lower boundary.
- C 38 to 60 inches+, brown (10YR 5/3, dry) to very dark grayish-brown (10YR 3/2, moist) silty clay loam; hard when dry, firm when moist; massive; noncalcareous, pH 6.2.

The AC horizon and the C horizon vary from moderately acid to neutral.

This is one of the most productive soils in the county. It is well suited to all crops grown in the area. It is used extensively for growing corn and other crops needed for livestock. It is well suited to irrigation. Capability unit I-1; range site, Loamy lowland.

#### RIVERWASH

**Riverwash (Ra).**—This land type consists of an unstable accumulation of very sandy alluvium. It occurs as sandbars and islands and in old river channels. It is only slightly above the riverbed. The deposits change in character, size, and depth with each flood. Cottonwoods and willows are the native trees.

This land type is not suited to cultivated crops and is poor for pasture. Although in some areas trees may eventually grow to fair size, most will have little commercial value. Capability unit VIII-1.

#### SAND DUNES, SARPY MATERIAL

**Sand dunes, Sarpy material (Sa).**—This mapping unit includes areas in the valley of the Republican River, which have the undulating or rolling relief typical of sand-dune topography. The loamy fine sand of which these dunes consist is less weathered and contains more nonquartz minerals than Derby loamy fine sand.

These sandy deposits have a grayish-brown surface layer, 5 to 10 inches thick, over a very pale brown substratum. The reaction is medium acid. The slope gradient ranges from 6 to 10 percent.

A typical area of this land type occurs three-eighths of a mile north of the center of sec. 18, T. 11 S., R. 5 E., in a native grass meadow.

These areas are best suited to native grasses. They are not suited to crops, because of low fertility, low moisture-storing capacity, and susceptibility to wind erosion. Capability unit VIe-3; range site, Sands.

## SARPY LOAMY FINE SAND

**Sarpy loamy fine sand (Sb).**—This is a light-colored, neutral to calcareous soil in the valleys of the Republican and Kansas Rivers. It is lighter colored and coarser textured than the Cass soils.

This soil is flooded periodically but has rapid drainage. There is little runoff because water passes rapidly through the subsoil. The water table is generally within 8 feet of the surface. The profile is sandy throughout.

Typical profile (located 150 feet east and 50 feet north of the W¼ corner of sec. 18, T. 11 S., R. 5 E., on a cultivated 2 percent slope):

- A<sub>1</sub> 0 to 20 inches, grayish-brown (10YR 5/1.5, dry) to dark grayish-brown (10YR 4/2, moist) loamy fine sand; soft when dry, very friable when moist; massive; non-calcareous, pH 7.2; gradual lower boundary.
- C 20 to 60 inches+, pale-brown (10YR 6/3, dry) to grayish-brown (10YR 5/2, moist) loamy fine sand; weakly stratified with erratic lenses of sand and fine sandy loam; soft when dry, very friable when moist; single grain; noncalcareous, pH 7.0.

The color varies from light gray to very pale brown. In many profiles there are dark layers at variable depths. The depth to calcareous material ranges from a foot to several feet. Rusty brown streaks or splotches are common below a depth of 4 feet.

The crops commonly grown in the county are well suited to this soil. Capability unit IIIs-1; range site, Sands.

## SHELLABARGER SANDY LOAMS

These are deep, well-drained, noncalcareous soils that have developed in old sandy sediments in the uplands above the valleys of the Republican and Smoky Hill Rivers. They are loamy throughout, but the subsoil contains more clay than the surface soil. They are less sandy and have a more distinct B horizon than Derby loamy sand. The B horizon of these soils is less clayey than that of the Farnum soils.

Typical profile (located 100 feet southwest of the N¼ corner of sec. 20, T. 12 S., R. 5 E., in a cultivated field on a 2 percent convex slope):

- A<sub>11</sub> 0 to 10 inches, dark grayish-brown (10YR 4/2, dry) to very dark grayish-brown (10YR 2.5/2, moist) sandy loam; slightly hard when dry, very friable when moist; very weak granular structure; noncalcareous; gradual lower boundary.
- A<sub>12</sub> 10 to 20 inches, brown (7.5YR 5/3, dry) to dark-brown (7.5YR 3.5/3, moist) sandy loam; slightly hard when dry, very friable when moist; structureless; noncalcareous; gradual lower boundary.
- B<sub>2</sub> 20 to 40 inches, light-brown (7.5YR 6/4, dry) to brown (7.5YR 4/4, moist) sandy clay loam; hard when dry, friable when moist; massive; clay films coat sand grains and partially bridge spaces between; noncalcareous; gradual lower boundary.
- B<sub>3</sub> 40 to 48 inches+, light-brown (7.5YR 6/4, dry) to brown (7.5YR 4/4, moist) sandy clay loam; hard when dry, friable when moist; massive; noncalcareous.

Many profiles on the lower slopes have a layer of loamy sand at a depth of about 3 feet. Preventing wind erosion and the encroachment of gullies from the stronger slopes are the most serious management problems.

Except for corn, most of the crops commonly grown in the county are suitable for these soils. The fertility is moderately low.

**Shellabarger sandy loam, 1 to 4 percent slopes (Sc).**—This soil has the profile described as typical. Some small inclusions of loamy fine sand and loamy sand occur. They

are the result of wind erosion. These inclusions comprise less than 10 percent of the area. Capability unit IIIe-3; range site, Loamy upland.

**Shellabarger sandy loam, 4 to 8 percent slopes (Sd).**—Where this soil is cultivated, the A horizon is about 4 inches thinner than in the profile described. Included are small areas of sandy clay loam. These comprise less than 15 percent of the total acreage of this unit. Severely eroded or gullied areas are shown on the map by symbols. Erosion control and fertility maintenance are the main problems. Capability unit IVe-4; range site, Loamy upland.

**Shellabarger sandy loam, 8 to 20 percent slopes (Se).**—This soil occurs along the major streams and their tributaries. Most of it is in native grasses or in trees. Because of the very severe erosion hazard, it is not suitable for cultivation. Capability unit VIe-2; range site, Loamy upland.

## SOGN ROCKY CLAY LOAM

**Sogn rocky clay loam (Sf).**—This is a dark colored, clayey soil that is only 10 inches deep over limestone. It has a shallower profile and a much shallower root zone than the Florence soil. It occurs above the Sogn complex. The slopes range up to 8 percent (fig. 11).

Typical profile (located 75 feet east of the NW corner of sec. 15, T. 12 S., R. 7 E., in a native grass pasture on a 3 percent convex slope):

- A<sub>1</sub> 0 to 9 inches, very dark gray (10YR 2.5/1, dry) to black (10YR 2/1, moist) clay loam; contains numerous limestone fragments; hard when dry, friable when moist; strong medium granular structure; noncalcareous.
- D. 9 inches+, limestone.

The soil is shallower near the steeper slopes, and in places small areas of bedrock are exposed. This soil is not suited to cultivation, because it is shallow and stony. It is best suited to native grasses. Capability unit VIIs-1; range site, Shallow.

## SOGN COMPLEX

**Sogn complex (Sg).**—This complex is composed of soils that occur in such an intricate pattern of narrow bands, outcrops, and varying slopes that it was not practicable to map them separately. It is part of the native grass prairie of the Flint Hills. Although the proportion of the different soils varies from place to place, the mapping unit is about 30 percent Sogn rocky clay loam; 20 percent Tully silty clay loam; and 50 percent unnamed Regosols developed from calcareous shale.

The Regosols have a very dark grayish-brown silty clay loam surface horizon, 7 to 18 inches thick, underlain by calcareous clay loams and soft shales. This grades to consolidated bedrock, which occurs at depths of 18 to 36 inches. The structure of the altered material is granular. The exact character of materials and organization may vary in different localities.

Sogn rocky clay loam and Tully silty clay loam are described elsewhere in this report.

The Sogn complex is a complex in every respect; a complex of soils, slopes, and range sites. The slopes range from about 15 to 40 percent. There is an intricate pattern of rock escarpments and very steep slopes intermixed with gentler slopes. Ordinarily, the slopes of less than 30 percent gradient would be in the Loamy upland range site, and the slopes of more than 30 percent

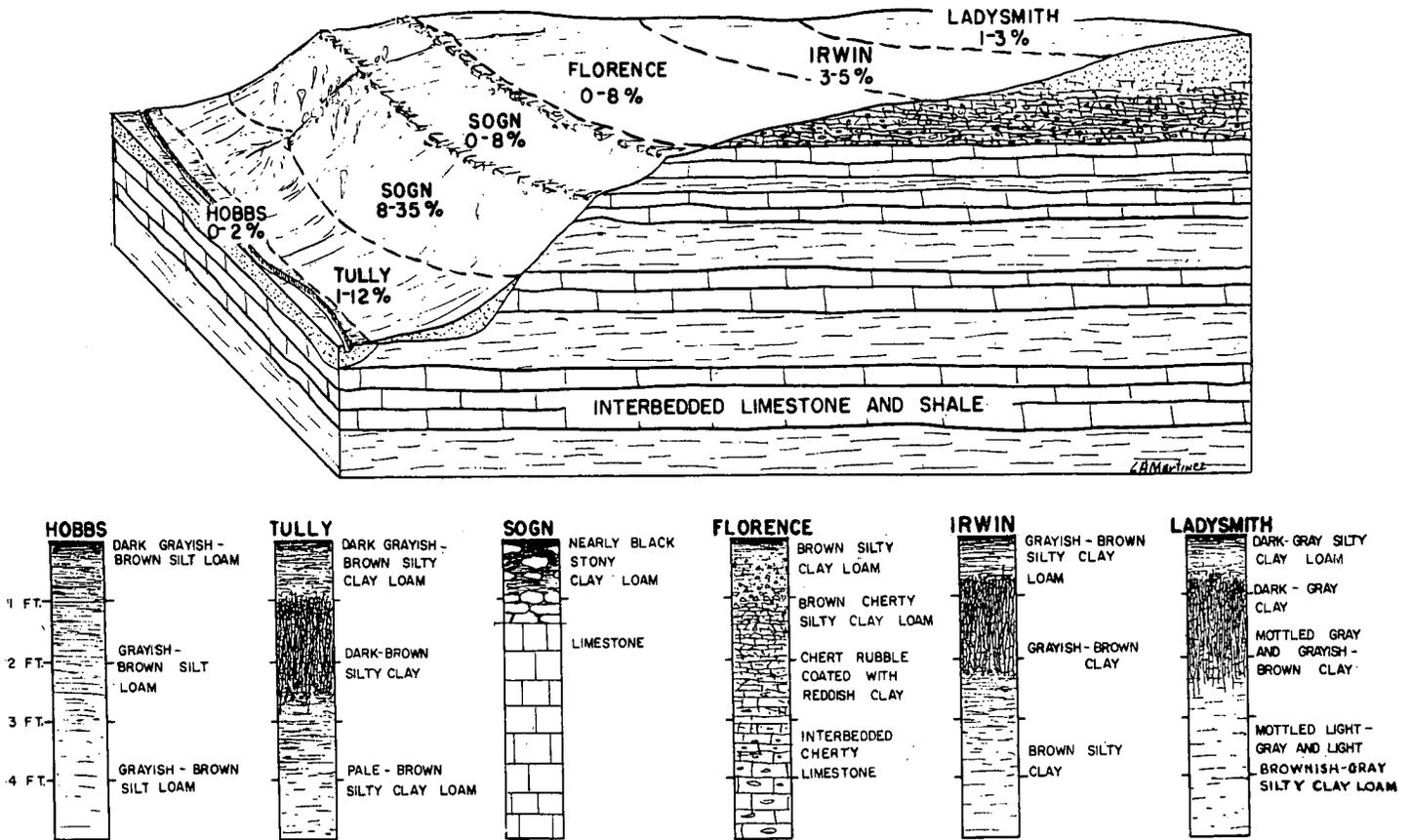


Figure 11.—Diagram showing the relationship of the soils in the southeastern part of Geary County.

would be in the Limestone breaks range site. The slopes of 30 percent or more are not grazed readily by cattle. As a result, this complex is classified in the Limestone breaks range site, even though a large percentage of it consists of gentler slopes.

The range site classification may be used as a guide, but each pasture must be studied to determine the proper stocking rate and the management needs. Capability unit VIe-4; dominant range site, Limestone breaks.

**SOLOMON SILTY CLAY**

**Solomon silty clay (Sh).**—This is a deep, dark-colored, slightly developed alluvial soil on the first bottoms of the Smoky Hill River. It occupies nearly level areas and depressions in old stream meanders. It resembles Sutphen silty clay but is calcareous and occurs at lower levels on the valley floor.

The upper part of the profile is dark gray, and the lower part is light brownish gray. The soil is underlain at depths of 4 to 5 feet by weakly stratified fine sandy loam. The drainage is somewhat poor to poor.

Typical profile (located 100 feet south and 200 feet east of NW corner sec. 32, T. 12 S., R. 5 E., in a cultivated field on a 1 percent slope):

- A<sub>1p</sub> 0 to 6 inches, dark-gray (10YR 4/1, dry) to black (10YR 2/1, moist) silty clay; hard when dry, very firm when moist; massive to weak cloddy structure; calcareous, pH 7.4; abrupt lower boundary.
- A<sub>1</sub> 6 to 18 inches, gray (10YR 5/1, dry) to very dark gray (10YR 3/1, moist) silty clay; very hard when dry,

very firm when moist; moderate very fine subangular blocky structure; calcareous, pH 7.3; clear lower boundary.

- AC 18 to 34 inches, grayish-brown (10YR 5.5/2, dry) to very dark gray (10YR 3.5/1, moist) clay; very hard when dry, very firm when moist; moderate very fine subangular blocky structure; calcareous, pH 7.3; abrupt boundary.
- C<sub>1</sub> 34 to 50 inches, light brownish-gray (10YR 6.5/2, dry) to dark grayish-brown (10YR 4.5/2, moist) clay; very hard when dry, very firm when moist; massive; calcareous, pH 7.2; abrupt lower boundary.
- C<sub>2</sub> 50 to 60 inches+, light-gray (10YR 7/2, dry) to light brownish-gray (10YR 6/2, moist) fine sandy loam; slightly hard when dry, friable when moist; massive; calcareous, pH 7.4.

When precipitation is adequate but not excessive and is well distributed throughout the growing season, this soil produces good yields of wheat and sorghum. Capability unit IIIw-1; range site, Clay lowland.

**SUTPHEN CLAY, MODERATELY DEEP OVER SAND**

**Sutphen clay, moderately deep over sand (Sm)**—This is a dark-colored soil underlain by sandy material at depths of 3 or 4 feet. It occurs in slightly concave areas in the valley of the Republican River. The drainage is somewhat poor to poor. Water moves slowly through the subsoil.

This soil resembles Sutphen silty clay but is more poorly drained and has moderately coarse strata within 4 feet of the surface. It consists of dark-colored clay underlain at depths of 2 to 4 feet by stratified sandy alluvium.

Typical profile (located 150 feet west of farm driveway, and 250 feet south of highway in the SW $\frac{1}{4}$  sec. 27, T. 11 S., R. 5 E., in a cultivated field on a 1 percent concave slope):

- A<sub>1</sub> 0 to 6 inches, very dark gray (10YR 3.5/1, dry) to black (10YR 2/1, moist) clay; very hard when dry, very firm when moist; moderate medium subangular blocky structure; noncalcareous, pH 7.0; clear lower boundary.
- AC 6 to 24 inches, grayish-brown (10YR 5/2, dry) to dark-gray (10YR 4/1, moist) clay; very hard when dry, very firm when moist; weak subangular blocky structure; noncalcareous, pH 7.0; abrupt lower boundary.
- C<sub>1</sub> 24 to 40 inches, light brownish-gray (10YR 6.5/2, dry) to grayish-brown (10YR 5.5/2, moist) silt loam; hard when dry, firm when moist; massive; calcareous, pH 7.8; abrupt lower boundary.
- C<sub>2</sub> 40 to 60 inches+, very pale brown (10YR 8/3, dry) to pale-brown (10YR 6/3, moist) loamy fine sand; loose when dry, very friable when moist; single grain; texture coarser with depth; calcareous, pH 8.1.

Small areas of this soil are overlain by alluvium deposited by the flood of 1951. Where these deposits are from 6 to 24 inches thick, the texture of the surface layer ranges from clay to silty clay loam. In these spots the depth to the sandy horizons is correspondingly greater.

In wet years this soil is unproductive because of a high water table, overflow from the river, and runoff from the upland. Good yields of wheat, oats, and sorghum are common in years when wetness is not a problem. Capability unit IIIw-1; range site, Clay lowland.

#### SUTPHEN SILTY CLAY

**Sutphen silty clay** (Sn).—This is a dark-colored, somewhat poorly drained alluvial soil. It occurs on the second bottoms of the Smoky Hill and Republican Rivers. It differs from Solomon silty clay in being generally noncalcareous to a depth of 36 inches and in occurring at higher levels. The drainage is somewhat poor. Runoff is slow, and water percolates slowly through the soil.

The profile is clayey to depths of more than 5 feet.

Typical profile (located 1,400 feet south and 300 feet east of the NW corner of sec. 13, T. 11 S., R. 4 E., in a cultivated field on a  $\frac{1}{2}$  percent slope):

- A<sub>1</sub> 0 to 23 inches, very dark gray (10YR 3/1, dry) to black (10YR 2/1, moist) silty clay; hard when dry, very firm when moist; moderate fine and very fine subangular blocky structure; noncalcareous, pH 6.6; clear lower boundary.
- AC 23 to 36 inches, very dark gray (10YR 3/1, dry) to black (10YR 2/1, moist) clay; very hard when dry, very firm when moist; weak subangular blocky structure; noncalcareous, pH 6.7; clear lower boundary.
- C 36 to 60 inches+, dark grayish-brown (10YR 4/2, dry) to dark-gray (10YR 4/1, moist) silty clay; a few, fine, distinct mottles of pale brown and yellowish brown; very hard when dry, very firm when moist; weak subangular blocky structure—massive in lower part; noncalcareous, pH 7.4.

This soil is best for wheat and sorghum. The main limitations are wetness and the difficulty of tilling the heavy clayey surface soil. Capability unit IIw-1; range site, Clay lowland.

#### TULLY SILTY CLAY LOAMS

These deep soils have developed in unconsolidated sediments derived from limestone, shale, and loess. They occupy slopes bordering the small streams in the Flint Hills (fig. 12).

These soils are well drained and well aerated. They are clayey throughout. The surface soil is dark grayish brown, and the subsoil is dark brown.

Typical profile (located  $\frac{1}{4}$  mile east of the W $\frac{1}{4}$  corner of sec. 27, T. 12 S., R. 7 E., in a native grass pasture on a 3 percent slope):

- A<sub>1</sub> 0 to 10 inches, dark grayish-brown (10YR 4/2, dry) to very dark grayish-brown (10YR 3/2, moist) silty clay loam; hard when dry, friable when moist; moderate fine granular structure; contains many roots; noncalcareous, pH 5.5; gradual lower boundary.
- AB 10 to 16 inches, dark grayish-brown (10YR 4/2, dry) to very dark grayish-brown (10YR 3/2, moist) silty clay loam; hard when dry, firm when moist; moderate medium granular structure; contains a few small chert fragments; noncalcareous, pH 5.7; clear lower boundary.
- B<sub>2</sub> 16 to 32 inches, dark-brown (7.5YR 4/2, dry; 3/2, moist) silty clay; very hard when dry, very firm when moist; strong fine and medium subangular blocky structure; contains a few small chert fragments; noncalcareous, pH 5.8; clear lower boundary.
- B<sub>3</sub> 32 to 44 inches, dark-brown (7.5YR 4/2, dry; 3/2, moist) silty clay loam; very hard when dry, very firm when moist; moderate medium blocky structure; noncalcareous, pH 5.9; clear lower boundary.
- C 44 to 60 inches+, pale-brown (10YR 5.5/3, dry) to dark-brown (7.5YR 4/2, moist) silty clay loam; hard when dry, firm when moist; weak blocky structure to massive; noncalcareous, pH 6.2.

The surface soil ranges from silt loam to clay loam in texture and from brown to dark grayish brown in color when dry. In many places fragments of chert, less than 1 inch in size, are scattered throughout the profile. The texture of the subsoil ranges from silty clay loam to light clay.

These soils are well suited to the cultivated crops commonly grown in the county.

**Tully silty clay loam, 1 to 4 percent slopes** (Tb).—This soil has the profile described as typical. A few small areas are eroded. Capability unit IIe-1; range site, Loamy upland.

**Tully silty clay loam, 4 to 8 percent slopes** (Tc).—Areas kept in grass differ little from Tully silty clay loam, 1 to 4 percent slopes. Cultivated areas have lost as much as 4 inches of the original surface soil. Some small areas have lost more, but these are less than 15 percent of this unit. The structure of the surface soil in cultivated areas is not so strongly granular as in areas under grass. Runoff is greater and infiltration is slower in cultivated areas. Erosion is the major hazard. Capability unit IIIe-2; range site, Loamy upland.

**Tully silty clay loam, 8 to 20 percent slopes** (Td).—Most of this unit has slopes of 8 to 12 percent. Most of it is in native grass. Some is in cultivation. Small areas that are severely eroded are shown on the map by erosion symbols. Capability unit VIe-2; range site, Loamy upland.

#### TULLY SOILS, SEVERELY ERODED

**Tully soils, severely eroded** (Te).—This unit includes the Tully soils that have lost their original surface soil and have some shallow gullies. The slopes are dominantly 4 to 8 percent. The plow layer consists almost entirely of the more clayey subsoil. These soils are susceptible to further erosion damage. Capability unit IVE-3; range site, Clayey upland.

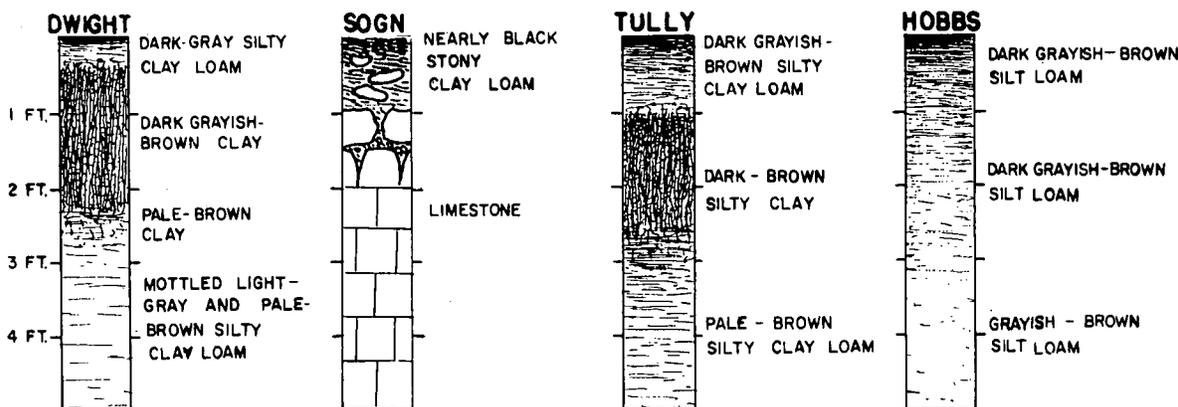
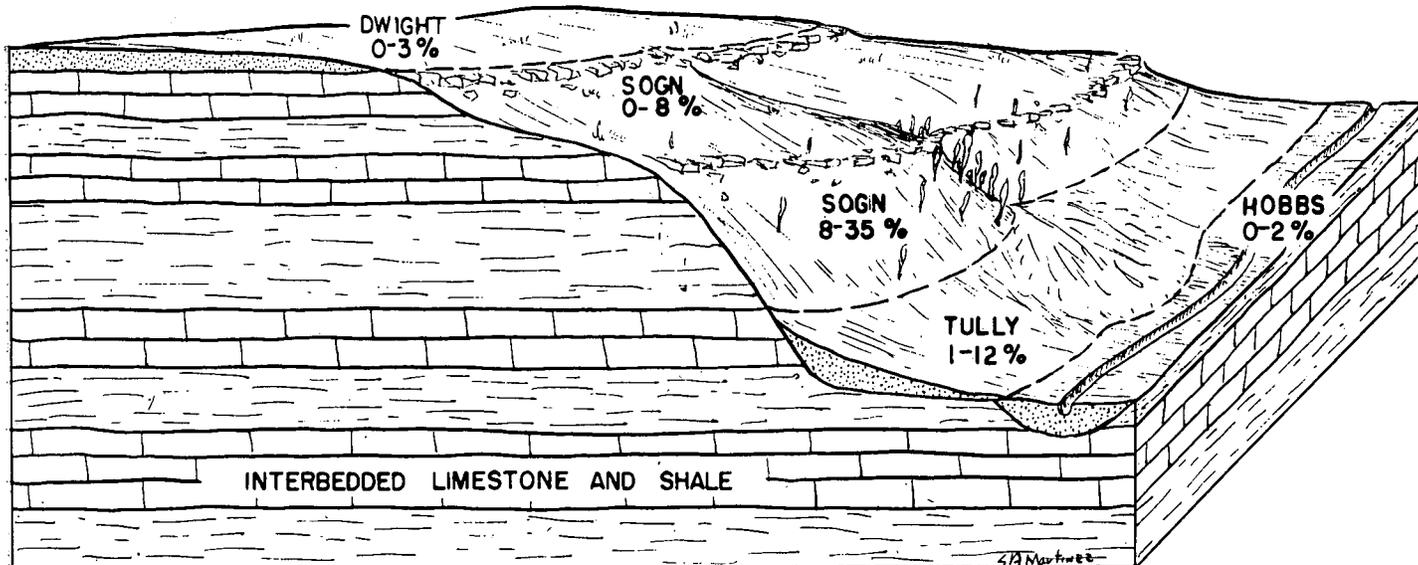


Figure 12.—Diagram showing the relationship of the soils in the Flint Hills.

**HASTINGS SILTY CLAY LOAMS**

These are deep, dark-colored, upland soils that have developed from loess. They occur chiefly between the Monona and Crete soils (fig. 13). The Hastings soils are more friable and less clayey than the Crete soils. They are more strongly developed than the Monona soil.

These soils are well drained. Runoff is moderate. The surface soil is dark grayish brown, and the subsoil is brown. The reaction ranges from moderately acid at the surface to slightly acid in the lower horizons.

Typical profile (located in the NW¼NW¼ sec. 20, T. 10 S., R. 5 E., on a cultivated 1 percent slope):

- A<sub>1p</sub> 0 to 7 inches, dark grayish-brown (10YR 4/2, dry) to very dark grayish-brown (10YR 3/2, moist) silty clay loam; slightly hard when dry, friable when moist; weak granular structure; noncalcareous, pH 5.4; abrupt lower boundary.
- A<sub>1</sub> 7 to 12 inches, dark grayish-brown (10YR 4/2, dry) to very dark grayish-brown (10YR 3/2, moist) silty clay loam; hard when dry, friable when moist; moderate medium granular structure; noncalcareous, pH 5.6; clear lower boundary.
- B<sub>1</sub> 12 to 22 inches, dark grayish-brown (10YR 4/2, dry) to very dark grayish-brown (10YR 3/2, moist) silty clay loam; hard when dry, firm when moist; moderate fine blocky structure; noncalcareous, pH 5.9; gradual lower boundary.

- B<sub>21</sub> 22 to 28 inches, brown (10YR 5/3, dry) to dark-brown (10YR 4/3, moist) silty clay loam; very hard when dry, firm when moist; moderate medium blocky structure; noncalcareous, pH 6.0; gradual lower boundary.
- B<sub>22</sub> 28 to 38 inches, pale-brown (10YR 6/3, dry) to brown (10YR 5/3, moist) silty clay loam; very hard when dry, firm when moist; moderate fine blocky structure; noncalcareous, pH 6.2; gradual lower boundary.
- BC 38 to 60 inches +, pale-brown (10YR 6/3, dry) to brown (10YR 5/3, moist) silt loam; hard when dry, firm when moist; weak blocky to massive structure; noncalcareous, pH 6.5.

The surface soil is mostly silty clay loam but contains inclusions of silt loam. In some places there are calcium carbonate concretions within 45 inches of the surface. Where these soils are associated with the Shellabarger soils, the surface layer contains more fine sand.

These soils are well suited to all the crops grown in the county.

**Hastings silty clay loam, 0 to 1 percent slopes (Wa).**— This soil occurs on nearly level areas that overlook the valley of the Republican River. The surface and subsoil layers may be somewhat coarser textured and more friable where this soil is adjacent to more steeply sloping areas. This soil has the profile described as typical. Capability unit I-1, range site, Loamy upland.

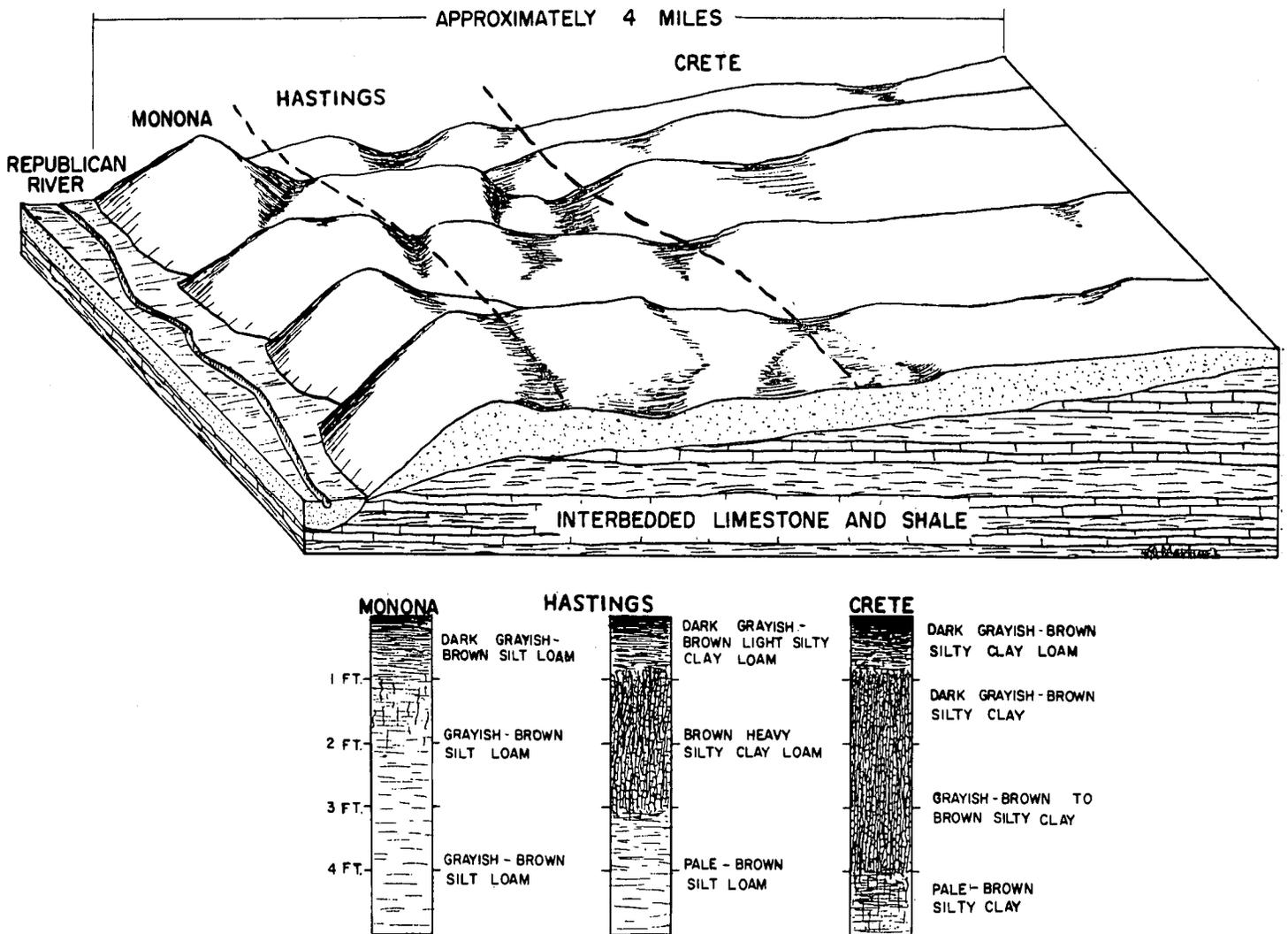


Figure 13.—Diagram showing the relationship of the soils in the northwestern part of the county.

**Hastings silty clay loam, 1 to 4 percent slopes (Wb).**—This soil occurs on gently sloping convex ridgetops and lower slopes. The depth to the B<sub>2</sub> horizon averages 18 inches. Runoff is moderate. Included are small eroded areas in which the B horizon and the A horizon are mixed. Erosion is the major hazard. Capability unit IIe-1; range site, Loamy upland.

**Hastings silty clay loam, 4 to 8 percent slopes (Wc).**—The solum is somewhat thinner than that of the Hastings soils on gentler slopes. The A horizon is 6 to 8 inches thick. The B horizon is browner and generally more friable than in the soils on gentler slopes. Less than 15 percent is eroded. Runoff is moderate to rapid, and permeability is slow to moderate. Erosion is the major hazard when this soil is cultivated. Capability unit IIIe-2; range site, Loamy upland.

**Hastings silty clay loam, 8 to 12 percent slopes (Wd).**—Less than 20 percent of this soil is cultivated. The surface soil averages 6 inches thick under cultivation and slightly thicker under grass. The horizons are somewhat thinner than in the Hastings soils on gentler slopes, and the texture of the B horizon is no coarser than a medium

silty clay loam. Small areas that are severely eroded are shown by symbols on the map. Erosion is a major hazard. Capability unit IVe-2; range site, Loamy upland.

#### HASTINGS SOILS, SEVERELY ERODED

**Hastings soils, severely eroded (We).**—This unit consists of severely eroded soils on 2 to 8 percent slopes. The original darkened surface layer has been entirely removed, and the browner, finer textured subsoil is exposed. Shallow gullies are common. These soils are susceptible to further erosion. The surface soil is heavy silty clay loam and the plowsole is entirely within the B horizon. Capability unit IVe-3; range site, Loamy upland.

## Formation and Classification of Soils

### Soil-Forming Factors

Soils are formed by the forces of the environment acting upon soil materials deposited or accumulated by geological agencies. The characteristics of a soil at any particular

place are determined by (1) the climate under which the soil material has accumulated and has existed since accumulation; (2) the physical and mineralogical composition of the parent material; (3) the relief, or lay of the land, which influences drainage, moisture content, aeration, susceptibility to erosion, and exposure to the sun and the elements; (4) the biological forces, that is, the plants and animals that live in and on the soil; and (5) the length of time the climate and biological forces have acted upon the soil material.

### Climate

Climate influences both physical and chemical weathering processes and also affects the biological forces at work in the soil material. Generally, the soil-forming processes are more active when the soil is warm and moist. Either too much or too little moisture slows down the soil-forming processes.

The climate in Geary County is subhumid. In recent geological time, the summers have been hot and the winters moderately cold. The annual range in temperature is fairly wide, and changes in temperature are often abrupt.

The amount and distribution of rainfall are highly variable, and dry periods are common. The climate is one that favors development and persistence of a grassland vegetation.

### Parent materials

The soils of Geary County were derived from eolian, alluvial, colluvial, and residual material. The Monona, Hastings, Crete, and Geary soils have developed in eolian (windblown) silts. The Derby, Farnum, and Shellbarger soils have developed in eolian sands. The Dwight, Irwin, and Ladysmith soils have developed in fine-textured materials of undetermined origin over shales and limestone. The Florence and Sogn soils have developed in limestone and shale residuum.

The Hobbs, Muir, Sarpy, Cass, Humbarger, Sutphen, and Solomon soils have developed in water-deposited materials. The Tully soil was derived from clayey sediments that have been moved by water and gravity and have accumulated at the base of slopes.

The rocks of Geary County are of the Permian System. They are shale and limestone formations of the Chase and Council Grove groups (fig. 14). The Flint Hills are underlain largely by rocks of the Chase Group (figs. 15 and 16). The rocks of the Council Grove group are thinner bedded and less massive than those of the Chase group. Many of the soils in Geary County were derived from these rocks. The kinds of bedrock exposed in the county are listed in table 4, which is based on The Kansas Rock Column, published in 1951 by the Kansas State Geological Survey.

Eolian (windblown) and alluvial (water-deposited) sediments of Pleistocene and post-Pleistocene age mantle the bedrock in many places. The windblown materials are thickest in the northwestern parts of the county.

### Relief

Relief influences the development of soil chiefly by controlling the movement of water on the surface. It is important in soil formation where the slopes are steep because the resulting rapid runoff removes surface soil almost as fast as it is formed; consequently, soils tend to be thin and immature.

TABLE 4.—Permian bedrock strata that outcrop in Geary County

Group	Formation	Member	Thickness
Chase	Nolans limestone	Herington limestone	8
		Paddock shale	12
		Krider limestone	4
	Odell shale		30
	Winfield limestone	Cresswell limestone	10
		Grant shale	10
		Stovall limestone	1
	Doyle shale	Gage shale	45
		Towanda limestone	5-15
		Holmesville shale	30
	Barnston limestone	Fort Riley limestone	30
		Oketo shale	0-6
		Florence limestone	35
	Matfield shale	Blue Springs shale	45
		Kinney limestone	3
Wymore shale		30	
Wreford limestone	Schroyer limestone	8-15	
	Havensville shale	10	
	Threemile limestone	9	
Council Grove	Speiser shale		17
	Funston limestone		5-10
	Blue Rapids shale		25
	Crouse limestone		10
	Easley Creek shale		17

The relief of the areas of windblown material is typified by moderately deep, entrenched drainageways having gently sloping and sloping convex shaped surfaces. Nearly level and gently sloping divides lie between the drainageways. The divides vary in width. They are usually broadest in areas distant from the major streams. The Republican River flows through the center of this area and influences the relief of the mantled upland.

The rest of the county is influenced to a lesser degree by windblown materials. The relief is characterized by deeply entrenched valleys having steep slopes. Outcrops of bedrock are prominent on the hillsides. The divides are nearly level to sloping and have both plane and convex surfaces as a rule. Residuum from the bedrock is the parent material of most of the soils in this part of the county.

### Vegetation

The original plant cover in Geary County was dominantly tall grasses. Big and little bluestem, side-oats grama, Indiangrass, switchgrass, and dropseed were the chief grasses. Trees were largely confined to steep bluffs, generally those facing north, and on the flood plains.

Soils that developed under grassland vegetation tend to have thick, dark-colored surface soils. In general, grasses return more bases to the soil than most other kinds of vegetation.

### Time

It takes time for soils to develop, that is, to form horizons that differ from one another. Water moves through the soil profile, and gradually soluble matter and

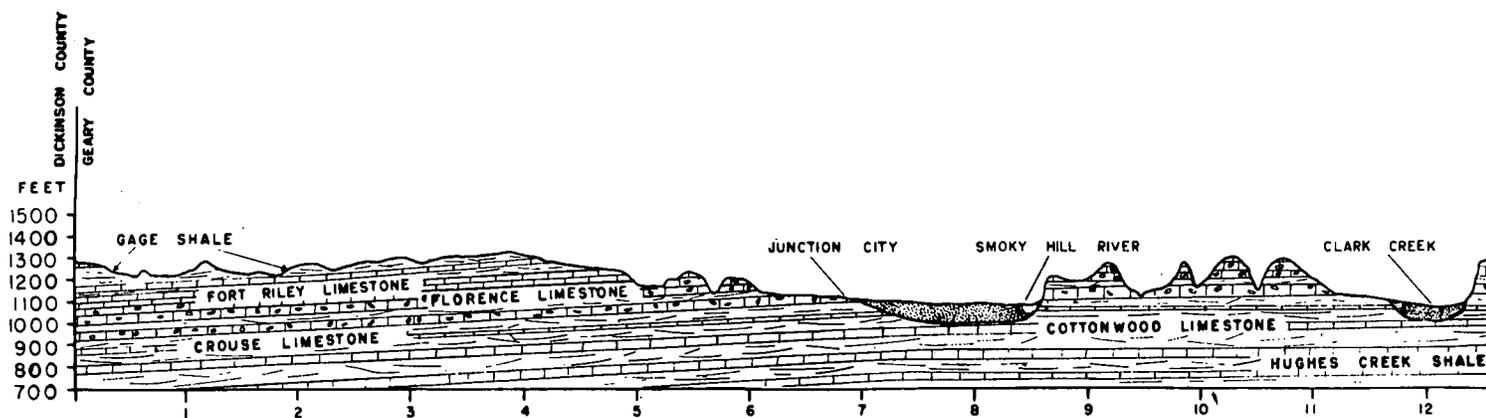


Figure 14.—Cross section o



Figure 15.—Road cut on United States Highway No. 40. Chert at surface weathered from Schroyer limestone, which was once 8 to 10 feet above the present surface. Threemile limestone at base of cut, overlain by Havensville shale.

fine particles are leached from the surface and deposited in the subsoil. The amount of leaching depends upon the length of time that elapses and amount of water that penetrates the soil. As the fine particles are deposited in the subsoil, a characteristic kind of soil structure is usually developed.

### Classification of Soils

Three soil orders and five great soil groups are represented in Geary County. The classification of the soil series of Geary County, by order and great soil group, is as follows.

#### ZONAL SOILS

The zonal order comprises soils with evident, genetically related horizons that reflect the predominant influence of climate and living organisms in their formation.

*Chernozems*.—These are dark-colored grassland soils that have A, AB, B, BC, C<sub>ca</sub>, and C horizons. The BC or C horizons have distinct layers of lime accumulation. The Crete and Hastings soils are Chernozems.

*Brunizems*.—These are dark-colored grassland soils that have A, AB, B, BC, and C horizons. They lack distinct layers of lime accumulation in the lower BC and C horizons. The Derby, Farnum, Florence, Geary, Irwin, Lady-smith, Monona, Muir, Shellabarger, and Tully soils are

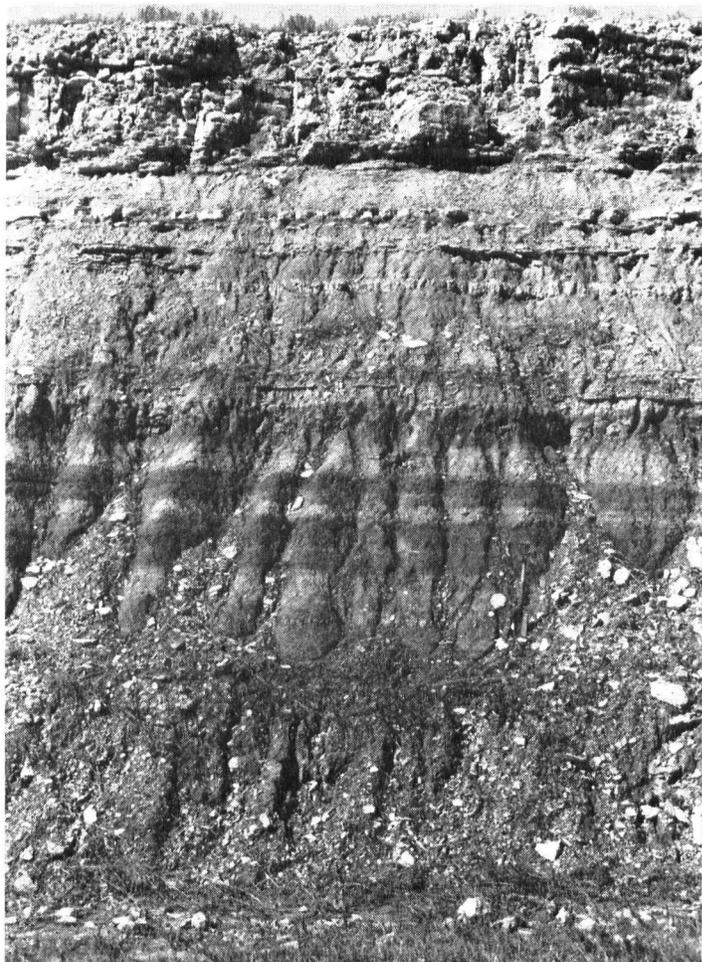
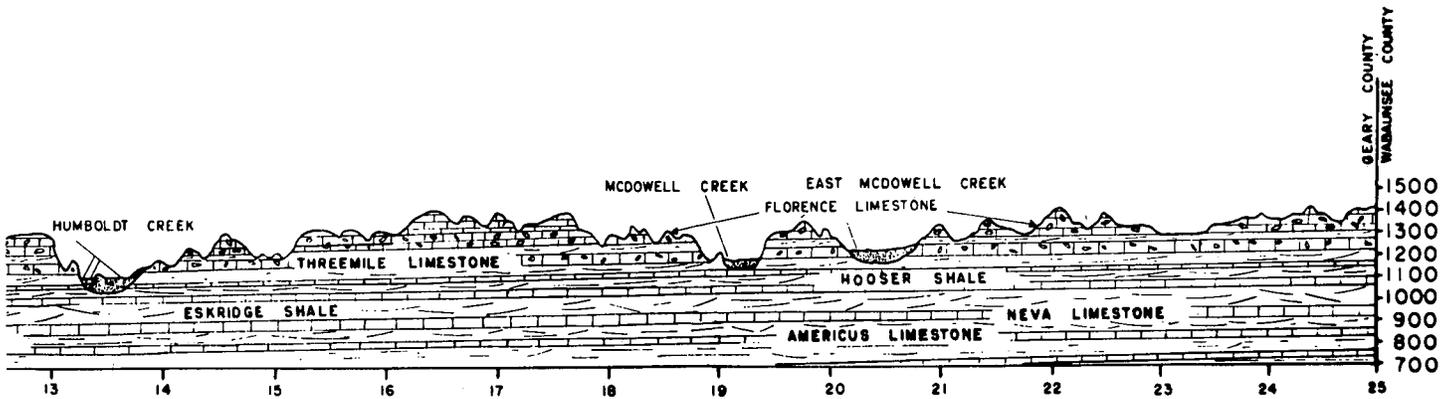


Figure 16.—Florence cherty limestone above varicolored Blue Springs shale.



bedrock in Geary County.

Brunizems. The Monona soil is at the extreme western edge of its extent and has minimal development.

**INTRAZONAL SOILS**

The intrazonal order comprises soils with evident, genetically related horizons that reflect the dominant influence of a local factor of topography, parent materials, or time over the effects of climate and living organisms.

*Planosols.*—These are dark-colored grassland soils that have A, B, BC, C<sub>ca</sub>, and C horizons. They have an abrupt boundary between the A and B horizons. The Dwight soils are Planosols.

**AZONAL SOILS**

The azonal order comprises soils that lack distinct, genetically related horizons commonly because of youth, resistant parent material, or steep topography.

*Lithosols.*—These are shallow, weakly developed soils that have A<sub>1</sub>, AC, and D<sub>1</sub> horizons. The entire thickness of soil and parent material is generally less than 15 inches. The Sogn soils are Lithosols.

*Alluvial soils.*—This great soil group consists of young soils and land types little changed by their environment. They are developing in recently deposited alluvial materials on the flood plains and low terraces. Modal profiles have an A<sub>1</sub>, AC, and C horizon sequence, but in places only a weakly developed A<sub>1</sub> horizon can be determined. Some soils show stratification, but it represents deposition and not soil development. The soil series and land types in this group are Cass, Hobbs, Humbarger, Sarpy, Solomon, Sutphen, Riverwash, and Sand dunes, Sarpy material.

**Soil Characteristics that Suggest Soil-Forming Processes**

Most of the soils in Geary County have A horizons that are very dark colored and indicate accumulation of organic matter. The Derby and Sarpy soils and Sand Dunes, Sarpy materials, have surface soils that are light colored or thin.

The low pH of the developed horizons indicates that most of the soils have had bases leached from them. However, the bases leached away have been partially replenished in many soils by the action of the grass vegetation that adds bases to the surface soil as the residues

decay. Many of the soils have horizons that contain secondary lime accumulations. The Chernozem soils are distinctive in this respect, although many of the Brunizem soils may contain weakly expressed lime accumulations. The characteristics of the Chernozem soils in Geary County are not so strongly expressed as is common in more representative soils of this great soil group.

Most soils of the uplands have textural B horizons in which surfaces of the peds (aggregates) have continuous clay films that are normally darker colored than the ped interiors. These B horizons contain appreciably more clay than the A horizons above them. The B horizons of the sandy soils contain clay which forms bridges between the grains, thereby giving body to these soils. Soil structure or aggregation is expressed in all soils to some degree. The soils with weakly developed horizons have structure but lack accumulations of clay and do not have clay films coating the peds.

The profiles of most soils have dark organic staining extending from the surface into the B horizons. This dark staining grades off to colors of higher chroma or value. The position of soils in respect to relief determines largely their color and also their permeability. Soils having strong, uniform colors are generally well drained. Mottled or grayish colors in the subsoil are signs of impeded internal drainage.

Alluvial soils generally are youthful soils without recognizable B horizons. They contain accumulated organic matter in the surface soil. Differences in texture of layers below the A horizons are generally the result of stratification as the materials were deposited.

**General Nature of Geary County**

**History and Development**

Francisco Coronado, the Spanish explorer, was the first white man known to have visited the area that is now Geary County. That was in 1542. In 1719, a French explorer named Dutisne was near the site of the present Fort Riley. John C. Fremont crossed the Smoky Hill River near the site of Junction City in 1843.

In 1852, Col. T. T. Fauntleroy recommended the establishment of a fort at or near the mouth of the

Republican River. It was needed to protect the wagon trains of the early settlers from the Kiowa, Comanche, and Kaw Indians. In the fall of that year, a detachment of soldiers arrived and set up a camp, which later became Fort Riley.

The first civilian settlers began to trickle into the area in 1854. In November 1854, 40 men cast ballots for a representative to Congress. Geary County was established in 1855. At first it was called Davis County, but later it was renamed Geary County in honor of John Geary, third governor of the Kansas territory.

By 1860, the population of the county was 1,163. In the next 10 years it grew to 5,526. In 1950, the population was 21,671. Junction City, the county seat, had a population of 217 in 1860 and a population of 13,462 in 1950.

The county is predominantly agricultural. There is very little industry. Alfalfa dehydrators, railroad shops, sand and gravel pits, limestone quarries, feed-mixing plants, and one chemical fertilizer plant are the principal industries. Most of the commercial activity in Junction City is associated with nearby Fort Riley.

The Union Pacific Railroad runs through Junction City. Good transportation is also available by airlines and buslines.

## Natural Resources

As Geary County has no mineral wealth or forests, its greatest natural resources are its soils and the grass of the Flint Hills. The gently sloping soils of the northern and western parts of the county are utilized for crops. Most of the eastern part of the county is covered with native grasses and is part of a great grazing area that extends into Oklahoma.

In general, Geary County has ample water from wells, ponds, and streams. In the river valleys a little water is available for irrigation.

Limestone from the Fort Riley formation is thick enough for building material. Some limestone is quarried west of Junction City for the building industry. Sand and gravel are obtained in the valley of the Republican River.

## Climate

Geary County has a typical continental climate. The summers are hot, and the winters are moderately cold. Table 5 shows the annual temperature and precipitation at the United States Weather Bureau station at Manhattan, in Riley County. The records at this station have been quoted because they cover more years than the records kept at Junction City. The variations in annual precipitation from 1858 to 1956 are shown in figure 17.

The precipitation is heaviest in the early part of the summer. Most of it falls during severe thunderstorms. The winters are dry, clear, and open. In summer, the rate of evaporation is high and the relative humidity is low.

Temperatures of more than 100 degrees have been recorded in May, June, July, August, and September. Nevertheless, the average temperature for the period June through September is only 76 degrees.

The average frost-free season is about 172 days—April 23 to October 15. The earliest frost recorded in fall was on September 13, and the latest in spring was on May 27. Low areas that lack good air drainage are especially subject to local frosts when low air stratification permits cold air to fill local depressions.

TABLE 5.—*Temperature and precipitation at Manhattan, Riley County, Kansas*

[ELEVATION, 1,040 FEET]

Month	Temperature <sup>1</sup>			Precipitation <sup>2</sup>			
	Average	Absolute maximum	Absolute minimum	Average	Driest year (1860)	Wettest year (1951)	Average snowfall
December.....	32.2	77	-16	0.86	0.46	0.40	3.5
January.....	29.2	74	-31	.71	.60	.53	4.0
February.....	32.4	82	-32	1.22	1.84	1.44	4.6
Winter.....	31.3	82	-32	2.79	2.90	2.37	12.1
March.....	44.0	95	-12	2.84	.00	2.77	4.0
April.....	55.2	99	5	2.66	.12	2.75	1.1
May.....	64.8	104	23	4.43	1.13	10.29	( <sup>3</sup> )
Spring.....	54.7	104	-12	8.71	1.25	15.81	5.1
June.....	74.7	113	37	9.04	2.69	11.12	( <sup>3</sup> )
July.....	80.2	115	40	3.73	2.09	15.32	( <sup>3</sup> )
August.....	78.5	116	40	4.24	2.85	6.32	0
Summer.....	77.8	116	37	12.58	7.63	32.76	( <sup>3</sup> )
September.....	70.5	112	25	3.93	1.35	6.13	0
October.....	58.1	98	11	2.25	.42	2.70	.2
November.....	44.0	87	-9	1.77	1.58	.61	.9
Fall.....	57.5	112	-9	7.95	3.35	9.44	1.1
Year.....	55.3	116	-32	32.03	15.13	60.38	18.3

<sup>1</sup> Average temperature based on a 96-year record, through 1955; highest and lowest temperatures based on a 95-year record, through 1952.

<sup>2</sup> Average precipitation based on a 96-year record, through 1955; wettest and driest years based on a 98-year record, in the period 1858-1955; snowfall based on a 56-year record, through 1952.

<sup>3</sup> Trace.

Because the county is in the paths of the polar continental and the gulf maritime air masses, the weather changes rapidly and frequently. This is typical of the central plains. Although it is situated in the eastern third of the State, Geary County is subject to the sporadic pattern of precipitation that is typical of arid climates.

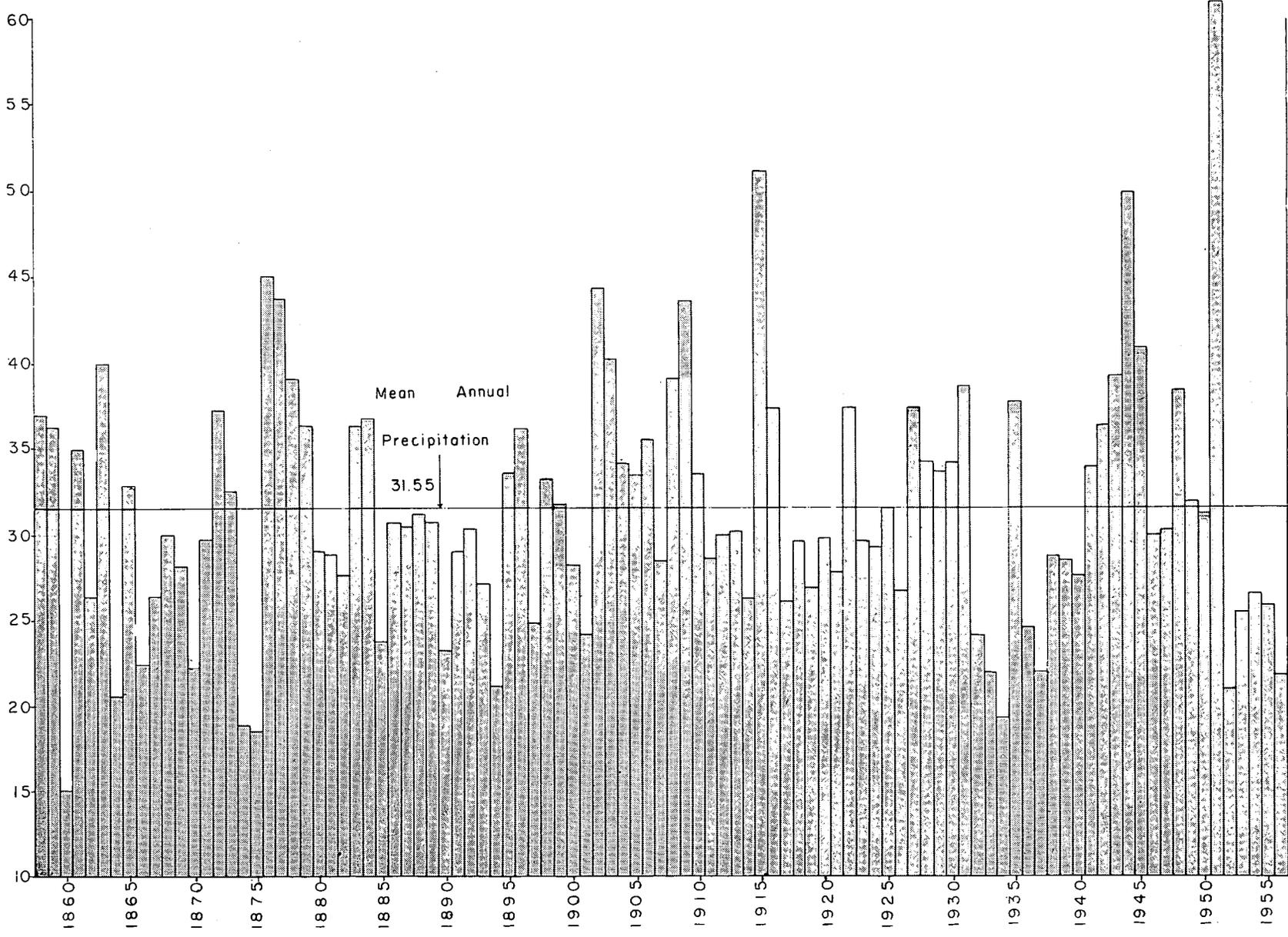
The prevailing wind in this part of Kansas is from the south. The maximum velocity occurs in March, April, and May. Unfortunately this is the time when the soil is most susceptible to erosion.

The dry weather in the latter part of July and the first week or two of August coincides with the silking of corn and, consequently, it affects corn yields. In most years corn crops are reduced materially by dry weather. It is

Figure 17.—Annual precipitation at Manhattan, Kans., from 1858 to 1956.

GEARY COUNTY, KANSAS

INCHES OF PRECIPITATION



seldom, however, that the drought is severe enough to cause complete failure of all crops.

Hail damage varies widely from year to year. The greatest losses occur when the wheat crop is damaged in May or June, just prior to harvest.

## Agriculture

Because most of the early settlers came from the States of Illinois, Indiana, Iowa, Missouri, and Ohio, it was natural that they attempted to grow corn. No wheat was planted till the fall of 1855, when a Joseph Beavers sowed 20 bushels of seed that he had purchased from the Delaware Indians. Until 1919, the corn acreage exceeded the wheat acreage. Since 1935, the wheat acreage has consistently exceeded the corn acreage. More than two and a half times as many acres are now in wheat as in corn.

The acreages of the principal crops grown in Geary County are shown in table 6.

TABLE 6.—*Acreages of principal crops in stated years*

Crop	1929	1939	1949	1954
	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>
Wheat threshed.....	22, 757	38, 166	38, 621	26, 699
Corn.....	37, 078	14, 484	11, 764	10, 643
Oats threshed.....	4, 350	5, 018	4, 535	4, 312
Sorghum for all purposes except sirup.....	6, 298	9, 404	4, 189	10, 296
Alfalfa for hay.....	8, 715	2, 946	9, 112	12, 331

Geary County is suited to cattle raising. Beef cattle are usually handled in one of the following five ways:

1. A herd of cows is maintained and calves are creep fed. After 12 or 13 months, the calves that weigh about 800 pounds are sold as baby beef.

2. Steers and heifers are deferred fed. Calves are purchased in fall, fed on roughage and grain, and pastured during spring and summer. They are finished in the feed lot and are marketed in fall when they weigh about 1,000 pounds.

3. Calves are pastured in summer and fed in winter on silage, alfalfa hay, and grain. They are marketed in spring.

4. A herd of cows is maintained; calves are kept in pasture during the summer; and in fall, when they weigh about 400 pounds, they are sold as feeders.

5. Yearling steers and heifers are bought for summer

grazing; they are pastured in spring, fattened on grass, and shipped to market in fall.

The continuing growth of Junction City and Fort Riley increases the demand for Grade A milk. This demand has stimulated the upgrading of dairy herds. Although the quality of the herds is improving, the number of cows is not increasing.

Sheep have never been common in this county because of the difficulty of controlling coyotes and because the tall grasses are relatively better suited to cattle than to sheep.

Hogs have never been raised in large numbers, because Geary County is primarily an area of wheat and grass. Some hogs are raised for home use.

Table 7 shows the number of milk cows, beef cattle, hogs, sheep, and chickens in the county at different times.

TABLE 7.—*Number of livestock in stated years*

Livestock	1930	1940	1950	1954
Cattle and calves.....	24, 793	<sup>1</sup> 17, 848	23, 026	26, 666
Milk cows.....	2, 424	3, 535	2, 594	2, 189
Hogs and pigs.....	16, 567	<sup>2</sup> 4, 271	8, 338	5, 239
Sheep and lambs.....	1, 986	<sup>3</sup> 784	396	399
Chickens.....	<sup>1</sup> 101, 708	<sup>2</sup> 72, 345	<sup>2</sup> 66, 006	<sup>2</sup> 64, 287

<sup>1</sup> Over 3 months old.

<sup>3</sup> Over 6 months old.

<sup>2</sup> Over 4 months old.

In the past 30 years the size of farms has increased steadily. The improvement of farm machinery has made it possible for the farms to be operated more efficiently and at the same time has made it necessary for farms to be larger, to pay for the more costly machinery. Table 8 shows the number of farms in the various size groups for the three years, 1940, 1950, and 1954.

TABLE 8.—*Number of farms of different sizes in stated years*

Size in acres	1940	1950	1954
3-29.....	19	47	40
30-69.....	27	23	22
70-139.....	116	79	64
140-179.....	117	57	58
180-219.....	45	36	26
220-259.....	75	64	54
260-499.....	183	171	167
500-999.....	83	98	89
1,000+.....	22	28	32

A KEY TO THE SOIL SERIES OF GEARY COUNTY

1. Soils with a developed texture profile.
  - 1.1 Eluviated A horizon originally less than 7 inches thick; boundary between A horizon and B horizon abrupt; B horizon of very compact blocky clay; developed in fine textured materials overlying shale and limestone..... DWIGHT
  - 1.2 Eluviated A horizon originally more than 7 inches thick; boundary between A horizon and B horizon not abrupt.
    - 1.21 B<sub>2</sub> horizon blocky; very compact; clayey.
      - 1.211 Transition zone between A horizon and B horizon generally less than 3 inches thick; areas nearly level, very poorly drained, and often wet during cool seasons.
        - 1.2111 A horizon dark gray or very dark gray silty clay loam; solum developed in fine-textured materials underlain by shale at depths of 5 to 10 feet..... LADYSMITH
        - 1.2112 A horizon dark grayish-brown fine sandy loam; solum developed in eolian sand; depth to underlying bedrock more than 10 feet..... FARNUM
      - 1.212 Transition zone between A horizon and B horizon generally more than 3 inches thick; areas nearly level to moderately sloping; moderately slow internal drainage; wet only in extremely wet seasons.
        - 1.2121 Soils underlain by and developed in loess..... CRETE
        - 1.2122 Soils developed in fine-textured materials overlying shale and limestone..... IRWIN
    - 1.22 B horizon blocky; moderately compact; loamy.
      - 1.221 Soils underlain by and developed in recent alluvium..... MUIR
      - 1.222 Soils underlain by and developed in nonreddish loess..... HASTINGS
      - 1.223 Soils underlain by and developed in reddish loesslike material..... GEARY
      - 1.224 Soils developed in colluvium from limestone, shale, and loess..... TULLY
    - 1.23 B horizon massive.
      - 1.231 B horizon of reddish cherty clay..... FLORENCE
      - 1.232 B horizon of light-brown noncherty sandy clay loam..... SHELLABARGER
2. Soils without a developed texture profile.
  - 2.1 Soils of the flood plains.
    - 2.11 Soils with coarse-textured subsoil..... SARPY
    - 2.12 Soils with moderately coarse textured to medium textured subsoil..... CASS
    - 2.13 Soils with medium textured or moderately fine textured subsoil.
      - 2.131 A horizon calcareous; areas in flood plain of the Smoky Hill River..... HUMBARGER
      - 2.132 A horizon noncalcareous; areas in flood plains of small streams..... HOBBS
    - 2.14 Soils with fine-textured subsoil.
      - 2.141 A horizon calcareous; areas in closed meander depressions of river flood plains..... SOLOMON
      - 2.142 A horizon noncalcareous; areas on nearly level second bottoms..... SUTPHEN
  - 2.2 Soils of the uplands.
    - 2.21 Soils deep to bedrock.
      - 2.211 Soils of moderately coarse texture; underlain by material of moderately coarse texture..... DERBY
      - 2.212 Soils of medium texture; underlain by material of medium texture..... MONONA
    - 2.22 Soils very shallow to bedrock..... SOGN





# Accessibility Statement

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