

Series 1955, No. 7
Issued September 1960

Soil Survey

BROWN COUNTY

Kansas



UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
KANSAS AGRICULTURAL EXPERIMENT STATION

HOW TO USE THE SOIL SURVEY REPORT

THIS SURVEY of Brown County will help you plan the kind of farming that will protect your soils and provide good yields. It describes the soils, shows their location on a map, and tells what they will do under different kinds of management.

Find your farm on the map

To use this survey, start by finding your farm on the soil map that is at the back of this report. This is a large air photo of the county, on which you can see roads, streams, towns, and other landmarks. The index to map sheets will help you locate your farm; it shows what part of the county is on each sheet of the soil map.

Learn about your soils

Each kind of soil mapped in the county is identified on the soil map by a symbol.

Suppose you have found on your farm an area marked with the symbol McB3. You learn the name of the soil this symbol represents by looking at the map legend. The symbol McB3 identifies Morrill loam, 4 to 10 percent slopes, eroded. To learn how this soil looks in the field and what it can be used for, turn to the section, Soil Series and Mapping Units, and read the description of the Morrill series and the paragraph about Morrill loam, 4 to 10 percent slopes, eroded.

After you have read the description of the soil, you may want to know how to

take care of the soil and to get good yields. This is discussed in the section, Use and Management of Soils. To find out how much the soil can be expected to produce, turn to table 1, under the heading, Estimated Yields.

Make a farm plan

Study your soils, see whether you have been cultivating any that do not usually produce good yields, and compare the yields you have been getting with those you could expect under different management. Then decide whether or not you need to change your methods of farming. The choice, of course, must be yours. This report will help you make a new farm plan. It is not a plan of management for your farm or any other single farm in the county. If you find that you need help in farm planning, consult Soil Conservation Service technicians or the county agricultural agent. Members of your State experiment station staff and others familiar with farming in your county will also be glad to help.

* * *

This soil survey was made as part of the technical assistance furnished by the Soil Conservation Service to the Brown County Soil Conservation District. Fieldwork for the survey was finished in 1946. Unless otherwise specified, all statements in the report refer to conditions in the county at the time the fieldwork was in progress.

CONTENTS

	Page		Page
General soil map	1	Soil series and mapping units—Continued	
Soils of the stream valleys: Judson-Wabash.....	1	Morrill series.....	21
Soils of the strongly sloping loess hills: Monona-Ladoga.....	2	Morrill loam, 4 to 10 percent slopes.....	21
Soils of the rolling till-limestone uplands: Pawnee-Summit-Sogn.....	2	Morrill loam, 4 to 10 percent slopes, eroded.....	21
Soils of the smooth, sloping, loess-till uplands: Grundy-Shelby-Pawnee.....	3	Morrill loam, 10 to 18 percent slopes.....	21
Soils of the rolling loess-till uplands: Marshall-Morrill-Sharpsburg.....	3	Morrill loam, 10 to 18 percent slopes, eroded.....	21
Use and management of soils	3	Muir series.....	21
General management needs.....	5	Muir silt loam.....	22
Cropping systems.....	5	Pawnee series.....	22
Drainage.....	6	Pawnee clay loam, 2 to 7 percent slopes, eroded.....	22
Texture, structure, and tilth.....	6	Pawnee clay loam, 2 to 7 percent slopes, severely eroded.....	22
Organic matter, plant nutrients, and lime.....	6	Sharpsburg series.....	22
Conservation of soil and water.....	6	Shelby series.....	22
Capability groups of soils.....	6	Shelby clay loam, 4 to 10 percent slopes.....	23
Capability unit I-1.....	8	Shelby clay loam, 4 to 10 percent slopes, eroded.....	23
Capability unit IIe-1.....	8	Shelby clay loam, 10 to 18 percent slopes.....	23
Capability unit IIe-2.....	9	Shelby clay loam, 10 to 18 percent slopes, eroded.....	23
Capability unit IIs-1.....	9	Shelby gravelly loam, 10 to 18 percent slopes.....	23
Capability unit IIw-1.....	9	Shelby gravelly loam, 18 to 30 percent slopes.....	23
Capability unit IIIe-1.....	9	Sogn series.....	24
Capability unit IIIe-2.....	10	Sogn soils.....	24
Capability unit IIIe-3.....	10	Steinauer series.....	24
Capability unit IIIe-4.....	11	Steinauer clay loam.....	24
Capability unit IVe-1.....	11	Summit series.....	24
Capability unit IVe-2.....	11	Summit clay loam, 4 to 10 percent slopes.....	24
Capability unit IVe-3.....	11	Summit clay loam, 10 to 18 percent slopes.....	24
Capability unit VIe-1.....	12	Summit and Labette series, moderately shallow.....	24
Capability unit VIw-1.....	12	Summit and Labette soils, moderately shallow, 4 to 10 percent slopes.....	25
Capability unit VIIe-1.....	12	Summit and Labette soils, moderately shallow, 10 to 18 percent slopes.....	25
Capability unit VIIe-1.....	12	Summit and Labette soils, moderately shallow, 10 to 18 percent slopes, eroded.....	25
Estimated yields.....	12	Wabash series.....	25
Soil survey methods and definitions	12	Wabash silty clay.....	25
Soil series and mapping units	14	Soils and their environment	25
Alluvial land.....	14	Genesis and morphology of soils.....	25
Burchard series.....	15	Parent material.....	25
Burchard clay loam, 4 to 10 percent slopes.....	15	Climate.....	26
Burchard clay loam, 4 to 10 percent slopes, eroded.....	15	Vegetation.....	26
Burchard clay loam, 10 to 18 percent slopes.....	15	Topography.....	26
Burchard clay loam, 10 to 18 percent slopes, eroded.....	16	Time.....	26
Dennis series.....	16	Classification of soils.....	27
Dennis loam, 4 to 10 percent slopes.....	16	Profile descriptions.....	27
Edina series.....	16	Burchard clay loam.....	27
Edina silt loam.....	16	Dennis loam.....	27
Gara series.....	16	Edina silt loam.....	27
Gara loam, 4 to 10 percent slopes.....	17	Gara loam.....	27
Gara loam, 10 to 18 percent slopes.....	17	Grundy silty clay loam.....	27
Gara loam, 18 to 30 percent slopes.....	17	Judson silt loam.....	28
Grundy series.....	17	Judson silt loam, flood plains.....	28
Grundy silty clay loam, 0 to 1 percent slopes.....	17	Labette silty clay loam.....	28
Grundy silty clay loam, 1 to 4 percent slopes.....	17	Ladoga silt loam.....	28
Grundy silty clay loam, 4 to 7 percent slopes, eroded.....	17	Marshall silt loam.....	28
Judson series.....	18	Monona silt loam.....	28
Judson silt loam, 0 to 3 percent slopes.....	18	Morrill loam.....	28
Judson silt loam, 3 to 10 percent slopes.....	18	Muir silt loam.....	29
Judson silt loam, flood plains.....	18	Pawnee clay loam.....	29
Labette series.....	18	Shelby clay loam.....	29
Ladoga series.....	19	Sogn silt loam.....	29
Ladoga silt loam, 4 to 10 percent slopes.....	19	Steinauer clay loam.....	29
Ladoga silt loam, 10 to 18 percent slopes.....	19	Summit clay loam.....	29
Marshall series.....	19	Wabash silty clay.....	29
Marshall and Sharpsburg soils, 0 to 2 percent slopes.....	19	Laboratory determinations.....	29
Marshall and Sharpsburg soils, 2 to 4 percent slopes.....	19	General nature of the county	29
Marshall and Sharpsburg soils, 4 to 10 percent slopes.....	19	Agriculture	31
Marshall and Sharpsburg soils, 10 to 18 percent slopes.....	20	Glossary	31
Monona series.....	20		
Monona silt loam, 4 to 10 percent slopes.....	20		
Monona silt loam, 10 to 18 percent slopes.....	20		
Monona silt loam, 18 to 30 percent slopes.....	20		

SOIL SURVEY OF BROWN COUNTY, KANSAS

Survey by ROBERT W. EIKLEBERRY, Soil Conservation Service

Correlation by EDWARD H. TEMPLIN, Soil Conservation Service

United States Department of Agriculture in Cooperation with Kansas Agricultural Experiment Station

BROWN COUNTY is located in the northeastern part of Kansas, near the Missouri River (fig. 1). It is bounded on the north by the State of Nebraska, on the east by Doniphan County, Kansas, on the south by Atchison County and Jackson County, and on the west by Nemaha County. Hiawatha, the county seat, is about 55 miles north of Topeka, the State capital. The county is approximately 24 miles square. Its area is 369,920 acres, 96 percent of which is in farms. The population in 1950 was 14,651, and 77 percent of it was classed as rural. Industries other than agriculture are of minor importance.

The first settlements in the county were located in wooded areas near streams, where logs with which to build houses were easy to obtain. Settlement proceeded slowly. Only a few pioneers had the courage to face the perils of settling on Indian land prior to 1855. The boundaries of Brown County were established in 1855 by an act of the first legislature of the Territory of Kansas.

After the Civil War, many immigrants made homes in the county. The Missouri Pacific Railroad obtained control of 127,832 acres of the Kickapoo Indian Reservation, most of which was located in the county. An advertising campaign carried on by the railroad company induced many people to establish homes on this land.

For many years the farmers in Brown County have been active in cooperative organizations that have as their purpose the improvement of farming methods. The first such group was formed in 1864. In that same year, the first Brown County fair was held at Hiawatha. In 1874 the Brown County Agricultural, Horticultural, and Mechanical Association was started, and in 1882 the Brown County Improved Horse Association was organized. The Farmers' Institute was also in operation by 1882. One of the first watershed protection projects in the United States was that along Little Delaware Creek and Mission Creek, in the southern part of Brown County.

The Brown County Soil Conservation District, organized in 1940, was among the first in the State of Kansas. One farmer, at the organization meeting in the county agent's office, summed up the reasons why he was in favor of a soil conservation district:

I farm over 200 acres of sloping land in Brown County. I have terraces, grass waterways, and sod dams. I have been using fertilizer and manure. All this isn't enough. I want to save this farm and keep it producing. We have had the Extension Service demonstrations and educational programs for 20 years. These have been good. We need more of them. With all our work, we still have soil erosion and it's getting worse year after year; we must have more help. I am willing to work and want to farm right. My neighbors do, too. But we aren't engineers, soil scientists, or economists. We are farmers. If someone can show us how, we can do the job.

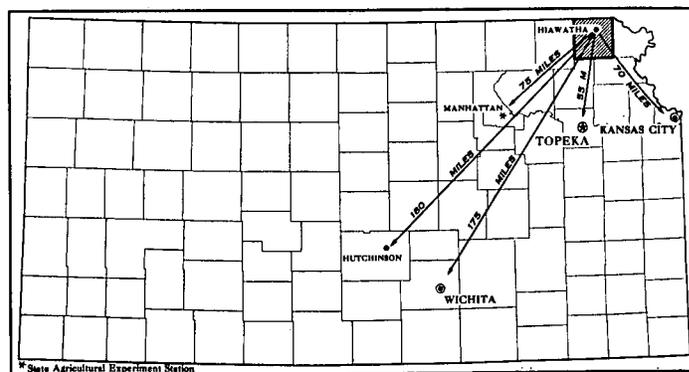


Figure 1.—Location of Brown County in Kansas.

The farmers of the county have taken advantage of the technical help available through the soil conservation district and have done a commendable job of conserving their soils and improving their farm management.

General Soil Map

The general soil map in the back of this report shows the main soil areas of the county. Each area consists of several soils that occur in a characteristic pattern. Each is named from its physiographic features and its dominant soils.

When you use the general soil map, remember that it shows general patterns and relationships only. Use the detailed soil map when you want to know about a specific soil or the soils on a specific farm.

SOILS OF THE STREAM VALLEYS: JUDSON-WABASH

The largest areas of this group of soils are located along Wolf Creek near Robinson and along Walnut Creek between Padonia and the northern boundary of the county. The dominant soils are fertile, deep, dark-colored silty and clayey Judson and Wabash soils that developed from stream-deposited material. Adjacent to the drainageways there are bands of mixed alluvial soils consisting of silts and silty clay loams. Muir soils occupy benches a little higher than the flood plains.

The Wabash soils are darker colored than the Judson soils and have more clay in the surface soil and subsoil. They are slowly drained. The Wabash and Judson soils are at lower elevations and are more likely to be flooded than the Muir soils.

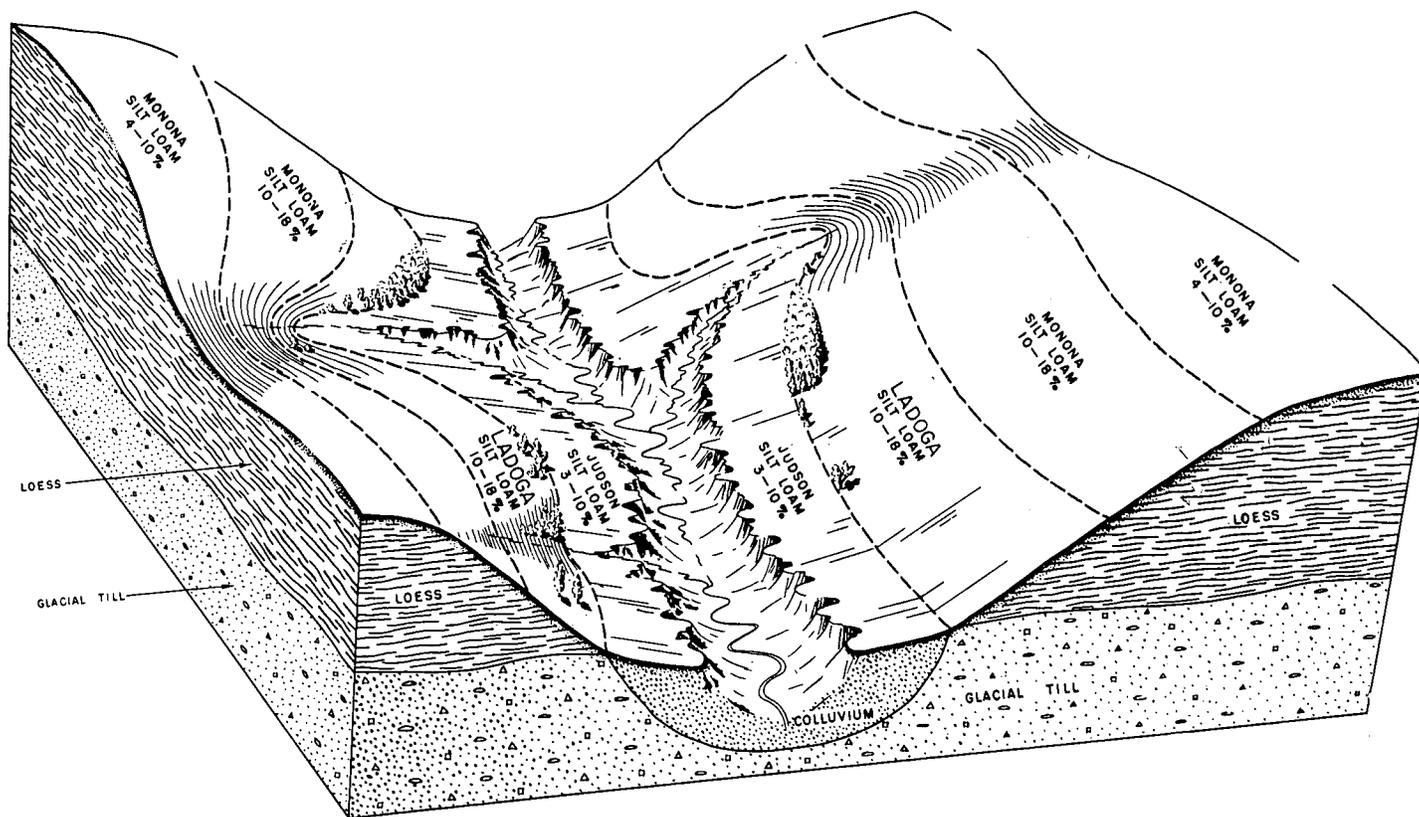


Figure 2.—Typical cross section of the strongly sloping loess hills.

The soils of the stream valleys were originally covered with trees. The broken areas along the streams still produce some timber.

These soils are suitable for all crops common to the county. They make excellent tame pasture and produce high yields of corn, wheat, oats, and alfalfa. Drainage of low, wet areas and protection from floods are the major problems.

The mixed alluvial soils next to the drainageways are generally in grass or trees. They are flooded frequently and are normally rough and broken. Some areas would be good for cultivated crops if they were cleared and leveled.

SOILS OF THE STRONGLY SLOPING LOESS HILLS: MONONA-LADOGA

This area is in the extreme northeastern corner of the county. It is dominated by acid soils that developed from loess. The landscape is characterized by steep slopes, narrow divides, and deeply entrenched streams (fig. 2). Trees grow along all the streams.

The Ladoga soils formed under a cover of oak and hickory. The Monona soils are prairie soils that formed under a cover of tall grasses (fig. 3). These soils are generally low in organic matter. Heavy rains cause serious sheet and gully erosion on unprotected cropland. This is one of the major problems of the area. All sloping cropland needs terraces and good waterways to control excessive runoff. Contour farming, terraces, and grassed waterways will help to control erosion.

Corn is the main crop, although the soils are well suited to clover and alfalfa. Some oats and wheat are grown,

but yields are not so good as on the more nearly level areas. The soils are also suitable for apples and small fruits, which are grown extensively on the same kind of soils in Doniphan County.

SOILS OF THE ROLLING TILL-LIMESTONE UPLANDS: PAWNEE-SUMMIT-SOIGN

Areas of these soils lie in the western part of the county and along the southern side of Wolf Creek (fig. 4). Most of the soils have formed from leached Kansan till and Pennsylvanian limestone and shale.

The Pawnee soils are dark-colored, acid clay loams that have a dense, fine-textured claypan in the subsoil. They are not well suited to corn because the claypan restricts the movement of air and water. Grain sorghum will yield more bushels of grain, year in and year out, on Pawnee soils than will corn.

The Summit soils are deep, very dark colored, neutral to calcareous clay loams that formed from material weathered from limestone and limy shales. They are well suited to all the common crops.

The Soign soils are thin, dark-colored steeply sloping silt loams. They are best suited to perennial grasses and legumes. The more rough and broken areas are suited only to pasture. Many areas are covered with brush and low-quality trees—elm, post oak, redbud, sumac, and hackberry. If cleared and well managed, these areas can be developed into improved pasture.

Minor soils in this group are the Burchard and Steinauer. These are deep, neutral to calcareous clay

loams that formed from limy Kansan till. The Burchard soils are well suited to all crops common to the county. The Steinauer soils occupy steeper slopes and are best suited to pasture or hay. Where they have been cultivated, severe sheet and gully erosion have resulted.

SOILS OF THE SMOOTH, SLOPING, LOESS-TILL UPLANDS: GRUNDY-SHELBY-PAWNEE

The soils in this area are deep, dark-colored, nearly level to gently sloping clay loams and silty clay loams. They occur extensively in the southeastern and northwestern parts of the county.

The Grundy soils have a thick, acid surface soil that is normally granular. They are capable of taking in and storing most of the rain that falls, but during periods of intense rainfall much runoff and erosion occur on sloping cultivated fields that are not protected by proper conservation practices. Because they have a clay subsoil, these soils are not so well suited to corn as the more permeable silty soils in the eastern part of the county. Nevertheless, they are among the best soils in the county for wheat. They are also suited to alfalfa, sorghums, soybeans, and flax. Cultivated sloping areas need terraces, grassed waterways, and contour farming.

The Shelby soils are deep, dark-colored, strongly acid clay loams that formed from Kansan till under tall-grass vegetation. They generally lie on the lower slopes and receive extra runoff from areas farther up the slopes. Consequently, many cultivated areas are gullied and have lost 4 to 8 inches of their once fertile topsoil. In eroded areas the soils are low in organic matter. Shelby soils have a wide range of use but they are commonly low in fertility and require lime and fertilizer for best yields of farm crops.

The Pawnee soils also occur on sloping uplands (fig. 5). They have a claypan subsoil. Where cultivated, they are generally eroded.

SOILS OF THE ROLLING LOESS-TILL UPLANDS: MARSHALL-MORRILL-SHARPSBURG

The soils of this area occur in the eastern part of the county. They are deep, dark colored, medium textured, and moderately permeable. They developed from Peorian loess and Kansan till. The rolling upland slopes of 3 to 7 percent are suited to all crops common to the county.

The Marshall and Sharpsburg soils are among the most productive upland soils in the State of Kansas. They are better suited to row crops than any other upland soil in the county. Measures for controlling runoff, preventing erosion, and maintaining fertility are needed to insure the best yields of cultivated crops.

The Morrill soils are easily identified by their reddish subsoil. They are not so fertile as either the Marshall or Sharpsburg soils but they do respond similarly to good management. All cultivated slopes of more than 4 percent need terraces, grassed waterways, and contour farming to safeguard them from erosion.

Use and Management of Soils

The soils of Brown County cover a wide range in use suitability and in management requirements. They vary widely in the physical and chemical characteristics that

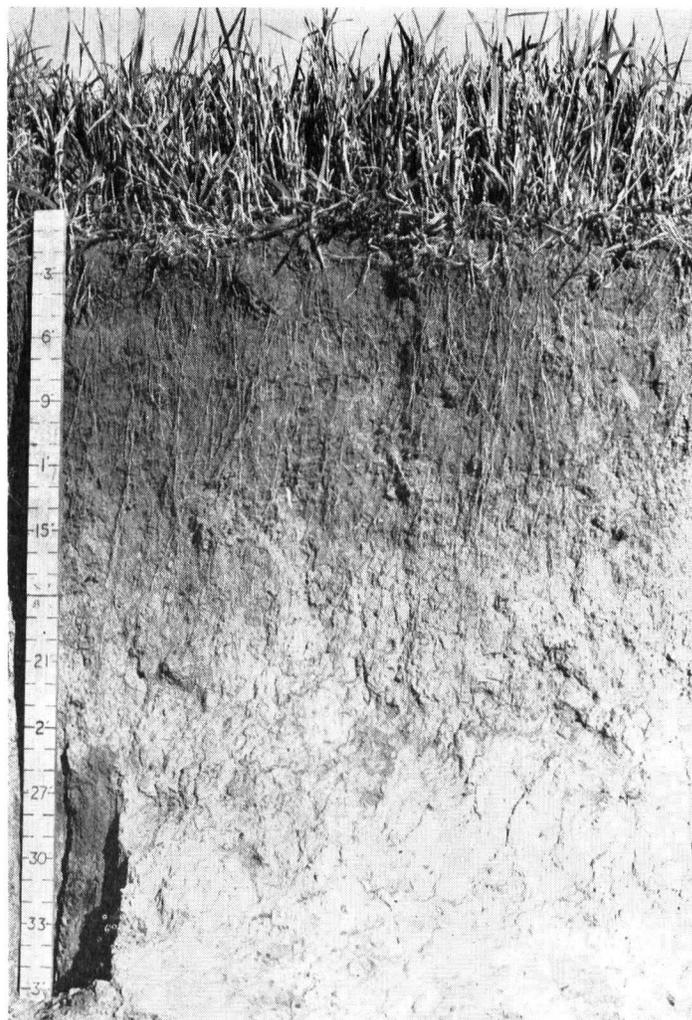


Figure 3.—Profile of Monona silt loam, showing deep grass roots.

determine how well a soil will grow plants and what kind of management it needs. The soils of the county range in texture from silty clay to gravelly loam. Some are well supplied with organic matter; some are not. Some need artificial drainage if they are used to grow cultivated crops. Most of the soils need lime and fertilizer, but in varying amounts.

Examples of the extremes in use suitability are Marshall silt loam and the Sogn soils. Marshall silt loam (fig. 6) is a good soil for general farm crops. It has a granular surface soil about 12 inches deep and a permeable subsoil and substratum. It is easily penetrated by air, water, and roots. The root zone is 5 or 6 feet deep. This is a soil that responds to good management and can be kept highly fertile.

The Sogn soils (fig. 7), on the other hand, are suitable only for grasses. They have only 4 to 6 inches of surface soil and 3 to 9 inches of subsoil over shattered rock or solid limestone. In a few places roots may find their way into cracks in the shattered bedrock, but in general the root zone is no more than 15 inches deep.

The tilth of the surface soil and the supply of plant nutrients in the surface soil are very important when crops

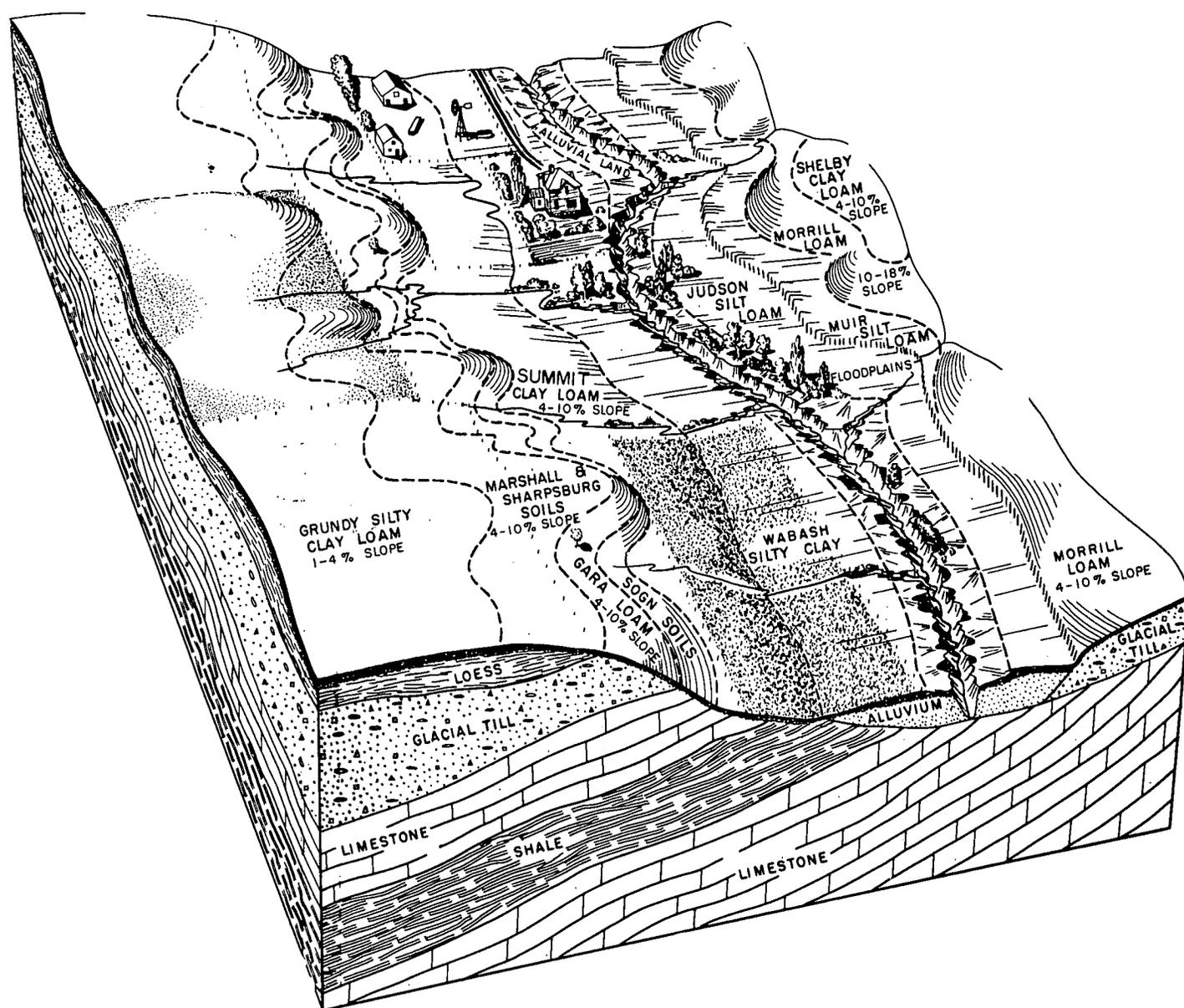


Figure 4.—Typical cross section of the rolling till-limestone uplands.

are young, but the subsoil must also furnish some nutrients and a great deal of water. If air and water move downward readily through the subsoil, the subsoil is said to be rapidly permeable. Rapid permeability is most common in sandy soils. If the subsoil is silt loam or silty clay loam, the movement of water is a little slower but generally adequate, as in the Marshall soils. Such soils are said to be moderately permeable. A subsoil of heavy clay, like that of the Grundy soils, is slowly permeable. Movement of air and water is slow. Even though roots may survive in some tight clay soils, they cannot absorb many of the nutrients the plant needs.

Many soil properties affect yields. It is important that you recognize the specific characteristics and qualities of your soils when you plan use and management. Some soil properties can be changed for the better. For example, acid soils can be limed so that alfalfa can be grown. Some

naturally wet soils, such as Wabash silty clay, can be drained to improve aeration and permit early preparation of seedbeds. Eroded soils or soils that are naturally low in organic matter can be improved by applying manure or growing legumes. Fertilizer can be applied to the Gara and Burchard soils to correct their deficiency in phosphorus.

Other soil properties are not easily changed. Slope, for example, and the physical character of the subsoil are things we more or less have to live with. Terraces, grassed waterways, and suitable crop rotations are effective means of controlling erosion and increasing yields on sloping areas of Marshall and Shelby soils. In wet years, terraces may make some areas of Grundy soils wetter than normal, because water moves into the subsoil very slowly. For this reason, terraces on such soils are built with a slight gradient to carry off excess water. The high clay content of the

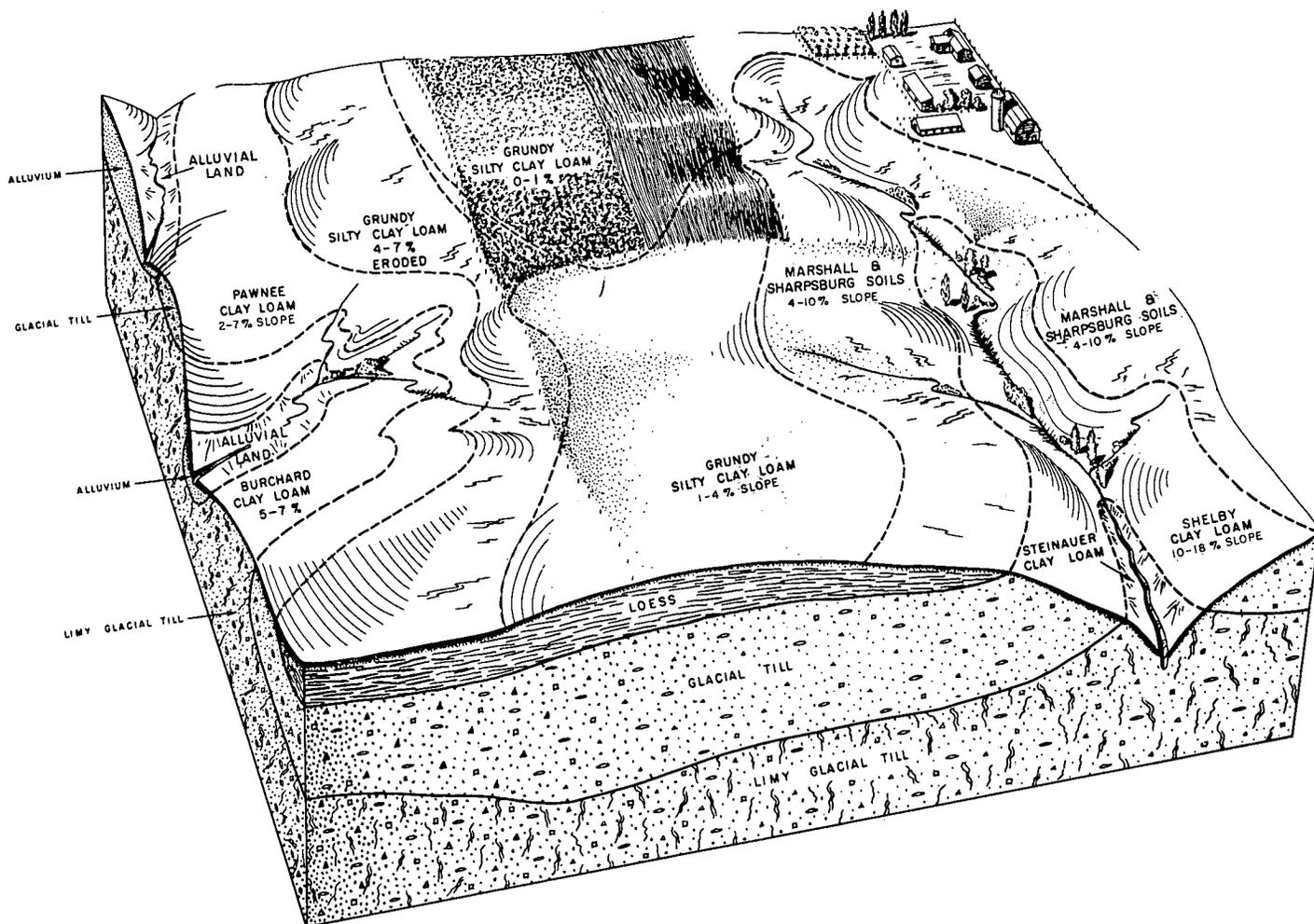


Figure 5.—Typical cross section of the smooth, sloping, loess-till uplands.

eroded Pawnee soils makes them difficult to work to a good seedbed.

It is important to recognize the problems of managing each soil and to realize that all soils cannot be treated alike. No single rotation, fertilizer treatment, or erosion control plan is good for all the soils in the county. Practices that are good on your neighbor's farm may or may not be good on your farm. It depends on what kinds of soil you have. There are many differences among soils, and different management plans are needed to get the best yields.

General Management Needs

Some of the practices that are basic to good farming for most of the soils of Brown County and the effects of these practices on the soils are discussed in the following paragraphs. More specific information on management needs is given in the section, Capability Groups of Soils.

The county agent and the local representative of the Soil Conservation Service are available to give advice and technical assistance on cropping systems, conservation needs, or other problems of farm planning.

CROPPING SYSTEMS

A good cropping system is one that suits the type of farming and provides acceptable yields of profitable crops. It will keep the soil productive and easy to work and, at the same time, keep erosion losses to a minimum.

In Brown County, the cropping systems are commonly based on corn, which is the major crop. Nearly level soils of the Marshall, Sharpsburg, Muir, Wabash, and Judson series can be used almost continuously for corn if plenty of fertilizer is applied and all the residue is utilized. On soils that are likely to erode, it is better to rotate corn with small grains and legume-grass mixtures. It is generally beneficial to include legumes in the cropping system, either as green-manure crops or as hay or pasture crops. Legumes supply nitrogen and organic matter; they help to keep the surface soil open and permeable and to preserve or improve its structure and tilth, and they may help to open up a tight, clayey subsoil. It is possible, however, to get most of the benefits of growing legumes by conserving the residues of other crops and by applying manure and commercial nitrogen. If hay is not needed for use on the farm, buying nitrogen fertilizer may be more economical than growing legumes.

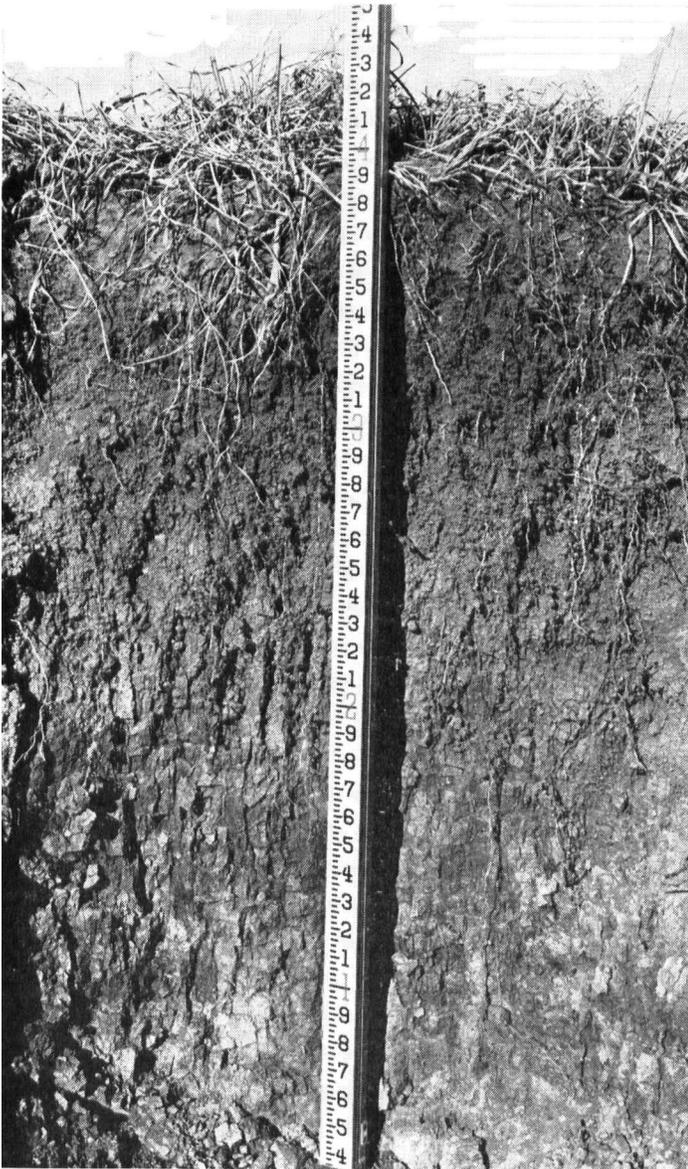


Figure 6.—Profile of Marshall silt loam, showing good depth and structure and dark color.

DRAINAGE

Some of the soils in Brown County are better suited to cultivated crops when artificially drained. A high water table keeps air from reaching the plant roots and limits the depth of the root zone. The crops most commonly grown in Brown County require a root zone 4 to 6 feet deep. If these crops are planted in a wet soil, they develop shallow roots and are likely to be damaged if the upper layers of the soil dry out in July and August.

TEXTURE, STRUCTURE, AND TILTH

Soil texture is important in management because it determines how hard or how easy a soil is to work and how much or how little water it will hold. Texture is not altered by management practices.

Soils that have a granular structure are generally easy to till and make good seedbeds. Structure can be damaged by working the soil when it is wet and by cultivating

frequently, especially if heavy equipment is used. Supplying organic matter by applying manure, turning under crop residues, and growing sod crops makes it easier to preserve good structure.

Both texture and structure affect tilth. Soil that is in good tilth breaks up easily and does not become sticky, plastic, or slick when wet. It is permeable to air and water. Organic matter helps to preserve or improve tilth. Legumes open up the surface soil and also keep it from being packed down by heavy rains. Plowing the soil when it is wet is likely to damage the tilth. Plowpans that have formed as a result of tilling wet soil can be broken up by plowing a little deeper than normal.

Since most of the common crops need a root zone 4 to 6 feet deep, the texture and structure of the subsoil are important as well as those of the surface soil. A tight, clayey, slowly permeable subsoil, in which water and air move slowly, is unfavorable for growing plants.

ORGANIC MATTER, PLANT NUTRIENTS, AND LIME

Keeping the supply of organic matter and plant nutrients at a level favorable for the crops grown is essential in a good soil management program.

Organic matter supplies and stores nitrogen and also helps to keep the soil permeable and easy to till. It can be supplied by returning crop residues, using green-manure crops, and applying manure.

Most of the soils need some commercial fertilizer to make up for deficiencies in one or more of the essential plant nutrients. Most of them need lime if they are used to grow legumes. The best way to determine how much fertilizer and lime to use is to have soil samples tested or to make field trials. The county agent can advise farmers about taking samples and arranging for soil tests.

CONSERVATION OF SOIL AND WATER

Sloping soils and soils that take in water slowly need special care to prevent erosion and loss of moisture, especially if row crops are grown. Terraces, grassed waterways, contour furrows, and farm ponds will help to control runoff and conserve moisture. A good supply of organic matter will help to keep the soil permeable, so that it will absorb water. Soils that are steep or very shallow are not suited to cultivated crops. A permanent cover of vegetation will keep these soils from eroding. The county agent and the local representative of the Soil Conservation Service are available to help farmers who have problems of soil and water conservation.

A good conservation program will (1) provide ways of removing excess water without unnecessary loss of soil; (2) allow larger amounts of water to be absorbed by the soil, to be available for plants; (3) maintain or restore fertility; (4) prevent damage to the soil by gully-ing, flooding, or waterlogging; (5) permit flexibility in choice of crops, so that the farmer can take advantage of favorable price and cost fluctuations; and (6) be within the scale of operations and the financial means of the farmer.

Capability Groups of Soils

Capability grouping is a system of classification used to show the relative suitability of soils for crops, grazing, forestry, or wildlife. It is a practical grouping based

on the needs and limitations of the soils, the risks of damage to them, and their response to management. In this report, soils have been grouped at three levels above the soil mapping unit. They are the capability unit, the subclass, and the class.

The capability unit, which can also be called a management group of soils, is the lowest level of capability grouping. A capability unit is made up of soils similar in kind of management needed, 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" means that the main limiting factor is risk of erosion if the plant cover is not maintained. The symbol "w" means that excess water retards plant growth or interferes with cultivation. The symbol "s" means that the soils are shallow, droughty, or low in fertility.

The broadest grouping, the 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 the classes except class I may have one or more subclasses.

In classes I, II, and III are soils that are suitable for annual or periodic cultivation for annual or short-lived crops.

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 they do not have quite so wide a range of suitability as class I soils. Some class II soils are gently sloping and consequently need moderate care to prevent erosion. Other soils in class II may be slightly droughty, 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 they need even more careful management.

In class IV are soils that require very careful management when cultivated.

In classes V, VI, and VII are soils that are not suited to cultivation for annual or short-lived crops but can be used for pasture, for woodland, or for wildlife shelter.

Class V soils are nearly level and gently sloping, but they are droughty, wet, low in fertility, or otherwise unsuitable for cultivation. None of the soils in Brown County are in class V.

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 and fair to high yields of 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. Yields of forest products may be fair to high. The soils have characteristics that restrict their use mainly to pasture and, in some places, to woodland.

In class VIII are soils that have practically no agricultural use. Some areas have value for watershed protection, wildlife shelter, or recreation. None of the soils in Brown County are in class VIII.

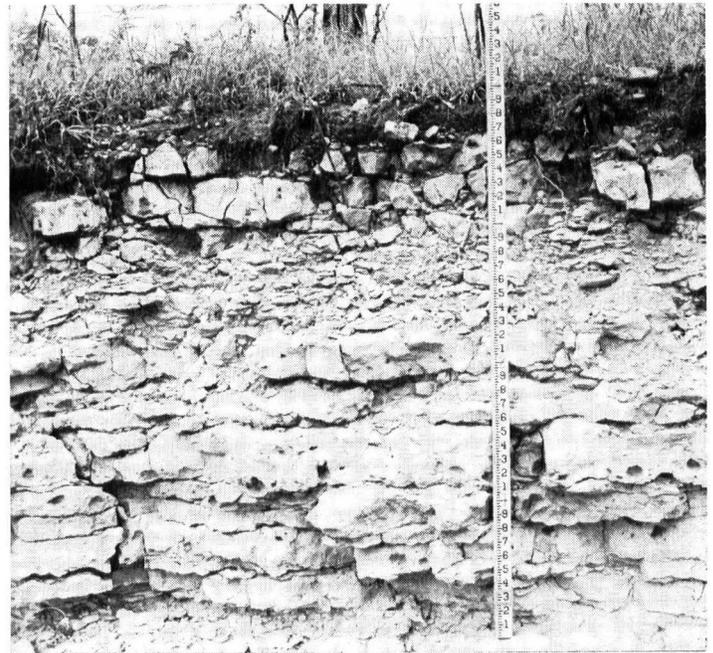


Figure 7.—Profile of Sogn stony clay loam, showing shallow silt loam surface soil that contains fragments of partly weathered limestone and shale and rests directly on limestone bedrock.

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

Class I.—Soils that have few limitations which restrict their use.

Unit I-1.—Deep, dark-colored, level soils on uplands and well-drained soils on bottom lands and terraces.

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

Subclass IIe.—Nearly level or gently sloping soils that will erode if not protected.

Unit IIe-1.—Deep, dark-colored, well-drained, gently sloping loamy soils on uplands.

Unit IIe-2.—Deep, moderately dark colored, moderately well drained, nearly level to gently sloping loamy soils on bottom lands.

Subclass IIs.—Soils moderately limited by clay subsoils.

Unit IIs-1.—Deep, dark-colored, nearly level upland soils with tight clay subsoils.

Subclass IIw.—Soils moderately limited by excess water.

Unit IIw-1.—Deep, dark-colored, nearly level, slowly drained bottom-land soils with heavy clay subsoils.

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

Subclass IIIe.—Soils severely limited by risk of erosion if they are not protected.

Unit IIIe-1.—Deep, dark-colored, moderately permeable, sloping loamy soils on uplands.

Unit IIIe-2.—Deep, moderately light colored, friable, acid loamy soils on moderately steep uplands.



Figure 8.—Sheet erosion on Grundy silty clay loam, 1 to 4 percent slopes. Excess water has broken through lister ridges that do not follow the contour.

Class III.—Continued

Subclass IIIe.—Continued

Unit IIIe-3.—Very dark colored clayey soils, with clay subsoils, on moderately sloping uplands.

Unit IIIe-4.—Deep, dark-colored, eroded, clayey soils, with tight clay subsoils, on moderately sloping uplands.

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

Subclass IVe.—Soils very severely limited by risk of erosion if they are not protected.

Unit IVe-1.—Deep, dark-colored, moderately sloping to moderately steep loamy soils with moderately permeable subsoils.

Unit IVe-2.—Deep, moderately permeable, acid loamy soils on steep uplands or eroded gently sloping uplands.

Unit IVe-3.—Moderately shallow to deep, very dark colored clayey soils, with clay subsoils, on steep uplands.

Class VI.—Soils that have severe limitations which make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife food and cover.

Subclass VIe.—Soils generally not suited to cultivation and severely limited by risk of erosion if cover is not maintained.

Unit VIe-1.—Moderately shallow to deep loamy soils on moderately steep to steep uplands subject to severe erosion.

Subclass VIw.—Soils generally not suited to cultivation and severely limited by risk of flooding.

Unit VIw-1.—Deep, dark-colored silts and clays on irregular or broken slopes adjacent to streams.

Class VII.—Soils that have very severe limitations which make them unsuited to cultivation and restrict their use largely to grazing, woodland, or wildlife.

Subclass VIIe.—Soils unsuited to cultivation and very severely limited by risk of erosion if cover is not maintained.

Unit VIIe-1.—Dark-colored loamy, gravelly, or stony soils on moderately steep to steep uplands.

In the following pages each capability unit is described briefly, the soils in each are listed, and some suggestions for use and management are given.

CAPABILITY UNIT I-1

Deep, dark-colored, level soils on uplands and well-drained soils on bottom lands and terraces

The soils in this unit have no serious limitations. Recognized good management will keep them productive. They have good moisture-holding and moisture-supplying capacity. There is no major conservation problem. The chief management needs are to maintain fertility, to keep the soils well supplied with organic matter, and to keep the surface soil open so it will absorb water. The soils in this unit are—

Judson silt loam, flood plains.

Marshall and Sharpsburg soils, 0 to 2 percent slopes.

Muir silt loam.

All crops common to the county grow well on these soils. Corn and small grains can be grown for long periods of time, provided organic matter is supplied and fertility is kept at a high level. This can be done by returning all crop residues to the soil and applying manure. A cropping system of 3 or 4 years of corn followed by 1 year of oats and then by alfalfa or red clover is well suited to these soils. If crop residues are utilized and fertilizer is applied, the time between legume crops can be lengthened.

Crops on these soils respond well to heavy applications of commercial fertilizer and manure. Hay and pasture respond well to additions of nitrogen and phosphorus. Keep the waterways grassed. Apply lime and fertilizer according to needs shown by soil tests and field trials.

CAPABILITY UNIT IIe-1

Deep, dark-colored, well-drained, gently sloping loamy soils on uplands

The soils in this unit have smooth and very gentle slopes. They are subject to sheet erosion (fig. 8). You can see small gullies in some cultivated fields. The soils in this unit are

Grundy silty clay loam, 1 to 4 percent slopes.

Marshall and Sharpsburg soils, 2 to 4 percent slopes.

These soils are suited to all crops commonly grown in the county. Corn can be grown 3 or 4 years in succession, if enough organic matter is supplied and enough fertilizer is applied. Grain sorghums grow well on these soils. They are not damaged so severely as corn by short periods of dry weather.

Contour farming will help to control runoff and to prevent sheet erosion. Some cultivated areas need terraces to break up long, gentle slopes. Waterways seeded to suitable mixtures of grasses and legumes are needed to carry runoff from cultivated fields.

Have the soils tested to find how much lime and fertilizer are needed. Use crop residues and manure to supply organic matter, which helps to keep the surface from crusting. Grow legumes to help open up the tight clay subsoil of the Grundy soil.

CAPABILITY UNIT He-2

Deep, moderately dark colored, moderately well drained, nearly level to gently sloping loamy soils on bottom lands

Judson silt loam, 0 to 3 percent slopes, is the only soil in this unit. It occurs on smooth, gentle slopes and is subject to some sheet and gully erosion. It generally lies at the base of steep slopes or adjacent to small drainage-ways that receive excess runoff from areas farther upslope. It is subject to flash flooding by water from adjacent areas. The nearly level areas are subject to silting by deposition. Deep gullies present a serious problem. Sometimes a gully will eat its way 50 to 100 feet back into a field during a single hard rainstorm.

This soil is well suited to all crops commonly grown in the county, and it produces good yields of tame grasses for hay and pasture. Some areas are acid and require lime if used for alfalfa. Farming on the contour will help to control rill and sheet erosion on areas of more than 1 percent slope. A cropping system is needed that will meet the feed and grain requirements of the farm and insure plenty of residues to help maintain the content of organic matter and preserve the structure of the surface soil. Fertilizers and lime, in quantities shown by experience and soil tests to be needed, will insure high yields of crops.

CAPABILITY UNIT He-1

Deep, dark-colored, nearly level upland soils with tight clay subsoils

Surface drainage and maintenance of tilth are the main problems in managing the soils in this capability unit. The soils are—

Edina silt loam.

Grundy silty clay loam, 0 to 1 percent slopes.

These soils are well suited to wheat, alfalfa, and grain sorghum. Wheat and alfalfa will respond to phosphorus. Corn is damaged by short periods of hot, dry weather because the tight clay subsoil releases water slowly. Nitrogen will improve yields of corn and oats, but it is not needed if large amounts of manure have been applied.

Improving surface drainage will help to insure an even stand of crops and will allow earlier preparation of seedbeds for spring crops. Crop residues and large amounts of manure will increase fertility and improve structure. Some areas are acid and will need lime if used for alfalfa. Applying lime and fertilizers, according to needs shown by experience and soil tests, will improve yields and help maintain tilth.

CAPABILITY UNIT Hw-1

Deep, dark-colored, nearly level, slowly drained bottom-land soils with heavy clay subsoils

Wabash silty clay is the only soil in this capability unit. It receives runoff from areas that lie farther upslope and is flooded by overflowing streams. Surface drainage is slow, and sometimes crops are drowned. Removing excess



Figure 9.—Severe sheet erosion in improperly managed cornfield on Marshall silt loam, 4 to 10 percent slopes.

surface water and maintaining fertility and tilth are the major problems.

A cropping system in which legumes are grown 4 years out of 10 will help to keep the subsoil open and the surface soil supplied with organic matter. Row crops can be grown 3 or 4 years in succession if fertility is kept at a high level.

Crops on this soil respond well to the use of fertilizers. Crop residues and manure will increase the supply of organic matter and help to increase or maintain fertility. Some areas are acid and require lime if alfalfa is grown. Apply lime and fertilizer according to needs indicated by soil tests and field experience.

CAPABILITY UNIT HHe-1

Deep, dark-colored, moderately permeable, sloping loamy soils on uplands

The soils in this unit range from medium to high in fertility, depending on past management. They take water well and store it for plants. Their clayey subsoil has good structure and moderate permeability. Preventing sheet and gully erosion is a major problem (fig. 9). These soils are—

Burchard clay loam, 4 to 10 percent slopes.

Marshall and Sharpsburg soils, 4 to 10 percent slopes.

Monona silt loam, 4 to 10 percent slopes.

These soils are suited to all crops commonly grown in the county. They are low in nitrogen and phosphorus, except where legumes have been grown or manure has been applied. Some areas may need lime if legumes are grown, but have soil tests made before you invest money in lime for these soils.

Unless you need hay, you probably will not find it profitable to grow alfalfa, although alfalfa supplies nitrogen and is beneficial in other ways. Large quantities of crop aftermath will have to be returned to the soil to maintain or improve the supply of organic matter. Keeping all crop residues at or near the surface and using all available barnyard manure will help to maintain the fertility and preserve the structure of these soils. A good cropping system is one that includes 2 or 3 years of row crops, 2 years of legumes, and 2 years of small grain.

Terracing cropland will help to control runoff that would otherwise cause erosion (fig. 10). Deep gullies develop where the slope pattern causes a concentration of water. Well-maintained grassed waterways are needed to prevent gullying. If the waterways are wide enough, hay can be harvested from them.



Figure 10.—A well-managed, even stand of corn on Marshall silt loam, 4 to 10 percent slopes; erosion controlled by contour farming, terraces, and grassed waterways.

CAPABILITY UNIT IIIe-2

Deep, moderately light colored, friable, acid loamy soils on moderately steep uplands

The soils of this unit are acid. Their subsoil is clay or silty clay that takes water slowly but stores a good supply and releases it to plants. The main problem is to keep water from running off before it has time to soak in. The soils in this unit are—

- Dennis loam, 4 to 10 percent slopes.
- Gara loam, 4 to 10 percent slopes.
- Ladoga silt loam, 4 to 10 percent slopes.
- Morrill loam, 4 to 10 percent slopes.
- Shelby clay loam, 4 to 10 percent slopes.

These soils are moderate to low in fertility. Under good management, they produce good yields of all crops commonly grown in the county. Yields can be improved by applying lime and fertilizer according to the needs shown by soil tests or field trials. A cropping system in which row crops are grown no more than 3 years out of 5 will help to improve or maintain productivity.

The surface soil, in most cultivated areas, is low in organic matter and tends to puddle and slick over when it rains. This causes water to run off. Controlling sheet and gully erosion is a problem unless the soil is adequately protected by terraces and waterways and is well supplied with organic matter. All cropland needs terraces to control runoff. Contour farming also reduces runoff.

CAPABILITY UNIT IIIe-3

Very dark colored clayey soils, with clay subsoils, on moderately sloping uplands

The soils of this unit take in water slowly. Their clay subsoil is one of their main limitations. In many culti-

vated fields erosion has removed from 4 to 10 inches of surface soil. Compared with other sloping, eroded soils in the county, these soils have more organic matter in their surface soil and are more fertile. The soils of this unit are—

- Grundy silty clay loam, 4 to 7 percent slopes, eroded.
- Summit clay loam, 4 to 10 percent slopes.
- Summit and Labette soils, moderately shallow, 4 to 10 percent slopes.

These soils are not so good for corn as the more permeable soils of the county, because of their clayey surface soil and slowly permeable subsoil. They are as well suited to wheat as any other soil on comparable slopes. They produce good yields of sorghums and legumes. Good utilization of crop residues, combined with a cropping system that includes a legume and limits row crops to not more than 3 years out of 5, will keep these soils in good tilth and reduce erosion. As a rule, such a system will also meet the feed and grain requirements of the farm.

Because of the sloping topography and the clayey surface soil, farming is more difficult on these soils than on the medium-textured, more permeable silty soils, and crops are damaged more often by drought. Unless legumes and grasses have been grown recently, the supply of organic matter may be small. This slows the infiltration of water and causes crusting that interferes with the growth of seedlings.

Deep-rooted legumes will improve the soil structure, add nitrogen, and increase permeability. All cropland needs terraces and grassed waterways. Contour farming will help to control erosion. Severe sheet erosion is likely if these soils are farmed without regard to direction or steepness of slope.

CAPABILITY UNIT IIIe-4

Deep, dark-colored, eroded clayey soils, with tight clay subsoils, on moderately sloping uplands

Pawnee clay loam, 2 to 7 percent slopes, eroded, is the only soil in this capability unit. It has an acid clay loam surface soil and a very compact, heavy clay subsoil. It takes in water slowly and loses much water by runoff; consequently, preventing sheet and gully erosion is a major problem.

This soil is not well suited to corn, but it can be used for oats, wheat, or grain sorghum. It needs lime, nitrogen, and phosphorus. Apply fertilizer and lime according to needs indicated by soil tests.

All the conservation practices needed for the soils of capability unit IIIe-3 are needed for this soil. A suitable cropping system would include not more than 2 years of row crops in 5 years. Growing legumes and turning under large quantities of crop residue are beneficial.

CAPABILITY UNIT IVe-1

Deep, dark-colored, moderately sloping to moderately steep loamy soils with moderately permeable subsoils

This capability unit includes moderately sloping soils from which most of the surface soil has been removed by erosion and moderately steep soils that still have 4 to 12 inches of surface soil. The soils in the unit are—

- Burchard clay loam, 10 to 18 percent slopes.
- Burchard clay loam, 4 to 10 percent slopes, eroded.
- Judson silt loam, 3 to 10 percent slopes.
- Marshall and Sharpsburg soils, 10 to 18 percent slopes.
- Monona silt loam, 10 to 18 percent slopes.

These soils will produce a good income if carefully managed so as to control erosion and maintain fertility. They are better suited to hay and pasture than to cultivated crops. Grow small grains, legumes, and perennial grasses most of the time, and include a minimum of row crops in the cropping system. Terrace cultivated fields and farm on the contour to help control sheet and gully erosion. Shape waterways and seed them to grasses and legumes.

If well managed, these soils produce about as much forage as some of the better soils. Fertilize new seedings according to needs shown by soil tests. Renovate weedy and overgrazed pastures, fertilize and lime them as needed, and limit grazing.

In cultivated fields that have not received heavy applications of manure or fertilizer, the fertility is medium to low. In eroded areas, the soils contain little organic matter. Runoff is rapid; consequently, there is likely to be gully erosion (fig. 11). Build diversion terraces to intercept runoff. Shape and seed gullies that already exist.

CAPABILITY UNIT IVe-2

Deep, moderately permeable, acid loamy soils on steep uplands or eroded gently sloping uplands

The main problems in managing the soils in this unit are to prevent sheet and gully erosion and to increase productivity. The soils are—

- Gara loam, 10 to 18 percent slopes.
- Ladoga silt loam, 10 to 18 percent slopes.
- Morrill loam, 4 to 10 percent slopes, eroded.
- Morrill loam, 10 to 18 percent slopes.
- Shelby clay loam, 4 to 10 percent slopes, eroded.
- Shelby clay loam, 10 to 18 percent slopes.



Figure 11.—Deeply gullied area of Judson silt loam, 3 to 10 percent slopes.

If other soils are available for necessary row crops, you can use these soils more profitably for hay and pasture. Nevertheless, they produce good yields of corn and sorghum, provided fertility is maintained at a high level and erosion is controlled. Keep the soils covered with close-growing crops or with crop residues most of the time. Limit row crops to 1 year out of 5 or 6.

If these soils are cropped, they need to be cultivated on the contour and protected by terraces and grassed waterways. Lime is needed if clover and alfalfa are grown.

CAPABILITY UNIT IVe-3

Moderately shallow to deep, very dark colored clayey soils, with clay subsoils, on steep uplands

The soils in this unit are steep, have slowly permeable subsoils, and take in water slowly. Consequently, they have excessive runoff and are subject to severe sheet and gully erosion. The soils are—

- Summit clay loam, 10 to 18 percent slopes.
- Summit and Labette soils, moderately shallow, 10 to 18 percent slopes.

These soils are suited to all the crops commonly grown in the county, but, because of the steep slopes, it is better not to use them for row crops. They produce excellent yields of hay and pasture. A suitable cropping system is one that consists of 3 or 4 years of bromegrass and alfalfa and 2 years of small grain.

Because they occur mostly at the base of steep slopes, these soils have a good supply of underground moisture and are protected from drying winds. Diversion terraces and grassed waterways are needed to control runoff on the adjacent slopes. Leaving crop residues on the surface will help protect the soils from beating rains and will encourage the infiltration of moisture into the subsoil. As the reaction is neutral, clover and alfalfa can be grown without lime. Phosphorus will usually improve yields of small grains and legumes. Soil tests will indicate about how much fertilizer to apply.

CAPABILITY UNIT VIc-1

Moderately shallow to deep loamy soils on moderately steep to steep uplands subject to severe erosion

The soils in this capability unit are either severely eroded; gravelly, steep, or cut up by streams and gullies. They are—

Burchard clay loam, 10 to 18 percent slopes, eroded.
 Gara loam, 18 to 30 percent slopes.
 Monona silt loam, 18 to 30 percent slopes.
 Morrill loam, 10 to 18 percent slopes, eroded.
 Pawnee clay loam, 2 to 7 percent slopes, severely eroded.
 Shelby clay loam, 10 to 18 percent slopes, eroded.
 Shelby gravelly loam, 10 to 18 percent slopes.
 Steinauer clay loam.
 Summit and Labette soils, moderately shallow, 10 to 18 percent slopes, eroded.

These soils are unsuited to cultivated crops but are well suited to perennial grasses and legumes for hay or pasture. Most of them are acid and need lime if legumes are grown. Eroded areas are low in nitrogen. Applying nitrogen on tame grasses and legumes, according to the needs indicated by soil tests or field trials, will increase production.

Pastures of native bluestem particularly need protection from overgrazing. Most pastures need control of brush and weeds. Sheet and gully erosion are serious problems in areas where cultivation has been attempted.

CAPABILITY UNIT VIw-1

Deep, dark-colored silts and clays on irregular or broken slopes adjacent to streams

Alluvial land is the only mapping unit in this capability unit. This land type takes in and stores large amounts of water. It is frequently flooded. It is best suited to grass or trees. Scouring, silting, bank cutting, and gully-ing make it unsuitable for crops. Erosion of streambanks can be controlled by maintaining a good cover of grass or trees.

If weeds are controlled and the fertility is maintained, Alluvial land will produce good yields of grass. Nitrogen will increase yields of grass if it is used in the quantities shown by soil tests to be needed.

Wooded areas need to be protected from overgrazing. Yields can be increased by thinning the stands, cutting selectively, and preventing fires.

CAPABILITY UNIT VIIc-1

Dark-colored loamy, gravelly, or stony soils on moderately steep to steep uplands

The soils of this capability unit are damaged by uncontrolled runoff, which causes severe erosion. They are—

Shelby gravelly loam, 18 to 30 percent slopes.
 Sogn soils.

Most areas of these soils have some grass and thin stands of trees that are of little economic value. In improperly managed areas, grass production is low. Most of the acreage is used for grazing, but some wood is harvested for fuel and posts.

Native grass pastures need protection from fire and from overgrazing. Renovating pastures is very expensive or impractical because of steep slopes, stones, gullies, or other physical obstacles. Once a good cover of vegetation has become established, protect it by careful management.

Estimated Yields

Estimated yields of the crops commonly grown in Brown County are given in table 1. The figures in columns A are estimates of the yields you will get if you (1) grow corn, wheat, or oats most of the time, (2) grow legumes less often than once in 8 years, (3) use little or no fertilizer, (4) fail to follow a suitable cropping system, and (5) take no measures to control erosion. In columns B are estimates of the yields you can get if you (1) rotate crops systematically, (2) use lime and fertilizer according to the needs of the particular soil and crop, (3) supply organic matter by applying manure or by plowing under crop residues or green-manure crops, (4) take all necessary measures to reduce erosion and to control insects and diseases, (5) drain wet soils and prevent floods, and (6) use improved crop varieties.

The pasture capacities given in the A columns are for unimproved pasture; those given in the B columns are for pasture that has been fertilized and seeded with mixtures that include legumes.

The estimates are based on data obtained through experiments in Brown County and on information obtained from farmers in the county. Remember that these are averages and that yields may be much lower in a year when the weather is unfavorable. It is also possible to get yields higher than the average by planting improved varieties of crops and practicing the best possible management.

By comparing the estimates in table 1 with the average yields you have been getting over the last 5 to 10 years, you can check the adequacy of your present management practices. If your average yields have been less than the estimates in columns B, you can probably improve them by adopting some of the practices discussed in the section, Use and Management of Soils.

Soil Survey Methods and Definitions

The scientist who makes a soil survey examines soils in the field and, according to his observations, maps the boundaries of each soil on an aerial photograph or other map.

FIELD STUDY.—The soil scientist bores or digs many holes to see what the soils are like. The holes are spaced irregularly, depending on the lay of the land. Usually they are not more than a quarter of a mile apart; in many areas they are much closer together. In most soils each boring, hole, or pit reveals several layers, called horizons, which collectively are known as the soil profile. The profile is studied to see how the horizons differ from one another and to learn the things about the soil that influence its capacity to support plants.

Color is usually related to the amount of organic matter. The darker the surface soil, as a rule, the more organic matter it contains. Color is also a clue to the natural drainage conditions. A bright brown subsoil is evidence of good drainage and aeration. Streaks and spots of gray, yellow, and brown usually show that the soil has poor drainage and aeration.

TABLE 1.—Estimated average acre yields of principal crops under two levels of management

[Yields in columns A are to be expected under common management, and yields in columns B, under improved management. See text for discussion of two levels of management. Absence of yield indicates crop is not ordinarily grown]

Soil name	Corn		Wheat		Oats		Alfalfa		Red clover		Soybeans		Tame pasture ¹			
	A	B	A	B	A	B	A	B	A	B	A	B	Bromegrass and alfalfa		Bluegrass	
	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Tons	Tons	Tons	Tons	Bu.	Bu.	Acres	Acres	Acres	Acres
Alluvial land							3.1	4.0					5.0	3.0	5.5	4.0
Burchard clay loam, 4 to 10 percent slopes	35	56	16	22	22	40	2.5	3.1	2.2	3.5	15	25	5.0	2.5	6.0	4.0
Burchard clay loam, 4 to 10 percent slopes, eroded	26	38	12	18	18	35	2.0	2.7	2.1	3.0			5.0	2.5	6.0	4.0
Burchard clay loam, 10 to 18 percent slopes	24	36	10	14	21	33	1.8	2.5	2.0	2.7			5.0	2.4	6.0	4.0
Burchard clay loam, 10 to 18 percent slopes, eroded							1.5	2.2	2.0	2.5			7.0	3.0	7.0	4.5
Dennis loam, 4 to 10 percent slopes	24	50	11	20	20	35	1.5	2.7	2.0	2.5			7.0	3.4	7.0	5.0
Edina silt loam	20	45	16	30	18	40	2.0	3.5								
Gara loam, 4 to 10 percent slopes	20	48	9	18	25	40	1.7	3.5	2.0	2.5	10	18	7.0	3.5	10.0	4.5
Gara loam, 10 to 18 percent slopes	22	40	14	18	18	35	2.0	2.8	1.9	2.3			7.0	3.4	10.0	4.5
Gara loam, 18 to 30 percent slopes													8.0	4.5	15.0	5.0
Grundy silty clay loam, 0 to 1 percent slopes	38	62	24	37	27	50	3.2	3.9	2.5	3.2	18	26	4.0	2.7	6.0	4.0
Grundy silty clay loam, 1 to 4 percent slopes	35	58	22	32	25	45	3.2	3.9	2.5	3.2	16	24	4.0	2.7	6.0	4.0
Grundy silty clay loam, 4 to 7 percent slopes, eroded	30	55	18	26	18	40	3.0	3.7	2.2	3.1	15	22	4.0	2.8	6.0	4.5
Judson silt loam, 0 to 3 percent slopes	58	82					3.5	4.5	2.5	3.5	18	28	3.0	2.2	4.0	3.5
Judson silt loam, 3 to 10 percent slopes							2.7	3.5					3.0	2.2	4.2	3.7
Judson silt loam, flood plains	60	85	19	30	24	41	4.0	4.5	2.7	3.6	22	34	3.0	2.3	4.0	3.5
Ladoga silt loam, 4 to 10 percent slopes	28	54	16	22	18	35	2.2	3.0	2.1	2.5	12	18	7.0	3.2	7.0	4.5
Ladoga silt loam, 10 to 18 percent slopes	22	47	14	22	18	35	2.0	2.8	1.9	2.3			7.0	3.4	7.2	4.8
Marshall and Sharpsburg soils, 0 to 2 percent slopes	52	75	22	32	35	50	3.0	4.2	3.1	3.5	22	32	4.0	2.5	6.0	4.0
Marshall and Sharpsburg soils, 2 to 4 percent slopes	48	70	20	27	30	42	3.0	4.0	3.0	3.5	22	30	5.0	2.5	6.0	4.0
Marshall and Sharpsburg soils, 4 to 10 percent slopes	43	65	18	25	22	40	2.8	3.5	2.3	3.1	18	26	6.0	2.5	6.0	4.0
Marshall and Sharpsburg soils, 10 to 18 percent slopes	40	55	16	20	16	38	2.5	3.2	2.1	3.0	16	22	7.0	2.7	7.0	4.5
Monona silt loam, 4 to 10 percent slopes	58	78	12	20	28	55	3.0	4.1	2.5	3.5	14	26	3.8	2.5	5.7	4.0
Monona silt loam, 10 to 18 percent slopes	43	60	10	18	20	35	3.0	4.0	2.1	3.0	12	20	4.0	2.8	6.0	4.5
Monona silt loam, 18 to 30 percent slopes							2.1	2.7					4.5	3.0	6.0	4.6
Morrill loam, 4 to 10 percent slopes	30	55	12	22	20	35	1.5	2.3	2.0	2.6	15	20	6.0	2.7	6.0	4.0
Morrill loam, 4 to 10 percent slopes, eroded	16	35	9	16	18	30	1.0	2.2	1.8	2.5			6.5	2.8	6.5	4.0
Morrill loam, 10 to 18 percent slopes	18	28	9	18	15	30	1.5	2.0	1.5	2.7			7.0	2.7	7.0	4.5
Morrill loam, 10 to 18 percent slopes, eroded													9.0	4.0	9.0	5.5
Muir silt loam	50	85	26	35	40	55	3.2	4.3	3.1	3.7	23	35	4.0	2.2	4.0	3.5
Pawnee clay loam, 2 to 7 percent slopes, eroded	17	40	12	22	25	40	2.0	2.7	2.0	2.5	10	18	6.0	3.1	6.0	4.0
Pawnee clay loam, 2 to 7 percent slopes, severely eroded													8.0	4.5	9.0	5.5
Shelby clay loam, 4 to 10 percent slopes	38	60	20	28	25	40	2.1	3.2	2.1	3.2	15	25	7.0	3.4	6.0	4.0
Shelby clay loam, 4 to 10 percent slopes, eroded	22	42	9	16	18	32	1.9	2.2	1.5	2.5			7.1	3.5	6.2	4.6
Shelby clay loam, 10 to 18 percent slopes	24	45	10	18	20	35	2.0	2.5	2.0	2.8			7.0	3.4	7.0	4.5
Shelby clay loam, 10 to 18 percent slopes, eroded							1.7	2.5					9.0	3.8	8.0	5.0
Shelby gravelly loam, 10 to 18 percent slopes													9.0	4.0	9.0	5.5
Shelby gravelly loam, 18 to 30 percent slopes															10.0	6.0
Sogn soils															10.0	6.0
Steinauer clay loam													5.0	2.8	6.0	4.0
Summit clay loam, 4 to 10 percent slopes	38	65	16	24	30	45	3.0	3.7	3.0	3.2	12	22	5.0	2.8	6.0	4.0
Summit clay loam, 10 to 18 percent slopes	24	52	12	20	22	38	2.5	3.2	2.2	2.7			6.0	3.0	6.0	4.0

See footnote at end of table.

TABLE 1.—*Estimated average acre yields of principal crops under two levels of management—Continued*

[Yields in columns A are to be expected under common management, and yields in columns B, under improved management. See text for discussion of two levels of management. Absence of yield indicates crop is not ordinarily grown]

Soil name	Corn		Wheat		Oats		Alfalfa		Red clover		Soybeans		Tame pasture ¹			
													Bromegrass and alfalfa		Bluegrass	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Summit and Labette soils, moderately shallow, 4 to 10 percent slopes.....	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Tons	Tons	Tons	Tons	Bu.	Bu.	Acres	Acres	Acres	Acres
Summit and Labette soils, moderately shallow, 10 to 18 percent slopes.....	27	48	12	22	25	40	2.0	2.7	2.0	2.5	10	18	6.0	4.0	7.0	4.5
Summit and Labette soils, moderately shallow, 10 to 18 percent slopes.....	22	40	10	18	20	35	1.5	2.2	1.5	2.0	-----	-----	6.0	4.0	7.0	4.5
Summit and Labette soils, moderately shallow, 10 to 18 percent slopes, eroded.....	-----	-----	-----	-----	-----	-----	1.2	2.0	-----	-----	-----	-----	7.0	5.0	9.0	5.0
Wabash silty clay.....	56	78	18	28	35	45	3.0	4.5	2.5	3.5	22	32	3.0	2.2	4.0	3.5

¹ Figures refer to number of acres required to support one cow for 6 months.

Texture, or the content of sand, silt, and clay, is determined by the way the soil feels when rubbed between the fingers and by laboratory analysis. Texture determines how well the soil retains moisture and plant nutrients and whether it is easy or difficult to cultivate.

Structure, which is the way the individual soil particles are arranged in aggregates and the amount of pore space between aggregates, gives clues to the ease or difficulty with which the soil is penetrated by plant roots and by moisture. Soil particles are not ordinarily evenly distributed. Channels have been formed by roots and earthworms, and cracks appear when the soils shrink and swell upon drying and wetting. Thus, the soils are a network of channels filled with air, roots, and water, bounded by the irregular surfaces of the soil particles.

Consistence, or the tendency of the soil to crumble or to stick together, indicates whether it is easy or difficult to keep the soil open and porous under cultivation.

Other characteristics observed in the course of the field survey and considered in study of the soil include the following: The depth of the soil over bedrock or compact layers, the presence of gravel or stones in amounts that will interfere with cultivation, the steepness and pattern of slopes, the degree of erosion, the nature of the parent material from which the soil has developed, and the acidity or alkalinity of the soil as measured by chemical tests.

CORRELATION.—On the basis of the characteristics observed by the soil scientists or determined by laboratory tests, soils are correlated by series, types, and phases.

Soil series.—Soils similar in kind, thickness, and arrangement of layers are normally designated as a soil series. In a given area, a soil series may be represented by only one soil.

Soil type.—Within a series, there may be one or more soil types. The types are differentiated by the texture of the surface layer.

Soil phase.—Soil types are divided into phases because of differences in slope, degree of erosion, or depth of soil over the substratum.

The phase (or the type, if it has not been subdivided) is the unit shown on the soil map. It is the unit that has

the narrowest range of characteristics. Use and management suggestions, therefore, can be more specific than for soil series or for yet broader groups that contain more variation.

Miscellaneous land types.—Certain types of land are not classified by soil types and series. They are called miscellaneous land types instead of soils and are identified by descriptive names. The only land type in Brown County is Alluvial land.

Undifferentiated group.—Two or more soils may be designated by the same map symbol and shown on the soil map as one unit. Two such groups occur in Brown County, the Marshall and Sharpsburg soils, and the Summit and Labette soils.

Soil Series and Mapping Units

In the following pages you will find descriptions of the soils mapped in Brown County—first a description of the series, then a short paragraph about each mapping unit. A little information about use and management is included. More information is in the section, Use and Management of Soils. The distribution of each soil is shown on the soil map in the back of this report. The acreage and proportionate extent of each soil are given in table 2.

Alluvial land

Alluvial land (Ac) (capability unit VIw-1).—This is a miscellaneous land type derived from silty and clayey sediments washed from the hillsides by streams. The sediments consisted mostly of reworked loess or glacial material, but in many places they have been modified by clay and sand washed from rough, stony land and by gravely sediments washed from the glacial slopes.

This land type is found adjacent to all the major drainageways in the county. It is associated with the Judson and Wabash soils. Most of the areas are cut by the winding streams, and the surface is irregular. All areas are frequently flooded, and some are poorly drained and re-

TABLE 2.—Acreage and proportionate extent of the soils

Mapping unit	Acreage	Extent
Alluvial land	23, 071	6. 2
Burchard clay loam, 4 to 10 percent slopes	1, 916	. 5
Burchard clay loam, 4 to 10 percent slopes, eroded	393	. 1
Burchard clay loam, 10 to 18 percent slopes	491	. 1
Burchard clay loam, 10 to 18 percent slopes, eroded	238	. 1
Dennis loam, 4 to 10 percent slopes	263	. 1
Edina silt loam	807	. 2
Gara loam, 4 to 10 percent slopes	345	. 1
Gara loam, 10 to 18 percent slopes	1, 571	. 4
Gara loam, 18 to 30 percent slopes	2, 762	. 7
Grundy silty clay loam, 0 to 1 percent slopes	17, 878	4. 8
Grundy silty clay loam, 1 to 4 percent slopes	22, 439	6. 1
Grundy silty clay loam, 4 to 7 percent slopes, eroded	94, 782	25. 6
Judson silt loam, 0 to 3 percent slopes	4, 087	1. 1
Judson silt loam, 3 to 10 percent slopes	12, 900	3. 5
Judson silt loam, flood plains	14, 384	4. 0
Ladoga silt loam, 4 to 10 percent slopes	677	. 2
Ladoga silt loam, 10 to 18 percent slopes	474	. 1
Marshall and Sharpsburg soils, 0 to 2 percent slopes	3, 701	1. 0
Marshall and Sharpsburg soils, 2 to 4 percent slopes	6, 732	1. 8
Marshall and Sharpsburg soils, 4 to 10 percent slopes	40, 376	10. 9
Marshall and Sharpsburg soils, 10 to 18 percent slopes	1, 096	. 3
Monona silt loam, 4 to 10 percent slopes	1, 687	. 5
Monona silt loam, 10 to 18 percent slopes	1, 746	. 5
Monona silt loam, 18 to 30 percent slopes	559	. 2
Morrill loam, 4 to 10 percent slopes	11, 326	3. 1
Morrill loam, 4 to 10 percent slopes, eroded	2, 175	. 6
Morrill loam, 10 to 18 percent slopes	9, 606	2. 6
Morrill loam, 10 to 18 percent slopes, eroded	1, 831	. 5
Muir silt loam	800	. 2
Pawnee clay loam, 2 to 7 percent slopes, eroded	8, 982	2. 4
Pawnee clay loam, 2 to 7 percent slopes, severely eroded	672	. 2
Shelby clay loam, 4 to 10 percent slopes	37, 497	10. 1
Shelby clay loam, 4 to 10 percent slopes, eroded	1, 890	. 5
Shelby clay loam, 10 to 18 percent slopes	3, 916	1. 1
Shelby clay loam, 10 to 18 percent slopes, eroded	420	. 1
Shelby gravelly loam, 10 to 18 percent slopes	3, 102	. 8
Shelby gravelly loam, 18 to 30 percent slopes	1, 522	. 4
Sogn soils	7, 848	2. 1
Steinauer clay loam	1, 183	. 3
Summit clay loam, 4 to 10 percent slopes	4, 680	1. 3
Summit clay loam, 10 to 18 percent slopes	1, 172	. 3
Summit and Labette soils, moderately shallow, 4 to 10 percent slopes	2, 180	. 6
Summit and Labette soils, moderately shallow, 10 to 18 percent slopes	4, 173	1. 1
Summit and Labette soils, moderately shallow, 10 to 18 percent slopes, eroded	590	. 2
Wabash silty clay	8, 980	2. 4
Total of 46 mapping units	369, 920	100. 0

main wet. Streambank cutting has taken place, and many side gullies have formed.

The uppermost 10 to 14 inches, in most places, is grayish-brown silt loam or silty clay loam. This is underlain by 5 to 10 inches of mixed light-gray silt and dark-gray to brown silt loam. The subsoil, beginning at a depth of approximately 20 inches, is brownish-gray silty clay or

silty clay loam that has some olive-brown mottles or stains. Thin layers of light-gray and dark-brown silt and clay occur in many places.

Most of the areas are too rough and broken and too small to be of much value for agriculture. Yet, some of the larger areas have been cleared and leveled—generally at considerable expense—and make excellent cropland if protected from overflow. Many areas that are not drained or protected from floods provide good pasture.

Burchard series

The soils of the Burchard series are dark-colored granular clay loams that have developed from glacial till. They occur chiefly in the southwestern part of the county, with the Steinauer and Pawnee soils.

The surface soil varies from dark brown to dark grayish brown in color and from 8 to 10 inches in thickness. In places it contains numerous small stones and enough sand or gravel to make it a little coarser than a clay loam. In virgin areas it contains much organic matter.

The upper 8 inches of the subsoil is dark-brown or brown, friable or moderately friable silty clay loam that is a little more compact than the surface soil. The subsoil gradually becomes coarser textured and lighter colored with depth. The lower part of it is brown or light-brown limy clay loam or sandy clay loam. At depths of 32 to 38 inches the profile merges with the parent till, which is a limy mixture of sand, silt, and clay (fig. 12).

Near Pawnee soils, the upper layers of the Burchard soils are generally a little darker colored and thicker than normal, and the lower part of the subsoil is not highly calcareous. Near Steinauer soils, the Burchard soils are shallower and lighter colored than normal and have lime close to the surface.

Under cultivation, Burchard soils are subject to serious water erosion unless they are protected adequately. Many areas are used for pasture; however, cultivated crops do well if the soil is properly managed and adequately fertilized.

Burchard clay loam, 4 to 10 percent slopes (BcB) (capability unit IIIe-1).—This soil has an 8- to 10-inch surface soil that is easily worked. It absorbs water and holds it well for plants. It is suited to all crops commonly grown in the county, and is well suited to corn, alfalfa, and sorghums. Cultivated areas will be damaged by severe sheet and gully erosion unless adequate protection is provided.

Burchard clay loam, 4 to 10 percent slopes, eroded (BcB3) (capability unit IVe-1).—This soil has lost 5 to 8 inches of its surface soil through sheet erosion, and there are some small gullies in most of the cultivated fields. The surface soil is lighter colored than that of the un-eroded Burchard clay loam, 4 to 10 percent slopes, and, where part of the subsoil has been mixed with it, it has more clay.

This soil is best suited to grasses or other hay crops. A crop of small grain grown just before a new sod crop is seeded will help control weeds and insure a better stand of grasses and legumes.

Burchard clay loam, 10 to 18 percent slopes (BcC) (capability unit IVe-1).—This soil has a 5- to 7-inch surface soil. Lime is generally a little nearer the surface than in Burchard clay loam, 4 to 10 percent slopes. Because of the strong slopes, runoff causes severe erosion

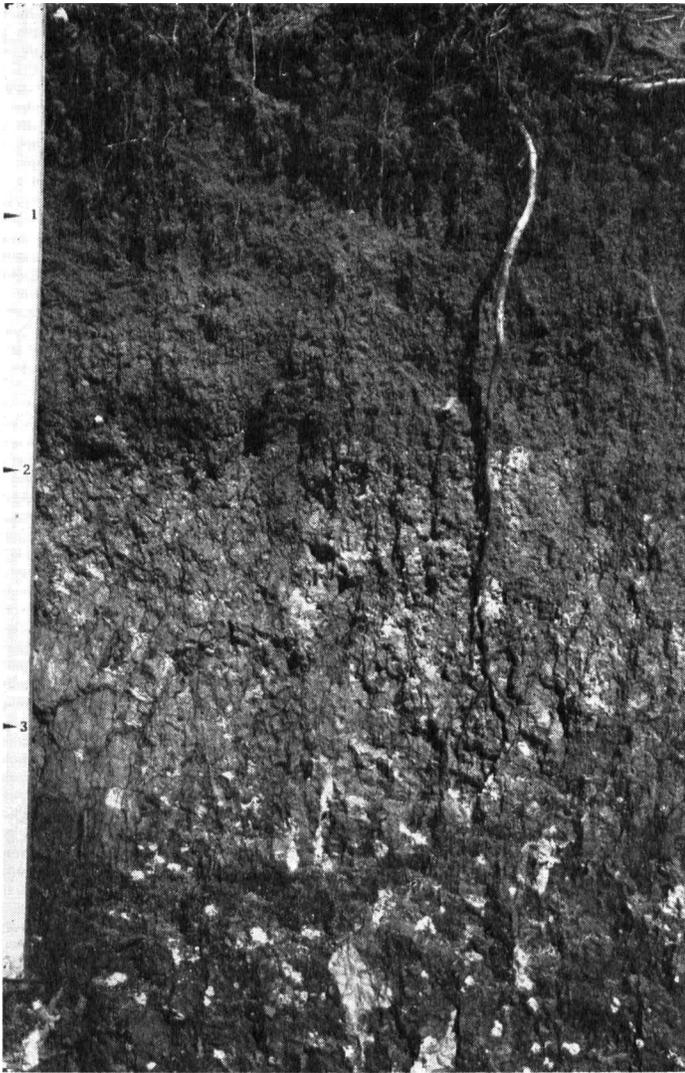


Figure 12.—Lime in the subsoil and parent glacial till of Burchard clay loam.

unless the soil is protected. The cropping system best suited to this soil consists of 4 years of sod crops and small grains after 1 year of row crops.

Burchard clay loam, 10 to 18 percent slopes, eroded (B_cC3) (capability unit VIe-1).—Uncontrolled runoff has made deep gullies in some areas of this soil, and little or none of the original surface soil remains. Further erosion can be prevented by maintaining a good cover of grass. Lime occurs within 14 to 20 inches of the surface. Because of the steep slopes and severe erosion, this soil is not suited to row crops or small grain. Bromegrass and alfalfa grow well if adequately fertilized and properly managed.

Dennis series

The soils of this series are deep, moderately light colored loams. They overlie thin-bedded silty and clayey shales and fine-grained sandstones, which normally occur at depths of more than 48 inches. The depth to less weathered bedrock generally exceeds 5 feet.

The surface soil is grayish-brown, medium acid loam 5 to 7 inches deep. A subsurface layer of dark-brown to pale-brown, acid sandy clay loam extends to a depth of about 10 inches.

The subsoil is brown to weak yellowish-brown, friable sandy clay loam that grades into dark yellowish-brown silty clay loam mottled with reddish brown.

These soils are moderately friable and have a fairly high water-holding capacity. Drainage is good to excessive.

These soils are medium acid and need to be limed if legumes are grown. Although the physical characteristics of these soils are favorable for plant growth, crop yields are low because supplies of organic matter and essential plant nutrients are small.

Dennis loam, 4 to 10 percent slopes (D_cB) (capability unit IIIe-2).—This is the only Dennis soil mapped in the county. It occurs in the southern part, near Horton.

In most of the cultivated areas, moderate erosion has removed from 3 to 6 inches of the surface layer. In a few places, runoff from higher lying areas has caused some gullying. For good yields, heavy applications of lime and fertilizer are required.

Edina series

The soils of the Edina series are deep, dark-colored silt loams that have a dense claypan in the subsoil. They occur in level or slightly depressed areas near Willis, Baker, and Powhattan. They are associated with the Grundy soils.

The surface soil is black to dark-brown, friable silt loam 6 to 8 inches thick. It is underlain by very dark gray to dark brown granular silt loam that extends to a depth of 14 inches. The next 3 to 4 inches is gray or light brownish-gray platy silt loam. This overlies a very dark brown to brownish-gray, blocky, tight clay subsoil that extends to a depth of 34 inches. Olive-brown clay, slightly mottled with brown and gray, extends from 34 to 40 inches. Beneath that, to a depth of 54 inches, is light grayish-brown silty clay or silty clay loam.

Surface drainage is slow and internal drainage is very slow.

Edina silt loam (E_c) (capability unit II_s-1).—This is the only Edina soil mapped in the county. Normally, it is surrounded by Grundy soils and cannot be farmed separately.

This soil is too wet in spring and too droughty in summer to be well suited to corn. It is better suited to small grain.

Gara series

The soils of the Gara series are moderately sloping to steep. They occur on slopes that border the valleys of large streams. Generally they are on north-facing slopes, below rounded ridgetops occupied by gently sloping Mor-rill soils.

The Gara soils have developed from glacial till, which is a mixture of gravel, sand, silt, and clay. The native vegetation was a mixture of grasses and trees. These soils have less organic matter than those formed under a cover consisting entirely of grass, but they have more than those that developed under trees. They are dark colored when wet and light colored when dry.

The surface layer is friable loam or silt loam that varies from about 4 to 8 inches in thickness and from brown to brownish gray in color. In eroded cultivated fields, the surface soil is clay loam.

The subsurface layer consists of about 3 inches of gray to light-gray, friable silt loam that is underlain at depths of 8 to 12 inches by brown clay loam or silty clay loam. The subsoil, to depths of 34 to 36 inches, is dense, brown or yellowish-brown clay or sandy clay. Below 36 inches, the soil becomes somewhat lighter colored. Gravel and pebbles are scattered through the subsoil.

These soils are medium to strongly acid. Generally they are low in nitrogen and phosphorus. Erosion has removed 4 to 7 inches of topsoil from most cultivated areas, and small gullies have formed in the cultivated fields.

Some areas of these soils are well suited to trees, but they have not produced merchantable timber because they hold little moisture and have not been well managed. Good management would include fencing out livestock to allow seedlings to grow, thinning occasionally to prevent overcrowding, selecting trees for cutting at marketable size, and planting suitable species. Trees will not grow well in areas that are also used for pasture.

Severely eroded areas are low in fertility. Permanent vegetation on these areas will prevent serious gully erosion. Gullies that have already formed can be controlled by diverting water from them and establishing vegetation.

Gara loam, 4 to 10 percent slopes (GcB) (capability unit IIIe-2).—Areas of this soil that occur near Morrill or Shelby soils are generally cultivated. If it is well managed, this soil will produce good yields of the crops commonly grown in the county. It will need to be terraced and farmed on the contour to control erosion. It needs lime if legumes are grown.

Gara loam, 10 to 18 percent slopes (GcC) (capability unit IVe-2).—Because of erosion, this soil has a thinner topsoil than Gara loam, 4 to 10 percent slopes. Some cultivated areas have lost so much surface soil that the clay subsoil is being mixed with the remaining surface soil. This soil contains little organic matter and, if cultivated, requires careful management to keep it in good condition. Row crops can be planted safely only about once in 6 years. Lime is needed if alfalfa and sweetclover are grown.

Gara loam, 18 to 30 percent slopes (GcD) (capability unit VIe-1).—This soil is used mostly for pasture, but it supports a thin stand of oak and hickory. Even in uneroded areas, the surface soil is only 4 to 6 inches thick. The subsoil contains more coarse sand and gravel than that of the more gently sloping Gara soils. Some large glacial boulders are scattered in the soil and on the surface.

This soil is subject to severe sheet and gully erosion unless it is protected by a good cover of perennial vegetation. It is best used for tame grasses and legumes for hay or pasture. Good yields of grasses and legumes can be obtained if lime and fertilizer are used according to needs shown by soil tests.

Grundy series

The Grundy soils are nearly level to moderately sloping. They occur with the Pawnee soils along the divide

that extends from the southeastern corner of the county to the northwestern corner. They are associated with the Edina soils in nearly level or depressed areas.

The surface layer of the uneroded Grundy soils is dark-brown to nearly black silty clay loam, 8 to 16 inches thick. It has a weak granular structure and is friable when moist.

The subsoil is 18 to 24 inches thick. The upper part is black to very dark grayish-brown, friable silty clay loam that has a strong coarse granular structure. The lower part is dark grayish-brown or very dark grayish-brown silty clay to clay that is firm and plastic and has a moderate blocky to strong coarse granular structure. The subsoil is called a "hardpan" or a "gumbo layer" by some farmers because it is sticky when wet and very hard when dry.

The subsoil grades to the dark grayish-brown silty clay or silty clay loam parent material.

Unless recently limed, the surface soil is acid; the subsoil ranges from neutral to medium acid.

These soils are slowly permeable. During periods of intense rainfall, runoff from the sloping areas is extremely high.

The Grundy soils are among the best in Kansas for wheat and other small grains but are less well suited to corn than the Marshall and Sharpsburg soils, which are less droughty. Most of the acreage is cultivated. Generally, only areas around farmsteads or adjacent to small drainageways are used for pasture. The big bluestem and little bluestem, which were the native grasses, have been grazed out, and the pastures are now mostly bluegrass.

Grundy silty clay loam, 0 to 1 percent slopes (GbA) (capability unit IIe-1).—This soil has a 10- to 15-inch surface soil that is granular in the lower part. The chief problems of use and management are caused by the tight clay subsoil. Under fairly good management, this soil will produce high yields of all suitable crops. This is the best upland soil in the county for wheat. Corn is sometimes damaged by short periods of hot dry weather.

Grundy silty clay loam, 1 to 4 percent slopes (GbB) (capability unit IIe-1).—Cultivated areas of this soil normally have a surface layer slightly thinner than that of Grundy silty clay loam, 0 to 1 percent slopes, because of sheet erosion. Controlling surface runoff during intense rains, by contour farming and general good management, will help to prevent further erosion. Runoff on long slopes can be controlled by terracing. Growing deep-rooted legumes and returning large quantities of crop residues to the soil will increase the water-absorbing capacity and improve the structure of this soil.

Grundy silty clay loam, 4 to 7 percent slopes, eroded (GbC3) (capability unit IIIe-3).—This soil will be severely damaged by sheet erosion unless runoff is controlled. Erosion has removed all but 4 to 8 inches of the surface soil from cultivated fields. In some areas part of the former subsoil is being mixed with the remaining surface soil. The topsoil in these areas is lighter colored than in the uneroded areas.

This soil will produce good yields of all suitable crops if it is properly managed and protected from erosion. Cultivated fields need organic matter in the form of crop residues or manure to improve structure, maintain or improve fertility, and control erosion. If you will apply

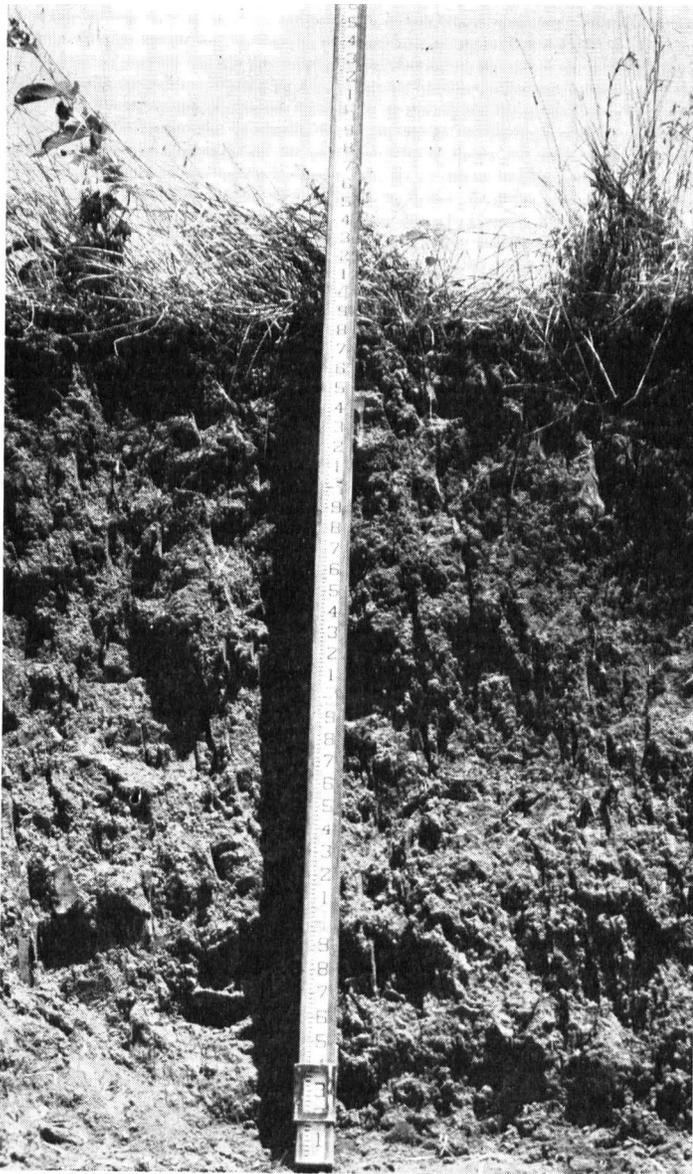


Figure 13.—Judson silt loam, flood plains, one of the best soils in Brown County, showing deep, dark-colored surface soil and moderately permeable, open subsoil.

lime and fertilizer according to needs shown by soil tests and field trials, you can expect to get better yields.

Judson series

The soils of the Judson series occur mostly on the floors of narrow stream valleys, with Wabash silty clay, and with Alluvial land. They have formed from very dark brown to nearly black surface material that rolled or washed from higher levels and accumulated at the base of the slopes and along the drainageways.

To a depth of 3 feet or more, these soils consist of dark-brown or dark grayish-brown, friable, fine granular silt loam or light silty clay loam. The silt loam predominates. In many areas adjacent to small streams, the uppermost 12 to 14 inches is stratified with layers of light-gray silt loam and dark-brown or black silt loam.

These soils are easy to farm and are fairly productive. They have an abundant supply of well-decomposed organic matter. Their water-holding capacity is high. They are slightly acid to medium acid to a depth of 5 feet. No free lime occurs in any part of the profile. Uncultivated areas support thick stands of grass.

Because the Judson soils occur along small drainageways that occasionally carry large volumes of water, they are susceptible to severe gully erosion. Many areas are already cut by deep gullies. The gullies often work upstream because of overfalls. Where there are no overfalls, properly constructed and maintained grassed waterways will prevent gullying.

Judson silt loam, 0 to 3 percent slopes (JcA) (capability unit IIe-2).—This soil occupies nearly level slopes adjacent to streams. It is fertile and is suitable for all crops grown in the county. Corn and alfalfa yield well if adequately fertilized. Oats sometimes lodge because of rank growth. Gullies can be controlled by shaping and then seeding to a mixture of perennial grasses and legumes.

Judson silt loam, 3 to 10 percent slopes (JcB) (capability unit IVe-1).—This soil generally has a lighter colored surface layer than Judson silt loam, 0 to 3 percent slopes. It occurs near small drainageways and streams and at the base of very steep slopes. Keeping it in perennial vegetation most of the time will prevent gullying. A mixture of bromegrass and alfalfa will produce good yields of hay. Corn grown between seedings to perennial grasses and legumes will yield well.

Judson silt loam, flood plains (Jb) (capability unit I-1).—This is the most extensive of the bottom-land soils that are suited to cropping. It occupies nearly continuous strips on the flood plains of almost all the streams and is associated with the more poorly drained Wabash silty clay. It is occasionally flooded by overflow from the streams, but all of it has sufficient slope to afford adequate drainage. The surface is nearly level except where it is modified by active or abandoned stream channels, slight elevations, or shallow depressions.

This soil consists of dark-colored, lime-free alluvium that has not been greatly modified by soil-forming processes. It has a 12- to 15-inch surface layer of fine granular silt loam that is dark grayish brown to almost black (fig. 13). The rest of the profile, to depths of 3 to 10 feet or more, is dark-brown to grayish-brown clayey alluvium. Layers of lighter colored or coarser textured materials are common in the subsoil.

This is the most productive soil in the county. It contains an abundance of organic matter and is moderately open and friable. It is easily managed. It produces high yields of corn, alfalfa, and sweetclover if well managed. Small grains are likely to produce a rank growth of straw and little grain. In some years they may be damaged by floods, but crops do not fail unless the bottom lands are flooded for abnormally long periods. This happens infrequently. The only uncultivated areas are small pastures adjacent to farmsteads and some narrow strips that are crossed by stream channels.

Labette series

The soils of the Labette series are similar to those of the Summit series, but they are browner and have less yellowish and somewhat less clayey subsoils. In Brown County, Labette soils are mapped only in undifferentiated

groups with the Summit soils. The two kinds of soils are suitable for the same uses and need the same kind of management. The mapping units are described under the heading, Summit and Labette series, moderately shallow.

Ladoga series

The soils of the Ladoga series occur in the northeastern part of the county, in scattered small areas at the base of long slopes below the Marshall or Monona soils. They have developed from loess—silty wind-deposited material. The original vegetation consisted of trees—chiefly elm, oak, and hickory—and some tall prairie grasses.

The Ladoga soils are lighter colored than the Marshall and Monona soils, which developed under grass. The surface soil is dark grayish-brown silt loam and is as much as 8 inches deep. The subsurface layer is brownish-gray silt loam that is somewhat heavier than the surface soil. The subsoil, which begins at a depth of about 12 inches, is yellowish-brown, plastic silty clay or clay. Beneath the subsoil is light-brown silty clay loam that becomes siltier and lighter colored with increasing depth. Water passes slowly through the heavy subsoil.

These soils are likely to erode if cultivated. Runoff is rapid in cultivated areas unless the slopes have been contoured and terraced. Deep side gullies from adjacent drainageways have cut into areas of these soils. These gullies are difficult to control after they have started. Special measures are needed, such as diverting water from the gullies by means of dikes or ditches.

These soils are used for general crops. They are low in productivity but can be improved by adding large amounts of barnyard manure and by returning all crop residues to the land. Generally they occur in acreages too small to be managed separately from the surrounding soils.

Ladoga silt loam, 4 to 10 percent slopes (LoB) (capability unit IIIe-2).—This soil has 4 to 8 inches of dark grayish-brown surface soil. The subsoil is yellowish-brown silty clay or clay loam. This soil is acid and requires lime if legumes are grown. It is gently sloping and can be farmed on the contour. Cultivated areas need terraces and good waterways to control erosion if row crops are grown.

Ladoga silt loam, 10 to 18 percent slopes (LoC) (capability unit IVe-2).—This soil has a thinner surface soil than Ladoga silt loam, 4 to 10 percent slopes. It absorbs water well if the content of organic matter is maintained; nevertheless, it is likely to erode if used for row crops.

This soil is acid. It is generally low in phosphorus and nitrogen. It will produce good yields of legumes and grasses if it is limed and fertilized according to the needs indicated by soil tests. Under good management, this soil will produce almost as good yields as the adjoining Marshall and Monona soils. If you grow row crops more than 1 year out of 5, it will be difficult to control erosion or maintain crop yields.

Marshall series

The soils of the Marshall series occur throughout the northeastern part of the county, in association with the Shelby and Morrill soils. The Marshall soils have formed from loess. They have deep, silty surface soils and granu-

lar, friable subsoils. The native vegetation consisted of prairie grasses.

The surface layer of dark grayish-brown, friable silt loam or silty clay loam is 10 to 14 inches thick. The uppermost 14 to 36 inches of subsoil is very dark brown silty clay loam. This layer is heavier than the surface soil and less permeable. It has a weak irregular blocky structure that breaks to moderate coarse granules. It is moderately permeable. The lower part of the subsoil, beginning at depths of 26 to 38 inches, is strong medium blocky, friable silty clay loam or silty clay.

The surface soil and subsoil are slightly acid to medium acid. Lime is needed, and phosphorus will be of some benefit to legume-grass seedings. Soil tests will show how much lime and fertilizer are needed.

Corn and grain can be grown on this soil without being rotated with alfalfa or other standover legume, provided that large amounts of fertilizers or manure are used and large quantities of crop residues are returned to the soil.

Where the slope is more than 4 percent, terraces, grassed waterways, and contour farming are needed to control erosion and prevent loss of plant nutrients. The surface soil is generally thinner than on the less strongly sloping areas, and the subsoil is more permeable. Almost all of these areas that have been cultivated are moderately eroded; they have lost from 4 to 6 inches of their original fertile topsoil.

In Brown County, Marshall soils are mapped only in undifferentiated groups with the Sharpsburg soils.

Marshall and Sharpsburg soils, 0 to 2 percent slopes (MoA) (capability unit I-1).—These soils have a very dark grayish-brown silt loam surface soil, 12 to 14 inches thick. The subsoil is very dark brown, friable, granular silty clay loam that becomes lighter colored with increased depth. The underlying parent material is yellowish-brown silty clay loam.

These soils are well suited to all crops commonly grown in the county. They respond to good management and are easily worked. Ordinary good farming practices will keep them in good physical condition.

Marshall and Sharpsburg soils, 2 to 4 percent slopes (MoB) (capability unit IIe-1).—In most cultivated fields, these soils have a little lighter colored surface soil than Marshall and Sharpsburg soils, 0 to 2 percent slopes. Some areas have a thinner surface soil. Contour farming and grassed waterways will help to control erosion caused by runoff. Leaving crop residues in the fields will supply organic matter and help to maintain fertility. If planted to alfalfa, these soils need lime and fertilizer. Soil tests will show how much to apply.

Marshall and Sharpsburg soils, 4 to 10 percent slopes (MoBB) (capability unit IIIe-1).—These soils occupy large areas in the eastern part of the county. Their rolling slopes are subject to severe sheet and gully erosion unless protected by good conservation measures. Small gullies occur in most cultivated fields that have not been terraced.

The surface soil, in most cultivated fields, is very dark grayish-brown silt loam, 6 to 8 inches thick. The subsoil, to a depth of 20 to 25 inches, is very dark brown, moderate coarse granular silt loam. The lower part of the subsoil is blocky, friable silty clay loam. The subsoil is more open and friable than that of the less strongly sloping Marshall and Sharpsburg soils. When these soils have



Figure 14.—Landscape in a Monona-Ladoga area.

a good supply of organic matter and are well managed, they take in water well.

Marshall and Sharpsburg soils, 10 to 18 percent slopes (McC) (capability unit IVe-1).—These soils have a surface layer of dark brown to very dark brown, friable silt loam, 4 to 6 inches thick. The subsoil is dark-brown to dark yellowish-brown silty clay loam. If farmed to row crops, these soils need careful management to control erosion. Deep gullies have formed in some areas. Mechanical means of conservation are expensive. Keeping a cover of perennial grasses and legumes on the soil and growing crops that produce lots of residue will help to prevent loss of soil.

Monona series

The soils of the Monona series have formed from thick deposits of wind-deposited material (loess). They occur in the extreme northeastern part of the county, which is an area of long, steep slopes, narrow divides, and ridge caps (fig. 14).

The surface soil of the Monona soils in Brown County is 3 to 7 inches of grayish-brown, weak granular, friable silt loam. The subsoil is grayish-brown or yellowish-brown, weak granular to coarse blocky, friable silt loam or silty clay loam. The underlying material is dark yellowish-brown, massive, friable silt loam with some mottling at depths of 4 to 6 feet. The native vegetation consisted of prairie grasses and, near the small drainageways, a few trees.

The surface soil is medium acid to strongly acid, and the subsoil and substratum are medium acid to neutral. Cultivated areas generally contain little organic matter or nitrogen. Lime is beneficial to legumes. If well managed, these soils will take in and store large quantities of moisture for plants.

Since the slopes are steep and the soils are erosive, the major problems are to control side-cutting of streambanks and gullying of hillsides.

Monona silt loam, 4 to 10 percent slopes (MbB) (capability unit IIIe-1).—This soil occupies rounded ridge caps and gentle slopes in the extreme northeastern part of the county. It has 6 to 7 inches of grayish-brown, weak granular, friable silt loam topsoil. The subsoil, to a depth of 20 to 26 inches, is granular, grayish-brown to yellowish-brown, friable silt loam or silty clay loam. The underlying parent material is yellowish-brown, friable silt loam.

This soil is well suited to corn, small grains, alfalfa, and red clover. Because of the slope and the lack of organic matter, it is subject to severe sheet erosion if it is cultivated without regard to the direction of the slope.

Monona silt loam, 10 to 18 percent slopes (MbC) (capability unit IVe-1).—This soil occupies the more rolling and steep areas adjacent to Monona silt loam, 4 to 10 percent slopes. The surface soil in cultivated fields is only 3 or 4 inches thick. Some deep gullies have formed.

This is a soil that responds to good management. If supplied with nitrogen, phosphorus, and lime, it will produce high yields of all crops. If crop residues are kept on the surface and erosion is controlled, row crops can be grown 1 or 2 years between seedings of perennial grasses and legumes. This soil is also suitable for small fruits and apples.

Monona silt loam, 18 to 30 percent slopes (MbD) (capability unit VIe-1).—In most cultivated fields this soil has lost nearly all of its original surface soil. Deep gullies have formed in these areas. They are very difficult to control.

This soil is best used for perennial grasses and legumes. A good cover of residues and growing crops will protect the soil from erosion and prevent more gullies from forming. Apple trees do well on this soil. Plant trees on the contour or on terrace ridges. Close-growing perennial grasses and legumes that form a sod will help control soil and water losses on these areas.

Morrill series

The soils of the Morrill series have formed from highly leached Kansan glacial till (fig. 15). They occur throughout the county on slopes below the Marshall and Sharpsburg soils. The major areas are near Morrill, which is in the northwestern part of the county, and near the town of Robinson, which is in the eastern part.

The surface soil is dark-brown, weak granular, friable loam, 5 to 10 inches thick. The subsoil, to a depth of 15 to 20 inches, has a weak subangular blocky structure that breaks into weak granules. It is dark-brown, friable clay loam. The lower part of the subsoil and the underlying material, from 30 to 38 inches, are reddish-brown to yellowish-red, weak blocky to granular, friable sandy clay to sandy clay loam and contain many pebbles and small stones. Small stones are scattered over the surface in a few places. On the eroded slopes of 4 to 10 percent, the surface soil, in many areas, has a reddish-brown cast, principally because sheet erosion has removed the surface soil. In some areas gullies are common.

The surface soil is medium acid to strongly acid, and the subsoil and substratum are medium acid.

These soils respond to good management. They take in and store large amounts of water for crops. Although they have not been productive in the past, they will produce good yields if large amounts of organic matter are added and plenty of fertilizer is used. These soils are low in nitrogen and phosphorus, which have been lost from the soil through weathering and leaching. Lime is needed to correct acidity. Soil tests will show how much lime, phosphate, and nitrogen are needed.

Erosion can be controlled by contour cultivation and graded terraces. Eroded soil can be built up by adding organic matter. Severely eroded areas need to be kept in permanent vegetation to prevent serious gully erosion. Applications of lime, fertilizer, and manure will help to establish grasses and legumes on these areas.

Morrill loam, 4 to 10 percent slopes (McB) (capability unit IIIe-2).—This soil has a 6- to 10-inch surface layer of dark-brown, friable loam. The subsoil is friable, dark-brown clay loam. Under proper care and management this soil will produce good yields of all suitable crops. Lime is necessary for the best growth of legumes. Corn and small grains respond well to heavy applications of nitrogen.

Morrill loam, 4 to 10 percent slopes, eroded (McB3) (capability unit IVe-2).—There are many gullies in this soil, and the surface soil in cultivated fields is less than 4 inches thick. Lime, nitrogen, and phosphate are needed for legumes and grasses. This soil is not suited to row crops.

Morrill loam, 10 to 18 percent slopes (McC) (capability unit IVe-2).—This soil has 6 to 8 inches of loamy, fertile surface soil. Because of the steep slopes and excessive runoff, this soil is best suited to close-growing crops, such as wheat, clover, grasses, and legumes. Lime and fertilizer applied according to needs shown by soil tests and field trials will improve yields of legumes and grasses.

Morrill loam, 10 to 18 percent slopes, eroded (McC3) (capability unit VIe-1).—This soil has lost most of its original surface soil and has deep gullies. It will erode further unless protected by a cover of perennial vegetation. It is best suited to perennial grasses and legumes, such as brome grass and alfalfa, for hay or pasture.

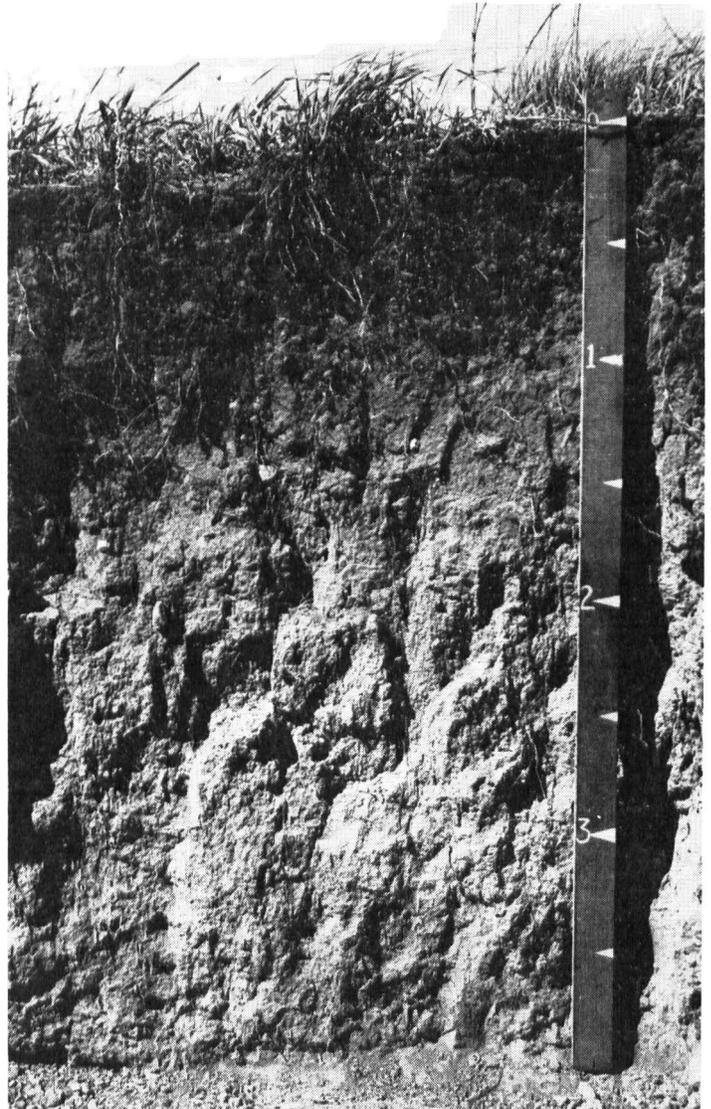


Figure 15.—Profile of Morrill loam, to a depth of 48 inches.

Muir series

The soils of the Muir series occur on high terraces, commonly called benches, adjacent to the stream bottoms. These soils have developed from silt washed from uplands and old stream bottoms. All areas have medium to good surface drainage and internal drainage, and none of them is subject to flooding or erosion.

The surface soil is mellow, fine granular silt loam, 14 to 16 inches thick, that contains an abundance of organic material. It is dark grayish-brown when dry and almost black when wet. The subsoil of brown or dark-brown, coarse granular silty clay loam is slightly heavier than the layer above but is friable throughout. Below a depth of 30 inches, the subsoil and the underlying material are light-brown or light yellowish-brown silt loam. At a depth of about 4 feet, light grayish-brown or brownish-gray friable silt occurs.

The surface soil is medium acid to slightly acid, and the underlying material is slightly acid to neutral. These

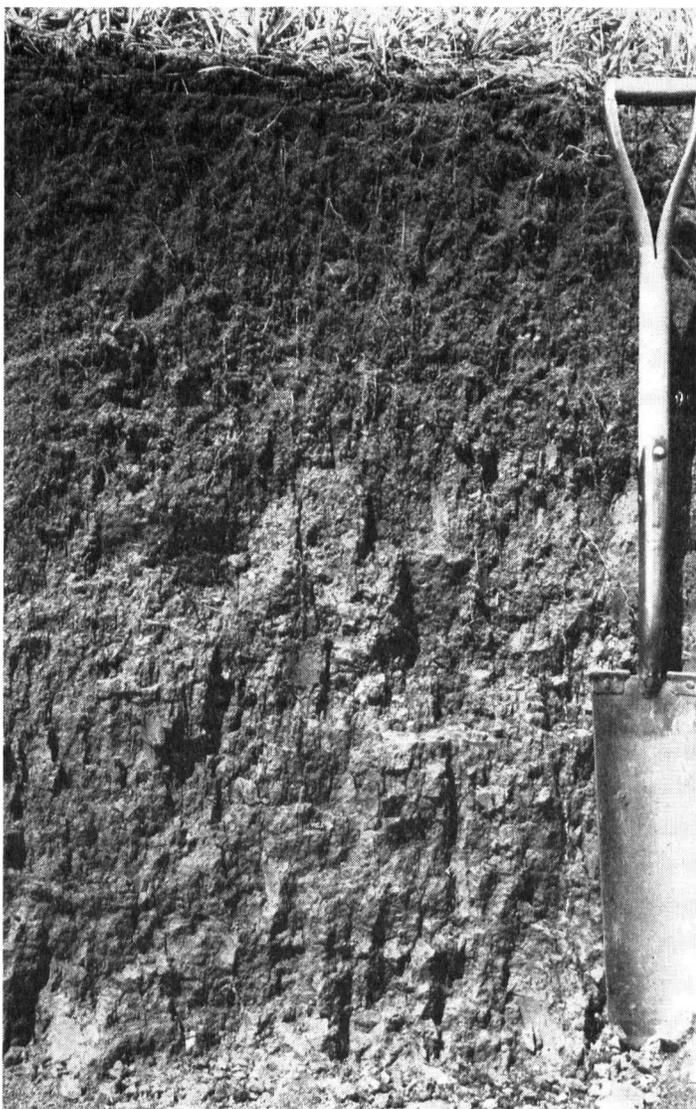


Figure 16.—Sharpsburg silty clay loam, to a depth of 50 inches.

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

Muir silt loam (Md) (capability unit I-1).—This is the only Muir soil mapped in the county. It is a very good soil for general farming. It is easily managed and has no problem of erosion.

Almost all of this soil is cultivated. Corn is the principal crop. Next in acreage are wheat, oats, and alfalfa. Lime, applied according to needs shown by soil tests, will improve yields.

Pawnee series

The soils of the Pawnee series occur in the southern and western parts of the county. They are associated with the Grundy soils, which lie above them on the slopes. The Pawnee soils developed on gently sloping glacial uplands and have a dense clay or claypan subsoil. Surface drainage is good.

The surface soil in uneroded areas is very dark brown or almost black, friable, granular, acid silty clay loam

and is about 8 to 12 inches thick. In places, the lower part of the surface soil consists of 2 or 3 inches of leached silty clay loam that is lighter colored or gray. In Brown County, most cultivated areas of this soil are eroded and have only 4 to 7 inches of surface soil.

The upper part of the subsoil consists of brown or grayish-brown, dense, massive clay that contains enough sand to give it a gritty feel. It is hard when dry and plastic when wet. The boundary between the friable surface soil and the dense subsoil is abrupt. The lower part of the subsoil is light-brown or yellowish-brown, moderately compact, gritty clay loam or clay that contains a few small pebbles and a little sand. At a depth of 4 to 5 feet, this layer rests on glacial drift similar to that beneath the Morrill soils.

These soils are not productive, chiefly because of their thin surface soil and dense claypan subsoil. Lime and high-analysis fertilizer would be beneficial. Deep-rooted legumes would help to open up the subsoil. Adding large amounts of organic matter will increase the rate of infiltration and keep the surface soil from drying and crusting.

Pawnee clay loam, 2 to 7 percent slopes, eroded (PaB3) (capability unit IIIe-4).—This soil normally has 4 to 7 inches of clay loam surface soil. The subsoil is compact clay that is hard when dry. Some gullies occur in most cultivated fields. This soil is not well suited to corn because of its dense claypan subsoil. It is best suited to wheat, clover, oats, and grain sorghums. Terrace cropland and farm it on the contour. Fertility is low, and the soil is acid unless it has been limed.

Pawnee clay loam, 2 to 7 percent slopes, severely eroded (PaB4) (capability unit VIe-1).—Some deep gullies have formed in this soil where it has been cultivated, and it has lost most or all of its surface soil. The clay subsoil is now at the surface. This soil will produce a fair amount of grass and legumes if fertilized according to needs shown by soil tests. Small grains may be grown between seedings to perennial vegetation, but, if more productive soils are available, it is better to use this soil for grass and legumes than for grain.

Sharpsburg series

The soils of the Sharpsburg series are much like those of the Marshall series, but they are less friable and the subsoil contains more clay. In Brown County, Sharpsburg soils (fig. 16) are mapped only in undifferentiated groups with Marshall soils. The mapping units are described under the Marshall series.

Shelby series

The soils of the Shelby series are associated with Marshall and Sharpsburg soils in the eastern part of the county and with Grundy soils in the southern and western parts. They lie on slopes below the associated soils. The Shelby soils have formed from glacial till (fig. 17). In some places a thin layer of loess lies on the glacial till, which is a mixture of clay, silt, sand, and gravel. The original vegetation consisted of prairie grasses.

These soils are noncalcareous to depths of 36 inches or more. The surface soil is acid, and the subsoil is slightly acid. The underlying glacial till normally is neutral to slightly calcareous at depths of more than 36 inches.

The surface soil, to a depth of 7 to 9 inches, is very dark gray, friable clay loam. This is underlain by dark grayish-brown to very dark grayish-brown, weak irregular blocky, moderately friable clay loam or silty clay loam.

The subsoil, beginning at a depth of 16 to 18 inches, is yellowish-brown to dark yellowish-brown silty clay mottled with pale olive, brown, brownish yellow, and reddish brown. It contains some pebbles and fine sand. It has a strong medium subangular blocky structure and is normally firm when dry and plastic when moist. A layer of yellowish-brown to dark yellowish-brown, friable silty clay begins at a depth of 24 inches. This material has a moderate medium subangular blocky structure and is hard when dry and plastic when wet. It extends to a depth of 30 inches. It is underlain by yellowish-brown to dark yellowish-brown, coarse granular, friable gritty clay. This layer generally contains some pebbles and coarse sand. It has grayish-brown and pale-olive mottles and concretions of iron and manganese. Some glacial boulders and pebbles generally occur in the lower part of the subsoil.

The leached, weathered glacial till of clay loam is normally reached at depths of 40 to 60 inches. It is mottled with brownish yellow and black.

Two types of Shelby soils are mapped in Brown County: Shelby clay loam and Shelby gravelly loam. The main difference between the two types is that the gravelly loam contains a larger quantity of small, waterworn pebbles and has a thinner surface soil. It has some glacial boulders, and all horizons contain some sand and gravel. Many gravel pits are located on Shelby gravelly loam. On steep slopes, the surface soil is normally only 4 to 6 inches thick.

Because the Shelby soils in this county are moderately or steeply sloping, runoff is rapid. Soils under cultivation need protection from erosion. Suitable methods for control of erosion include growing meadow crops frequently, contouring and terracing, or keeping the land in close-growing legumes and grasses. Permanent vegetation will prevent serious gully erosion in severely eroded areas. Applications of lime, fertilizer, and manure will help to establish grass.

Shelby clay loam, 4 to 10 percent slopes (S_aB) (capability unit IIIe-2).—This soil has 7 to 9 inches of dark-brown, friable clay loam surface soil. The upper part of the subsoil is dark grayish-brown, moderately friable clay loam or silty clay loam. This is underlain at a depth of 16 to 18 inches by yellowish-brown silty clay. Some fine sand and pebbles are normally found throughout the profile. In many places this soil is mantled with 10 to 14 inches of loess that has a silt loam or silty clay loam texture. This soil is suited to all crops commonly grown in Brown County.

Shelby clay loam, 4 to 10 percent slopes, eroded (S_aB3) (capability unit IVe-2).—The surface layer of this soil is only 4 to 5 inches thick or less. In most fields some of the former subsoil is being mixed with the surface soil by plowing. Small gullies have formed. This soil is best suited to small grains and legume-grass crops.

Shelby clay loam, 10 to 18 percent slopes (S_aC) (capability unit IVe-2).—This soil generally has more small glacial boulders scattered in or on it than the Shelby clay loams on slopes of 4 to 10 percent. Some small gullies have formed in cultivated fields.

This soil is acid. It is low in nitrogen and phosphorus and generally lacks organic matter. It needs lime if



Figure 17.—Shelby clay loam, to a depth of 50 inches.

grasses and legumes are grown. A good supply of crop residues will help to control erosion and to open the surface so water can get through. Wheat or oats can be grown between seedings of perennial grasses and legumes.

Shelby clay loam, 10 to 18 percent slopes, eroded (S_aC3) (capability unit VIe-1).—This soil was originally like Shelby clay loam, 10 to 18 percent slopes, but it now has some large deep gullies and little or none of the original surface soil. It is best to keep it in perennial grasses and legumes. Additions of lime and fertilizer will insure a more vigorous growth of grasses and legumes. Soil tests and field trials will show how much is needed.

Shelby gravelly loam, 10 to 18 percent slopes (S_bC) (capability unit VIe-1).—This soil has a 4- to 6-inch surface layer of gravelly loam. Various amounts of sand and gravel occur in the subsoil. Many areas are underlain with 5- to 7-foot beds of sand and gravel, which make good road-surfacing material. This soil is best used for perennial grasses and legumes and improved pastures.

Shelby gravelly loam, 18 to 30 percent slopes (S_bD) (capability unit VIIe-1).—This soil has a very weakly

developed subsoil. The underlying beds of glacial sand, gravel, and clay are at depths of 2 to 4 feet. Some large glacial boulders are scattered over the surface. This soil is best used for well-managed tame pasture.

Sogn series

Soils of the Sogn series occur throughout the county, principally on north-facing slopes adjacent to drainage-ways. These soils have developed from limestone and calcareous shale. Most of them have slopes of 18 to 30 percent. Runoff is excessive where the grass is thin. Most overgrazed areas are excessively eroded. The soil material is neutral to calcareous from the surface downward.

The surface soil varies from dark grayish-brown to light yellow, depending on the content of organic matter and the extent of erosion. Normally it is dark grayish-brown, friable silt loam about 6 inches deep. It contains fragments of partially weathered limestone and shale. In some places this layer rests directly on limestone bedrock.

The subsoil is yellowish-brown silty clay loam and is generally not more than 8 inches thick.

The depth of the soil depends somewhat on how much the limestone has resisted weathering, but mostly it depends on how much erosion has taken place. The underlying layers of limestone and shale are broken and shattered, and roots penetrate deep into the substratum.

Because of their stony character and unfavorable relief, these soils are unsuitable for cultivation.

Sogn soils (Sc) (capability unit VIIe-1).—All of the Sogn soils in the county are included in this undifferentiated unit. These soils have all the essential plant nutrients, but they are difficult to manage and are not productive during extended periods of dry weather. They are used almost exclusively for pasture, some of which is brushy. They require a permanent vegetative cover. They need to be protected from overgrazing because destruction of the grasses permits serious water erosion. Overgrazing also decreases production and causes the better grasses to disappear. Pastures on these soils are excellent in seasons of normal or high rainfall. Some trees, mostly hickory, oak, and elm, grow on the north-facing slopes.

Steinauer series

Soils of the Steinauer series occur mainly in the southwestern part of the county, with the less steeply sloping Burchard soils. The slopes range from 10 to 30 percent but are dominantly about 15 percent. These soils are the most weakly developed of any on the glacial uplands. The parent material is limy glacial till.

The surface layer varies considerably in color, texture, and depth. Typically it is dark-brown or dark grayish-brown clay loam about 6 inches thick. The subsoil is a transitional layer of light-brown or yellowish-brown clay loam, about 4 inches thick, between the surface soil and the parent glacial material. It is friable throughout. It takes in and stores large amounts of water for plants.

Normally these soils have many stones and boulders throughout; many large boulders are scattered over the surface.

Steinauer clay loam (Sd) (capability unit VIe-1).—This is the only Steinauer soil mapped in the county. In

many places it has no subsoil, and the surface soil rests directly on the slightly altered glacial material, which consists of a mixture of brownish-gray clay loam and sandy clay. The subsoil or the underlying glacial material contains many pockets of calcareous material. Runoff is rapid; and many gullies have formed that cannot be crossed with farm machinery.

This soil is unsuited to cultivation because of the steep slopes and large boulders. Under proper management it is good for grasses. Pastures should not be overgrazed, because the shallow surface soil soon erodes if the grass is destroyed.

Summit series

Soils of the Summit series occur mostly in the western part of the county with the Sogn soils. The surface soil is black or dark-brown, crumbly, friable clay loam about 10 inches deep. The subsoil is brown or dark reddish-brown; crumbly, permeable silty clay or clay that becomes more friable as depth increases. Below depths of 36 to 38 inches, it grades into yellowish-brown, friable silty clay loam. The surface soil and upper subsoil are about neutral, and the lower subsoil and underlying material are calcareous.

These soils are generally well supplied with organic matter and plant nutrients. If runoff is not controlled, water is lost from sloping cultivated fields during heavy rains. Erosion is a serious hazard in areas that lie down-slope from the steeper Sogn soils.

The Summit soils are suitable for all crops commonly grown in the county. They respond to good management. Legumes grow especially well because underground moisture that comes from higher, steeper slopes is usually near the surface. These soils have plenty of lime for legumes.

Summit clay loam, 4 to 10 percent slopes (SeB) (capability unit IIIe-3).—This soil has 8 to 10 inches of black clay loam surface soil. It has a moderately permeable, crumbly silty clay subsoil. If it is well supplied with organic matter, this soil will take water well and store it for plant use. Nitrogen and phosphorus are the plant nutrients most needed. If they are generously applied, this soil produces good corn. It is suitable for all crops grown in the county. Diversion terraces on the steeper slopes above these areas will prevent gullying.

Summit clay loam, 10 to 18 percent slopes (SeC) (capability unit IVe-3).—This soil is like Summit clay loam, 4 to 10 percent slopes, except that its surface soil in cultivated fields is only 4 to 6 inches thick and its subsoil is brighter yellowish brown in color. This soil can best be used for small grains and perennial grasses and legumes. Since it is not acid, it is well suited to alfalfa.

Summit and Labette series, moderately shallow

These soils occur mainly in the northwestern part of the county. They overlie the limestone on top of the ridges adjacent to the Sogn soils. Some areas occur below the sloping limestone ridges. These soils are neutral to slightly acid.

The surface soil, to a depth of about 8 inches, is dark grayish-brown to light reddish-brown, porous clay loam or silty clay loam. The lower part of the surface soil is reddish brown to light grayish brown and normally contains scattered fragments of limestone or partly weathered shale. This layer is generally underlain by brown or gray-

ish-brown silty clay mottled somewhat with rust brown and gray. This material, in turn, grades to a more pronounced brownish-gray silty clay or clay at depths of 15 to 20 inches.

A few areas contain some small chert fragments, most of which are below a depth of 20 inches. Limestone and limy shale outcrop in many areas. In some places the limestone occurs as ledges or as loose stones scattered over the surface.

These soils are a little more difficult to manage than the Summit clay loams because they are shallower and, consequently, more droughty. If they are plowed when wet, extremely hard clods are likely to form. Legumes and small grains are the most suitable crops. Corn is sometimes damaged by short periods of dry weather in July and the early part of August. No lime is required for legumes. Bromegrass and alfalfa can be grown in a cropping system with small grains. Uncultivated areas are used for hay or pasture.

Summit and Labette soils, moderately shallow, 4 to 10 percent slopes (SgB) (capability unit IIIe-3).—These soils have a 6- to 8-inch surface layer of dark grayish-brown or light reddish-brown clay loam or silty clay loam. The subsoil, to a depth of 28 to 36 inches, is silty clay or silty clay loam. Broken limestone or shale normally occurs at depths of 24 to 36 inches. These soils are more droughty than the deeper soils. They produce good yields of wheat, oats, legumes, and grasses, but they are not well suited to corn because of their limited capacity to store moisture.

Summit and Labette soils, moderately shallow, 10 to 18 percent slopes (SgC) (capability unit IVe-3).—These soils have a thinner surface soil than Summit and Labette soils, moderately shallow, 4 to 10 percent slopes. They are subject to severe erosion unless properly managed. Building terraces may be difficult because of the stones and rock ledges that occur in many areas of these soils.

Summit and Labette soils, moderately shallow, 10 to 18 percent slopes, eroded (SgC3) (capability unit VIe-1).—These soils are gullied and have lost most of their surface soil. Stones are scattered over the surface. Perennial grasses and legumes are the most suitable crops. Most areas need nitrogen and phosphorus.

Wabash series

The Wabash soils have developed from fine-textured sediments washed from the uplands. They are generally located next to the Judson soils on bottom lands that are subject to damaging overflows. The largest areas of the Wabash soils lie along Walnut Creek, Plum Creek, and Wolf Creek.

The 4- to 6-inch surface soil is dark-gray to almost black friable silty clay that has a weak irregular blocky structure. Under the plow layer and extending to a depth of about 16 inches is a layer of dark grayish-brown to almost black, friable silty clay or silty clay loam that has a weak subangular blocky to moderate granular structure. The subsoil, to a depth of about 30 inches, is dark-brown silty clay or silty clay loam and has a moderate coarse granular to moderate prismatic structure. This material is underlain by dark grayish-brown, faintly mottled, friable silty clay that has a weak prismatic or moderate coarse granular structure. Most areas

of these soils are level and have slow or very slow surface drainage and internal drainage.

Wabash silty clay (Wc) (capability unit IIw-1).—This soil is well suited to all crops commonly grown in the county. Most of it is cultivated. If it is drained and protected from overflow, crops grow well. Surface ditches or bedding will help drain off excess water. Severe overflow damage has been almost eliminated by deepening and straightening stream channels.

This soil is neutral to only slightly acid. Lime may be needed for best growth of legumes. Phosphorus will increase yields of wheat and of legume-grass hay. A complete commercial fertilizer applied to corn will increase yields. Apply lime and fertilizer according to needs shown by soil tests and field trials.

Soils and Their Environment

This section deals with the formation and classification of the different soil series in the county. The factors that cause differences among the soils are briefly discussed. A profile of a representative soil of each series is described. Laboratory data on some profiles are given in table 4.

Genesis and Morphology of Soils

Soil is the product of the forces of weathering and soil development acting on the parent material deposited or accumulated by geologic agencies. The characteristics of the soil at any given point depend on (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and has existed since accumulation; (3) the plant and animal life in and on the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil development have acted on the soil material.

Climate and vegetation are the active factors in soil genesis. The effects of climate and vegetation are modified by relief, by the nature of the parent material, and by age. It is the interaction of these factors that determines the nature of the soil profile.

Parent material

The soils of Brown County developed from materials derived from four primary sources: (1) upper Pennsylvanian limestone and shale, (2) Kansan glacial till, (3) loess, and (4) recent alluvium. The kinds of materials from which the different soils of the county have formed are listed in table 3.

Upper Pennsylvanian limestone and shale.—This is the bedrock. It outcrops along steep, north-facing slopes adjacent to drainageways. It consists of thin limestones and thick shales, ranging from the Beattie limestone, which occurs in the northwestern corner of the county, to the Burlingame limestone, found along the eastern border. Residuum weathered from the bedrock was the parent material of the Dennis, Labette, Sogn, and Summit soils.

Some of the shale is sufficiently sandy to be a source of ground water. Most of the limestone will produce meager supplies of water but seldom more than enough for domestic use and for livestock.

TABLE 3.—Parent material, dominant slope range, and native vegetation

Soil series	Parent material	Dominant slope range	Native vegetation
		<i>Percent</i>	
Alluvial land	Alluvium	0 to 10	Grass, trees.
Burchard	Glacial till	4 to 18	Grass.
Dennis	Sandstone and shale	4 to 10	Grass.
Edina	Loess	0 to 1	Grass.
Gara	Glacial till	10 to 30	Trees, grass.
Grundy	Loess	0 to 7	Grass.
Judson	Alluvium and colluvium	0 to 10	Grass.
Labette	Limestone and shale	4 to 18	Grass.
Ladoga	Loess	4 to 18	Trees, grass.
Marshall	Loess	4 to 10	Grass.
Monona	Loess	4 to 30	Grass.
Morrill	Glacial till	4 to 18	Grass.
Muir	Alluvium	0 to 1	Grass, trees.
Pawnee	Glacial till	2 to 7	Grass.
Shelby	Glacial till	4 to 18	Grass.
Sogn	Limestone and shale	18 to 30	Grass, trees.
Steinauer	Glacial till	4 to 18	Grass.
Summit	Limestone and calcareous shale.	4 to 18	Grass.
Sharpsburg	Loess	2 to 7	Grass.
Wabash	Alluvium	0 to 1	Grass.

Kansan glacial till.—The till deposited over the bedrock by the Kansan glacier contained silt, clay, sand, and gravel. It is the parent material of the Burchard, Gara, Morrill, Pawnee, Shelby, and Steinauer soils. These soils vary widely in character and productivity. Their fertility ranges from high to low. Some contain much organic matter; others, little. The Morrill and Shelby soils are well aerated and well drained. The Pawnee soils have very slowly permeable subsoils.

Loess.—Long after the Kansan till was deposited, layers of loess (windblown silt) were deposited over it. Apparently, much of the loess was blown from the valley of the Missouri River. Hanna and Bidwell¹ studied the loess deposits in an area that extends from a point in the northeastern corner of Brown County, near the Missouri River, to a point in the southwestern part of the county, 24 miles from the river. Sampling the soil at approximately 2½-mile intervals, they found that the thickness of the loess deposit decreased from approximately 100 feet at the river bluffs to 6 feet at the last sampling site. The texture became finer as distance from the river increased, up to 16 miles from the bluffs. Beyond that point, there was little, if any, decrease in particle size. Unlike the till, the windblown loess contains no grit or pebbles.

The Edina, Grundy, Ladoga, Marshall, Monona, and Sharpsburg soils formed from loess. These soils vary widely in character and productivity. Some contain much organic matter; others, little. Fertility ranges from high to low. The Marshall, Monona, and Sharpsburg soils are naturally well aerated and well drained; the Grundy and Edina have very slowly permeable subsoils. The Marshall

¹ HANNA, ROBERT M. and BIDWELL, O. W. THE RELATION OF CERTAIN LOESSIAL SOILS OF NORTHEASTERN KANSAS TO THE TEXTURE OF THE UNDERLYING LOESS. Soil Sci. Soc. Amer. Proc. 19: 354-359. 1954.

and Monona soils, which formed from deep loess, are among the best upland soils in the northeastern part of Kansas. The Grundy and Sharpsburg are almost as good.

Alluvium.—Alluvium recently deposited on the first bottoms of streams was the parent material of the Judson, Muir, and Wabash soils. It is also the material of which Alluvial land consists. The Judson soils formed from silty, friable material deposited by water that was moving fairly rapidly. Some colluvium was mixed with the alluvium. The Wabash soils formed from clayey alluvium deposited by less rapidly moving water.

Climate

Differences in climate are important over wide areas, from deserts to humid areas, but they have not been the cause of significant differences among the soils of Brown County. Climate is fairly uniform throughout the county. However, the heavy rainfall, which is concentrated during the growing season, has caused differences between the soils of this county and those of the western part of Kansas, where the climate is dry.

The effect of climate is modified by topography. How much of the rainfall soaks into the soil and how much runs off depends partly on the slope. The larger the amount of water that percolates through the soil, the more the soil is leached.

Vegetation

Most of the soils in Brown County developed under grass, principally big and little bluestem. Such soils—for example, the Grundy and Sharpsburg—are very dark brown to black because they have considerable organic matter in their surface layers. The soils that formed under a mixture of grass and trees—for example, the Gara and Ladoga soils—have accumulated less organic matter and generally have very light colored surface layers. The soils, such as the Wabash, that formed under a mixture of grass and marsh vegetation are black to a considerable depth. The native grasses have fibrous roots that penetrate to depths of 12 to 36 inches.

Topography

Differences in topography have had a major influence on the soils of Brown County. In level or nearly level areas, there has been little or no runoff; consequently, the supply of water for the native vegetation has been ample and the soils contain large quantities of organic matter. The Grundy, Judson, and Wabash soils are examples.

On slopes of 10 to 30 percent gradient, much of the rain that falls during intense storms runs off. Vegetation does not grow so well as on the more nearly level slopes; therefore, the soils accumulate less organic matter, and some of that that accumulates is washed away by runoff.

Time

Because the parent materials were deposited during different periods in geologic history, time has been an important factor in causing differences among the soils of Brown County. The oldest parent material was weathered from Pennsylvanian rocks; Kansan till and loess were laid down later; and the youngest parent material is recent alluvium.

The Judson soils, formed from recent alluvium, have only slight horizon differentiation. The Pawnee soils,

which developed from Kansan till exposed early in the Wisconsin age, have well differentiated horizons and are deeply leached. The Burchard and Steinauer soils, formed from Kansan till that was exposed at a later time, are less deeply leached and still contain carbonates. The Morrill soils have a degree of horizon differentiation that is normal for soils of the pre-loess landscape. The Gara soils, although they also developed from Kansan till, have less well differentiated horizons than other soils on Kansan till, because they are on steep slopes. Their age is difficult to estimate because normal erosion keeps unweathered till within reach of the soil-forming processes.

Classification of Soils

The soil series of Brown County are classified according to great soil groups as follows:

The soils of the Burchard, Dennis, Grundy, Labette, Marshall, Monona, Morrill, Muir, Sharpsburg, Shelby, and Summit series are *Brunizems*.

The soils of the Gara and Ladoga series are *Gray-Brown Podzolic soils*.

The soils of the Edina and Pawnee series are *Planosols*.

The soils of the Steinauer series are *Regosols*.

The soils of the Sogn series are *Lithosols*.

The soils of the Wabash series are *Humic Gley soils*.

The soils of the Judson series are *Brunizems* intergrading to *Alluvial soils*.

Profile Descriptions

The following pages contain detailed descriptions of profiles that are representative of the different soil series in Brown County. The Munsell color notations refer to the color of moist soils, unless otherwise stated. The exact location is given for each profile described.

Burchard clay loam.—The following profile was observed 200 feet east of the southwest corner of sec. 29, T. 4 S., R. 15 E.

- A₁ 0 to 6 inches, very dark grayish-brown (10YR 3/2) light clay loam; medium granular structure, partly destroyed by tillage; friable; gradual boundary.
- A₃ 6 to 12 inches, very dark grayish-brown (10YR 3/2) clay loam; moderate medium and coarse granular structure; friable; gradual boundary.
- B₂₁ 12 to 22 inches, dark-brown (10YR 4/3) heavy clay loam; moderate medium subangular blocky structure; firm; gradual boundary.
- B₂₂ 22 to 25 inches, dark-brown (10YR 4/3) heavy clay loam; scattered lime concretions; moderate medium subangular blocky structure; gradual boundary.
- B₃ 25 to 39 inches, dark yellowish-brown (10YR 4/4) clay loam; numerous large, soft concretions of lime; weak coarse subangular blocky structure; firm; strongly calcareous; gradual boundary.
- 39 to 45 inches, coarsely variegated brown (10YR 5/3) and brownish-yellow (10YR 5/6) clay loam; weak coarse blocky structure; numerous large, soft lime concretions and some black ferruginous concretions; firm; calcareous.
- C 45 inches +, light yellowish-brown (2.5Y 6/3) clay loam with spots and streaks of white and rust color; firm; structureless (massive).

Dennis loam.—The following profile was observed 200 feet east and 400 feet north of the south quarter corner of sec. 32, T. 4 S., R. 17 E.

- A_{1p} 0 to 4 inches, dark grayish-brown (10YR 4/2) loam; weak fine granular structure; friable; medium acid; abrupt boundary (plow-slice contact).

- A₁₂ 4 to 7 inches, very dark grayish-brown (10YR 3/2 moist; 5/2 dry) loam; weak to moderate medium granular structure; medium acid; gradual boundary.
- A₃ 7 to 10 inches, brown (10YR 4/3) light clay loam; moderate coarse granular structure; friable; clear boundary.
- B₂₁ 10 to 18 inches, brown (10YR 4/3) clay loam; peds coated with continuous clay films; strong coarse granular structure; friable; gradual boundary.
- B₂₂ 18 to 36 inches, yellowish-brown (10YR 4/4) heavy clay loam mottled with reddish brown; strong medium blocky structure; clay films; noncalcareous; indistinct boundary.
- B₃ 36 to 52 inches, brown clay loam containing fragments of partially weathered sandstone and shale; moderate coarse blocky structure; firm; noncalcareous; gradual boundary.
- C 52 to 56 inches, grayish shaly clay, with obscure bedding planes that become more distinct with depth; grades to massive silty to sandy shale; noncalcareous.

Edina silt loam.—The following profile was observed in a nearly level cultivated area, 1,320 feet south of the northeast corner of sec. 3, T. 3 S., R. 15 E.

- A_{1p} 0 to 8 inches, black (10YR 2/1) silt loam; weak granular structure; friable; gradual boundary.
- A₁₂ 8 to 14 inches, very dark gray (10YR 3/1) silt loam; weak to moderate coarse granular structure; friable; clear boundary.
- A₂ 14 to 17 inches, gray (10YR 6/1) silt loam; weak fine granular and weak platy structure; friable; smooth, abrupt boundary.
- B₂₁ 17 to 28 inches, very dark brown (10YR 2/2) clay containing tiny iron-manganese shot; weak blocky structure; very firm; smooth, clear boundary.
- B₂₂ 28 to 34 inches, mottled dark grayish-brown (2.5Y 4/2) and yellowish-brown (10YR 5/4) clay containing iron-manganese concretions and tiny, hard, lime concretions; moderate coarse irregular blocky structure; very firm; indistinct boundary.
- B₃ 34 to 40 inches, mottled olive-brown and brown silty clay containing many medium-sized shot and some small lime concretions; weak blocky structure; firm; gradual boundary.
- C 40 to 54 inches, light grayish-brown (2.5Y 6/2) silty clay mottled with brown (7.5YR 5/3) and containing numerous small, hard, lime concretions; structureless (massive); friable.

Gara loam.—The following profile was observed 300 feet north of the west quarter corner of sec. 14, T. 3 S., R. 17 E.

- A₁ 0 to 4 inches, grayish-brown (10YR 4/2) loam; moderate fine granular structure; friable; medium acid; clear boundary.
- A₂ 4 to 6 inches, grayish-brown (10YR 5/2, moist) loam; weak granular structure; friable; medium acid; clear boundary.
- B₁ 6 to 10 inches, dark-brown (10YR 4/3) clay loam containing some sand and gravel; moderate coarse granular structure; friable; strongly acid; gradual boundary.
- B₂₁ 10 to 15 inches, dark-brown (10YR 4/3) heavy clay loam; strong subangular blocky structure; firm; medium acid; gradual boundary.
- B₂₂ 15 to 36 inches, brown (10YR 5/3) heavy clay loam; moderate coarse subangular blocky structure; firm; medium acid; gradual boundary.
- B₃ 36 to 50 inches, brown (10YR 5/3) clay loam containing many pebbles and small stones from weathered Kansan till; weak coarse blocky structure; firm when moist; noncalcareous.

Grundy silty clay loam.—The following profile was observed 200 feet west of the southeast corner of sec. 25, T. 3 S., R. 16 E., in a cultivated area on a 1 percent slope.

- A_{1p} 0 to 8 inches, black (10YR 2/1) silty clay loam; weak granular structure; friable; acid; gradual boundary.

- AB 8 to 15 inches, black (10YR 2/1) silty clay; coarse granular structure; friable; acid; clear, smooth boundary.
- B₂₁ 15 to 20 inches, very dark grayish-brown (10YR 3/2, moist) silty clay; weak irregular blocky to strong granular structure; gradual boundary.
- B₂₂ 20 to 28 inches, very dark brown (10YR 2/2) clay; weak irregular blocky to moderate coarse granular structure; firm when moist, plastic and sticky when wet; gradual boundary, slightly acid.
- B₂₃ 28 to 54 inches, dark grayish-brown (10YR 4/2, moist) silty clay mottled with very dark gray (10YR 3/1) and yellowish brown (10YR 5/6); weak granular structure; gradual boundary.
- C 54 to 60 inches+, yellowish-brown (10YR 5/4) firm, mottled silty clay loam.

Judson silt loam.—The following profile was observed 1,400 feet south and 300 feet west of the northeast corner of sec. 26, T. 2 S., R. 17 E., in a cultivated field on a 3 percent slope.

- A₁ 0 to 40 inches, very dark brown (10YR 2/2, moist) silt loam; strong medium granular structure in upper 20 inches, grading to medium blocky in lower half; friable; worm casts moderately abundant; about neutral; indistinct boundary.
- AC 40 to 60 inches, very dark grayish-brown (10YR 3/2, moist) light silty clay loam slightly mottled with rusty colored streaks and spots; almost structureless; moderately permeable; noncalcareous; diffuse boundary.
- C 60 to 90 inches+, grayish-brown (10YR 5/2, moist) light silty clay loam mottled with strong brown and gray; noncalcareous.

Judson silt loam, flood plains.—The following profile was observed 200 feet north and 175 feet west of the center of sec. 6, T. 1 S., R. 18 E., in a nearly level cultivated field.

- A₁ 0 to 9 inches, very dark brown (10YR 2/2) heavy silt loam; weak granular structure in plow layer to 8 inches; moderate medium granular below; friable; permeable; about neutral; gradual boundary.
- A₁₂ 9 to 17 inches, very dark grayish-brown (10YR 3/2) silty clay loam; weak irregular blocky structure; friable; gradual boundary.
- A₁₃ 17 to 26 inches, dark-brown (10YR 3/3) light silty clay loam; moderate subangular blocky structure; friable; permeable; about neutral; gradual boundary.
- AC 26 to 60 inches, dark-brown (10YR 3/3) light silty clay loam; weak subangular blocky structure; friable; permeable; noncalcareous.

Labette silty clay loam.—The following profile was observed 600 feet south of the northeast corner of sec. 4, T. 1 S., R. 15 E., in a cultivated field on a 4 percent slope.

- A₁ 0 to 8 inches, dark-brown (7.5YR 3/2) silty clay loam; strong medium granular structure; friable; slightly acid; gradual boundary.
- B₁ 8 to 20 inches, dark-brown (7.5YR 3/2) heavy silty clay loam; strong medium granular structure; firm; slightly acid; diffuse boundary.
- B₂ 20 to 36 inches, reddish-brown (5YR 4/3) silty clay; strong subangular blocky structure; a few chert fragments and small limestone pebbles; about neutral; gradual boundary.
- B₃ 36 to 48 inches, reddish-brown (5YR 4/4) silty clay; strong medium blocky structure; many iron-manganese concretions; some chert fragments; gradual boundary.
- C 48 to 60 inches, brown shaly clay; firm; noncalcareous.
- D. 60 to 61 inches+, limestone bedrock.

Ladoga silt loam.—The following profile was observed 800 feet north of the west quarter corner of sec. 23, T. 1 S., R. 17 E., in a cultivated field on a 4 percent slope.

- A_{1p} 0 to 6 inches, dark grayish-brown (10YR 4/2) silt loam; weak granular structure; friable; medium acid; clear boundary.

- A₂ 6 to 8 inches, light brownish-gray (10YR 6/2) silt loam; moderate coarse granular structure; friable; medium acid; clear, smooth boundary.
- B₁ 8 to 11 inches, dark yellowish-brown (10YR 4/4) heavy silty clay loam mottled with grayish brown; moderate medium subangular blocky structure; medium acid; gradual boundary.
- B₂₁ 11 to 24 inches, dark yellowish-brown (10YR 4/4) light silty clay; moderate medium blocky structure; firm; medium acid; gradual boundary.
- B₂₂ 24 to 42 inches, brown (7.5YR 5/4) silty clay; moderate irregular blocky structure; noncalcareous; gradual boundary.
- C₁ 42 to 64 inches+, brown (7.5YR 5/4) silty clay loam (leached loess); porous-massive; friable; noncalcareous.

Marshall silt loam.—The following profile was observed 500 feet west of the southeast corner of sec. 26, T. 1 S., R. 18 E.

- A_p 0 to 6 inches, very dark grayish-brown (10YR 3/2) silt loam; weak granular structure; soft, friable; clear, smooth boundary.
- B₁ 6 to 13 inches, very dark brown (10YR 2/2) silt loam; moderate coarse granular structure; gradual boundary.
- B₂₁ 13 to 25 inches, very dark grayish-brown (10YR 3/2) silty clay loam; weak irregular blocky to moderate coarse granular structure; friable; gradual boundary.
- B₂₂ 25 to 41 inches, dark-brown (10YR 3/3) silty clay loam; coarse subangular blocky structure; friable; gradual boundary.
- B₃ 41 to 60 inches, dark yellowish-brown (10YR 4/4) light silty clay loam; weak subangular blocky structure; friable; clear, smooth boundary.
- C₁ 60 to 70 inches+, yellowish-brown (10YR 5/4), friable, noncalcareous silt loam (leached loess).

Monona silt loam.—The following profile was observed 300 feet west of the northeast corner of sec. 10, T. 1 S., R. 18 E.

- A_{1p} 0 to 6 inches, very dark grayish-brown (10YR 3/2) silt loam; weak granular structure; friable; medium acid.
- A₁₂ 6 to 11 inches, dark grayish-brown (10YR 3/2) silt loam; weak subangular blocky structure; friable; medium acid.
- AC 11 to 27 inches, dark-brown (10YR 3.5/3) silt loam; weak subangular blocky structure; friable; medium acid; gradual, smooth boundary.
- C 27 to 60 inches, yellowish-brown (10YR 5/4) silt loam (leached loess); structureless (massive); friable; noncalcareous.

Morrill loam.—The following profile was observed 200 feet east of the southwest corner of sec. 16, T. 3 S., R. 17 E.

- A_{1p} 0 to 5 inches, dark-brown (7.5YR 3/2) loam; weak granular structure; hard when dry, friable when moist; strongly acid; clear boundary.
- A₁ 5 to 10 inches, dark-brown (mottled 7.5YR 3/2 and 5YR 4/3) clay loam; weak subangular blocky to weak granular structure; friable; medium acid; abrupt, clear boundary.
- B₁ 10 to 15 inches, dark reddish-brown (5YR 3/4) gritty clay; medium blocky to weak granular structure; friable; medium acid; clear boundary.
- B₂ 15 to 24 inches, reddish-brown (5YR 4/4) clay; weak blocky structure; friable; medium acid; abrupt boundary.
- B₃ 24 to 38 inches, yellowish-red (5YR 4/6) sandy clay loam; weak subangular blocky structure; friable; many pebbles and small stones and some fine sand; clear boundary.
- C₁ 38 to 60 inches, yellowish-red (mottled 5YR 4/6, 10YR 6/4) sandy clay loam (leached glacial till); structureless (massive); friable.

Muir silt loam.—The following profile was observed 200 feet south and 125 feet west of the east quarter corner of sec. 15, T. 3 S., R. 15 E., in a level cultivated field.

- A₁ 0 to 14 inches, very dark grayish-brown (10YR 3/2, moist) heavy silt loam; granular structure; friable; slightly acid.
- B 14 to 34 inches, very dark brown (10YR 2/2, moist; 4/2, dry) light silty clay loam; strong coarse granular structure; friable; about neutral; very gradual boundary.
- C 34 to 48 inches+, dark yellowish-brown (10YR 4/4, moist; 3/4, dry) light silty clay loam; almost structureless; moderately permeable; friable; noncalcareous.

Pawnee clay loam.—The following profile was observed 300 feet north and 300 feet east of the west quarter corner of sec. 26, T. 3 S., R. 16 E., on a 4 percent slope.

- A₁ 0 to 10 inches, very dark brown (10YR 2/2) clay loam; moderate medium granular structure; friable; strongly acid; abrupt boundary.
- B₂₁ 10 to 13 inches, very dark grayish-brown (10YR 3/2) clay; moderate medium blocky structure; extremely firm; very hard; medium acid; gradual boundary.
- B₂₂ 13 to 28 inches, dark grayish-brown (10YR 4/2) clay; moderate blocky structure; extremely firm when moist; very slowly permeable; medium acid; gradual boundary.
- B₂₃ 28 to 31 inches, mottled grayish-brown (10YR 5/2) and brown (10YR 5/3) gritty clay with black iron-manganese concretions; weak blocky structure; very firm; slowly permeable; medium acid; gradual boundary.
- B₃ 31 to 45 inches, mottled brown (10YR 5/3) or yellowish-brown (10YR 5/6) gritty clay; massive; very firm; medium acid; gradual boundary.
- C 45 to 60 inches+, mottled brown gritty clay (leached Kansan till); weakly acid.

Shelby clay loam.—The following profile was observed 630 feet north of the southwest corner of sec. 17, T. 2 S., R. 17 E., in a pasture.

- A₁ 0 to 8 inches, very dark grayish-brown (10YR 3/2) light clay loam; moderate granular structure; very friable when moist; medium acid; gradual boundary.
- A₃ 8 to 12 inches, dark grayish-brown (10YR 3/2) clay loam; strong granular structure; friable; a few scattered pebbles; medium acid; clear boundary.
- B₂₁ 12 to 20 inches, dark-brown (10YR 3/3) heavy clay loam mottled with brown; strong medium subangular blocky structure; firm; medium acid; gradual boundary.
- B₂₂ 20 to 30 inches, dark yellowish-brown (10YR 4/4) heavy clay loam; moderate medium subangular blocky structure; firm; medium acid; gradual boundary.
- B₃ 30 to 40 inches, yellowish-brown (10YR 5/6) clay loam mottled with grayish brown and pale olive; strong coarse subangular blocky structure; firm; medium acid; contains concretions of iron and manganese and some pebbles and coarse sand; clear, wavy boundary.
- C 40 to 60 inches+, leached, weathered Kansan till of clay loam texture, mottled with brownish-yellow and black; fragments of disintegrated glacial boulders; fragments become more numerous with depth; parent glacial till is noncalcareous; calcareous till at depths of more than 10 feet.

Sogn silt loam.—The following profile was observed one-fourth of a mile north of the southwest corner of sec. 27, T. 1 S., R. 15 E., in a pasture on an 18 percent slope.

- A 0 to 8 inches, very dark gray (10YR 3/1) silt loam; granular structure; friable; neutral; clear boundary.
- D_r 8 inches+, light grayish-brown (10YR 6/2) weathered clayey shale overlying broken limestone at 16 inches.

Steinauer clay loam.—The following profile was observed 350 feet east of the southwest corner of sec. 29, T. 4 S., R. 15 E., in a native pasture on a 12 percent slope.

- A₁ 0 to 6 inches, very dark grayish-brown (10YR 3/2) clay loam; granular structure; friable; neutral; gradual boundary.

AC 6 to 10 inches, yellowish-brown (10YR 4/3) clay loam; moderate irregular blocky to moderate coarse granular structure; friable; calcareous; diffuse, wavy boundary.

C 10 to 36 inches, dark yellowish-brown (10YR 4/4) heavy clay loam glacial till containing some gravel and small pebbles; strongly calcareous; numerous soft pieces of lime.

Summit clay loam.—The following profile was observed 1,520 feet north of the southwest corner of sec. 27, T. 1 S., R. 15 E., on a 7 percent slope that has been cultivated but is now in pasture.

- A_{1p} 0 to 7 inches, black (10YR 2/1) clay loam; weak granular structure; firm; medium acid; clear boundary.
- A₁₁ 7 to 11 inches, black (10YR 2/1) silty clay loam; weak irregular blocky to moderate coarse granular structure; friable; clear boundary.
- B₁ 11 to 14 inches, very dark brown (10YR 2/2) silty clay; weak blocky to strong coarse granular structure; friable; clay films on all ped surfaces; neutral; gradual boundary.
- B₂ 14 to 19 inches, very dark brown (10YR 2/2) silty clay; some splotches of black in root channels; weak blocky to subangular blocky structure; yellowish-brown clay films on all surfaces; neutral; gradual boundary.
- B₂₂ 19 to 24 inches, mottled dark yellowish-brown (10YR 4/4) and very dark gray (10YR 3/1) silty clay; moderate coarse granular structure; firm; numerous clay films; gradual boundary.
- B₂ 24 to 40 inches, mottled dark-brown (7.5YR 4/4) and very dark gray (10YR 3/1) silty clay with a few rust-brown iron pellets; moderate fine blocky structure; firm; numerous clay films; neutral to calcareous.
- C 40 to 58 inches, mottled strong-brown (7.5YR 5/6) and dark grayish-brown (10YR 4/2) silty clay that rests on disintegrated calcareous shale; very weak granular structure; firm; some fragments of broken limestone at 52 inches.

Wabash silty clay.—The following profile was observed 1,800 feet east of the northwest corner of sec. 20, T. 4 S., R. 15 E., in a level cultivated field on bottom land with slow surface drainage.

- A₁ 0 to 30 inches, black (10YR 2/1, moist) silty clay; moderate medium granular structure; friable; gradual boundary.
- AC 30 to 60 inches+, dark-gray (10YR 4/1, moist) silty clay faintly mottled with (10YR 3.5/3); weak prismatic or moderate coarse granular structure or structureless (massive); friable.

Laboratory Determinations

Laboratory data for six soils in Brown County are given in table 4.

General Nature of the County

Physiography.—Brown County has two main physiographic divisions, the uplands and the lowlands. The lowlands occur along the streams. They vary in width from one-quarter to three-quarters of a mile and are generally level and fairly well drained. The uplands are subdivided into smooth to gently sloping areas, strongly sloping areas, and rough hilly areas. The smooth to gently sloping areas are on broad divides, generally at some distance from the larger streams. The more nearly level areas are around Everest, Willis, Baker, and Powhattan, and between Morrill and Reserve. The strongly sloping areas are in the vicinity of the streams. The rough hilly areas are along the creeks and around the headwaters of Pony, Walnut, and Plum Creeks.

TABLE 4.—Laboratory data for six soils in Brown County, Kansas

Soil name, location, and sample number	Depth	Organic matter ¹	Sand	Silt	Clay
Edina silt loam (Sample taken 1,300 ft. S. of NE. corner sec. 3, T. 3 S., R. 15 E.):	Inches	Percent	Percent	Percent	Percent
45-Kan-7-5-1	0-8	3.5	2.4	74.3	23.3
45-Kan-7-5-2	8-14	2.5	4.0	74.0	22.0
45-Kan-7-5-3	14-17	1.7	4.2	74.6	21.2
45-Kan-7-5-4	17-28	1.9	2.9	48.8	48.3
45-Kan-7-5-5	28-34	1.6	2.3	41.6	56.1
45-Kan-7-5-6	34-40	.6	2.1	44.0	53.9
45-Kan-7-5-7	40-54	.6	1.3	50.0	48.7
Grundy silty clay loam (Sample taken SE. corner sec. 25, T. 3 S., R. 16 E.):					
45-Kan-7-7-1	0-8	3.9	2.5	63.8	33.7
45-Kan-7-7-2	8-14	3.4	2.0	57.6	40.4
45-Kan-7-7-3	14-24	2.0	1.6	50.2	48.2
45-Kan-7-7-4	24-36	.6	1.3	55.5	43.2
45-Kan-7-7-5	36-44	.1	1.0	56.9	42.1
45-Kan-7-7-6	44-56	.0	.9	61.6	37.5
Ladoga silt loam (Sample taken 300 ft. W. of SE. corner sec. 32, T. 4 S., R. 17 E.):					
45-Kan-7-2-1	0-9	2.2	8.1	71.3	20.6
45-Kan-7-2-2	9-14	.9	6.1	68.3	25.6
45-Kan-7-2-3	14-24	.9	5.1	61.0	33.9
45-Kan-7-2-4	24-38	.0	4.8	56.9	38.3
45-Kan-7-2-5	38-44	.1	8.2	60.4	31.4
45-Kan-7-2-6	44+	.0	12.9	51.9	35.2
Monona silt loam (Sample taken 300 ft. W. of NE. corner sec. 10, T. 1 S., R. 18 E.):					
45-Kan-7-10-1	0-8	2.6	3.9	70.5	25.6
45-Kan-7-10-2	8-16	2.1	3.3	67.9	28.8
45-Kan-7-10-3	16-34	1.4	2.4	71.8	25.8
45-Kan-7-10-4	34-50	.9	2.0	72.3	25.7
45-Kan-7-10-5	50-65	.3	1.4	75.9	22.7
Pawnee clay loam (Sample taken 560 ft. N. of W¼ corner sec. 33, T. 3 S., R. 16 E.):					
45-Kan-7-6-1	0-8	2.8	14.2	59.6	26.2
45-Kan-7-6-2	8-12	2.6	18.1	49.6	32.3
45-Kan-7-6-3	12-14	2.3	15.0	43.0	42.0
45-Kan-7-6-4	14-24	1.7	16.8	35.7	47.5
45-Kan-7-6-5	24-42	1.7	23.0	35.8	41.2
45-Kan-7-6-6	42-54	1.8	29.5	33.2	37.3
Sharpsburg silt loam (Sample taken 500 ft. N. of W¼ corner sec. 16, T. 2 S., R. 17 E.):					
45-Kan-7-14-1	0-5	3.8	2.4	70.6	27.0
45-Kan-7-14-2	5-9	3.6	1.8	68.6	29.6
45-Kan-7-14-3	9-18	3.1	1.7	62.5	35.8
45-Kan-7-14-4	18-26	2.1	1.7	54.0	44.3
45-Kan-7-14-5	26-29	1.8	1.5	53.1	45.4
45-Kan-7-14-6	29-38	1.3	1.7	52.2	46.1
45-Kan-7-14-7	38-46	.7	1.4	57.5	41.1

¹ Determined by hydrogen peroxide method.

The general elevation of Brown County is 900 to 1,200 feet. The main divide between the Kansas River and the Missouri River crosses the county from northwest to

southeast. The streams south of this divide flow into the Kansas River, and those north of it flow into the Missouri River. Walnut, Wolf, and Plum Creeks are the largest streams in the county.

Climate.—Climatic data compiled from records of the United States Weather Bureau station at Horton, in the southern part of the county, are given in table 5. About 75 percent of the precipitation comes during the normal growing season. In May and June, 3 to 5 inches of rain may fall in 24 hours. This is the time when much of the cropland is freshly cultivated. The heavy rains produce a lot of runoff and are likely to cause floods and severe sheet and gully erosion.

The average date of the last frost in spring is April 19. The latest frost recorded was on May 15. The average date of the first frost in autumn is October 15. The earliest frost recorded was on September 17. The average growing season is 179 days. The length of the growing season has varied from 150 days (in 1907) to 198 days (in 1912 and 1930). It is adequate for all field crops commonly grown in the county.

TABLE 5.—Temperature and precipitation at Horton, Brown County, Kansas

Month	Temperature ¹			Precipitation ²			
	Average	Absolute maximum	Absolute minimum	Average	Driest year (1901)	Wettest year (1951)	Average snowfall
	° F.	° F.	° F.	Inches	Inches	Inches	Inches
December	30.2	74	-24	0.96	0.69	0.75	3.6
January	27.1	72	-33	.75	.60	.60	4.1
February	29.9	82	-25	1.15	1.66	1.45	4.8
Winter	29.1	82	-33	2.86	2.90	2.80	12.5
March	41.7	94	-17	1.63	1.26	5.33	4.1
April	53.0	96	9	2.92	4.37	4.03	1.1
May	63.0	104	27	4.48	1.45	6.17	(³)
Spring	52.6	104	-17	9.03	7.08	15.53	5.2
June	72.5	108	40	4.89	1.21	14.43	(³)
July	78.0	111	47	3.43	1.80	10.40	0
August	76.5	112	41	3.65	1.91	8.62	(³)
Summer	75.7	112	40	11.97	4.92	33.45	(³)
September	68.3	109	27	4.43	2.95	6.94	(³)
October	56.8	96	4	2.45	2.04	2.69	.3
November	42.5	84	-2	1.70	.95	1.23	.7
Fall	55.9	109	-2	8.58	5.94	10.86	1.0
Year	53.3	112	-33	32.44	20.84	62.64	18.7

¹ Average temperature based on a 65-year record, through 1955; highest temperature on a 62-year record and lowest temperature on a 63-year record, through 1952.

² Average precipitation based on a 65-year record, through 1955; wettest and driest years based on a 67-year record, in the period 1889-1955; snowfall based on a 57-year record, through 1952.

³ Trace.

Agriculture

In the summer of 1859, the Pike's Peak gold rush brought many pioneers through the county on their way to the West. This created a demand for corn, butter, and eggs, and those farmers who lived near the trail profited by the sales they made. In the following spring there was a great demand for corn in the new gold fields, and many wagons were loaded with it, every farmer selling all he could spare at 25 cents a bushel.

The next summer was exceedingly dry, and crops failed. Many settlers were without the necessities of life and would have suffered but for donations from the East. In the spring of 1861, thousands of bushels of corn and wheat were shipped in from the East and used as seed. That year's crop, fortunately, resulted in an abundant harvest.

Crops.—In 1954, 227,221 acres in the county was in cultivated crops. The main crops are corn, wheat, oats, sorghum, bromegrass, alfalfa, and clover. Their acreage in stated years is shown in table 6. Barley and rye are minor crops.

TABLE 6.—Acreage of principal crops in stated years

Crop	1929	1939	1949	1954
	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>
Corn for all purposes.....	118, 422	92, 631	90, 489	98, 585
Oats threshed or combined..	28, 215	25, 927	28, 651	40, 865
Wheat threshed or combined.	61, 071	65, 797	59, 818	38, 401
Sorghums for all purposes except sirup.....	208	5, 690	724	7, 975
Alfalfa cut for hay.....	13, 217	14, 463	16, 388	12, 666
Clover, timothy, and mix- tures of clover and grasses cut for hay.....	18, 415	2, 970	15, 861	17, 307

Livestock.—Livestock has always been a major source of income. In 1954, 95,049 acres in Brown County was used for pasture. Table 7 shows the number of livestock on farms in stated years.

TABLE 7.—Number of livestock on farms in stated years
[Enumeration in April 1930, 1940, and 1950 and in November 1954]

Livestock	1930	1940	1950	1954
	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>
Hogs and pigs.....	67, 635	¹ 24, 600	43, 920	39, 414
Cattle and calves.....	34, 648	² 26, 651	43, 586	54, 562
Sheep and lambs.....	12, 234	³ 5, 572	7, 078	9, 904
Horses and mules.....	11, 970	³ 7, 408	2, 296	739
Chickens.....	² 224, 238	¹ 155, 827	¹ 155, 589	¹ 153, 357

¹ Over 4 months old.
² Over 3 months old.

³ Over 6 months old.

Transportation and agricultural markets.—Within a hundred miles of Brown County are three major markets for livestock and grain: Kansas City and St. Joseph, Mo., and Omaha, Nebr. Produce can be shipped by rail from any town in the county. The main line of the Missouri Pacific Railroad connects the towns of Everest, Baker, Hiawatha, Padonia, and Reserve with Kansas City and

Omaha. A branch line of the Union Pacific Railroad connects Robinson, Hiawatha, Morrill, and Hamlin with St. Joseph. A branch of the Chicago, Rock Island, and Pacific Railroad runs through Horton, Powhattan, and Fairview.

Three United States Highways—No. 73, 75, and 159—cross the county from north to south, and United States Highway No. 36 crosses it from east to west. Hard-surfaced roads or good gravel roads reach all parts of the county. Small airports are located at Hiawatha and Horton.

Glossary

- Aeration, soil.** The exchange of air in the soil with air from the atmosphere.
- Aggregate.** Many fine soil particles held in a single mass or cluster.
- Alluvium.** Sand, mud, or other sediments deposited on land by streams.
- Bedrock.** The solid rock underlying soils and other earthy surface formations.
- Clay.** Mineral particles less than 0.002 mm. in diameter. As a textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.
- Clay loam.** Soil material that is 27 to 40 percent clay and 20 to 45 percent sand.
- Claypan.** A compact, clayey, slowly permeable layer separated more or less abruptly from the overlying soil; commonly hard when dry and plastic and stiff when wet.
- Clod.** A mass of soil brought about by digging or other disturbance.
- Colluvium.** Mixtures of soil material and rock fragments, moved by gravity and deposited near the base of strong slopes.
- Consistence, soil.** The attributes of soil material that are expressed by the degree and kind of cohesion and adhesion or by the resistance to deformation or rupture. Terms commonly used to describe consistence are *brittle, compact, firm, friable, impervious, sticky, plastic, and cemented*. Several terms may be used to describe the consistence of a soil at different degrees of moisture content. For example, "very plastic, very firm, very hard" means very plastic when wet, very firm when moist, and hard when dry.
- Brittle.** When dry, will break with a sharp, clean fracture, or, if struck a sharp blow, will shatter into cleanly broken hard fragments.
- Cemented.** Brittle and hard because of the presence of some cementing substance other than clay minerals, such as calcium carbonates, silica, or oxides or salts of iron and aluminum.
- Compact.** Dense and firm but not cemented.
- Firm.** Crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.
- Friable.** Crushes easily under gentle to moderate pressure between thumb and forefinger, and coheres when pressed together.
- Impervious.** Very resistant to penetration by water, air, and roots.
- Plastic.** Wire formable; moderate pressure required for deformation of the soil mass.
- Sticky.** Tends to adhere to other materials and objects when wet.
- Contour.** An imaginary line connecting points of equal elevation on the surface of the soil.
- Contour plowing.** Plowing on a level line at right angles to the direction of the slope; usually results in a curving furrow.
- Drainage.** The rapidity and extent of the removal of water from the soil by flow over the surface (runoff) and by flow through the soil to underground spaces (internal drainage).
- Environment, soil.** The aggregate of all the factors that affect the formation of a soil.
- Erosion.** The wearing away of the land surface through the action of moving water, wind, or other geological agents.
- Erosion, accelerated.** Erosion resulting from disturbance of the natural landscape, usually that caused by the activities of man.

Fertility. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors are favorable.

Fertilizer. Any natural or manufactured material added to the soil to supply plant nutrients.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flood plain. A nearly flat area that is close to a stream and is under water when the stream overflows.

Formation, soil. The processes that form soils from loose geologic materials, give them their distinguishing characteristics, and make it possible to classify them scientifically.

Gravel. Rounded or angular fragments up to 3 inches in diameter. An individual piece is a *pebble*.

Green-manure crop. Any crop grown and plowed under for the purpose of improving the soil.

Great soil group. Any one of several broad groups of soils with fundamental characteristics in common. Examples are *Brunizems* and *Planosols*.

Hardpan. A hardened or cemented layer; the soil material may be sandy or clayey, and it may be cemented by iron oxide, silica, calcium carbonate, or other substances.

Horizon, soil. A layer of soil approximately parallel to the surface and having more or less well-defined characteristics that have been produced through the operation of soil-forming processes.

Internal drainage. See drainage.

Leaching. The removal of materials in solution by the passage of water through the soil.

Loam. The textural class name for soil having a moderate amount of sand, silt, and clay. Loam is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand.

Lodge. To fall, as grass or grain beaten down by wind or rain or weighted down with seed.

Loess. Geological deposit of fine material, mostly silt, presumably transported by wind.

Management, soil. The preparation, manipulation, and treatment of soils for the production of crops, grasses, or trees.

Mottles. Irregular spots of different colors, commonly the result of poor drainage.

Nutrient, plant. Any element taken in by a plant that is essential to its growth and is used by it in elaboration of its food and tissue.

Overfall. The waterfall at the head of an actively growing gully.

Ped. An individual natural soil aggregate such as a crumb, prism, or block, in contrast to clod (see clod).

Permeability. The quality of a soil that enables water or air to move through it.

pH. A numerical designation of relative acidity and alkalinity in soils and other biological systems (see Reaction).

Plowpan. A dense compacted layer underneath the plow layer. It restricts the movement of water and air and limits the depth of the root zone.

Productivity. The present ability of a soil to produce a specified plant or sequence of plants under a specified system of management.

Profile, soil. A vertical section of the soil, extending through all its horizons and into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil mass, expressed in either pH value or in words, as follows:

	pH
Extremely acid.....	Lower than 4.5
Very strongly acid.....	4.5 to 5.0
Strongly acid.....	5.1 to 5.5
Medium acid.....	5.6 to 6.0
Slightly acid.....	6.1 to 6.5
Neutral.....	6.6 to 7.3
Mildly alkaline.....	7.4 to 7.8
Moderately alkaline.....	7.9 to 8.4
Strongly alkaline.....	8.5 to 9.0
Very strongly alkaline.....	9.1 and higher

Sand. Small fragments of rock or mineral, between 0.5 mm. and 2.0 mm. in diameter; coarse sand, 1.0 mm. to 0.5 mm.; sand, 0.5 mm. to 0.25 mm.; fine sand, 0.25 mm. to 0.1 mm.; very fine sand, 0.1 mm. to 0.05 mm. As a textural class, soil that is 85 percent or more sand and not more than 10 percent clay.

Separate, soil. One of the individual size groups of mineral soil particles—sand, silt, or clay.

Silt. Small grains of mineral soil, 0.05 mm. to 0.002 mm. in diameter. As a textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Silt loam. Soil material that is (1) 50 percent or more silt and 12 to 27 percent clay or (2) 50 to 80 percent silt and less than 12 percent clay.

Silty clay loam. Soil material that is 27 to 40 percent clay and less than 20 percent sand.

Slope. The incline of the surface of a soil. It is usually expressed as a percentage, representing the number of feet of fall per 100 feet of horizontal distance.

Soil. The natural body on the surface of the earth, in which plants grow; composed of organic and mineral materials.

Solum. The upper part of the soil profile, above the parent material, in which the processes of soil formation are taking place. In mature soils the solum includes the A and B horizons, and the character of the material may be, and usually is, unlike that of the parent material.

Stripcropping. The practice of growing crops in a systematic arrangement of strips. Commonly, cultivated crops and sod crops are alternated in strips. Strips are laid out on the contour on erosive soils and at right angles to the prevailing wind where wind erosion is a hazard.

Structure, soil. The morphological aggregates in which the individual soil particles are arranged. The most common types of structure are the following:
Subangular blocky. Having mixed rounded and plane faces, with vertices mostly rounded.
Granular. Hard or soft but firm small aggregates, angular or rounded, as in the A horizon of many Chernozems.
Crumb. Generally soft, small, porous aggregates, irregular in shape, as in the A₁ horizons of many soils.
 To indicate a lack of definite structure, the following terms are normally used:
Single grain (structureless). Each grain by itself, as in dune sand.
Massive (structureless). Large uniform masses of cohesive soil, sometimes with irregular cleavage, as in the C horizons of many heavy clay soils.

Subsoil. The soil below the plowed soil. The B horizon of soils that have distinct profiles.

Substratum. Any layer beneath the solum, or true soil.

Surface drainage. Runoff.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil; about 5 to 8 inches thick.

Terrace. An embankment or ridge constructed across sloping soils on the contour or at a slight angle to the contour. A terrace intercepts runoff and retards it so that more water will infiltrate and so that the excess will flow away slowly without causing erosion.

Terrace, geological. A nearly flat or undulating plain, commonly rather narrow and usually with a steep front, bordering a river, lake, or sea.

Texture, soil. The relative proportion of the various size groups of individual soil grains. See clay, sand, and silt.

Till, glacial. Unstratified deposits consisting of clay, sand, gravel, and boulders.

Tilth. The physical condition of a soil in respect to its fitness for the growth of a specified plant or sequence of plants.

Topsoil. A general term used in at least four different senses: (1) a synonym for surface soil or plow layer; (2) the original or present dark-colored upper soil; (3) the original or present A horizon; (4) a presumed fertile soil material used to topdress roadbanks, lawns, and gardens.

Undifferentiated group. Two or more soils designated by the same map symbol and shown on the soil map as one unit.

Upland. High ground; ground elevated above the lowlands along rivers or between hills.

Water table. The upper limit of the part of the soil or underlying rock material that is saturated with water.

Weathering. The physical and chemical disintegration and decomposition of rocks and minerals.

Accessibility Statement

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at (800) 457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at <http://offices.sc.egov.usda.gov/locator/app>.

Nondiscrimination Statement

Nondiscrimination Policy

The U.S. Department of Agriculture (USDA) prohibits discrimination against its customers, employees, and applicants for employment on the basis of race, color, national origin, age, disability, sex, gender identity, religion, reprisal, and where applicable, political beliefs, marital status, familial or parental status, sexual orientation, whether all or part of an individual's income is derived from any public assistance program, or protected genetic information. The Department prohibits discrimination in employment or in any program or activity conducted or funded by the Department. (Not all prohibited bases apply to all programs and/or employment activities.)

To File an Employment Complaint

If you wish to file an employment complaint, you must contact your agency's EEO Counselor (<http://directives.sc.egov.usda.gov/33081.wba>) within 45 days of the date of the alleged discriminatory act, event, or personnel action. Additional information can be found online at http://www.ascr.usda.gov/complaint_filing_file.html.

To File a Program Complaint

If you wish to file a Civil Rights program complaint of discrimination, complete the USDA Program Discrimination Complaint Form, found online at http://www.ascr.usda.gov/complaint_filing_cust.html or at any USDA office, or call (866) 632-9992 to request the form. You may also write a letter containing all of the information requested in the form. Send your completed complaint form or letter by mail to U.S. Department of Agriculture; Director, Office of Adjudication; 1400 Independence Avenue, S.W.; Washington, D.C. 20250-9419; by fax to (202) 690-7442; or by email to program.intake@usda.gov.

Persons with Disabilities

If you are deaf, are hard of hearing, or have speech disabilities and you wish to file either an EEO or program complaint, please contact USDA through the Federal Relay Service at (800) 877-8339 or (800) 845-6136 (in Spanish).

If you have other disabilities and wish to file a program complaint, please see the contact information above. If you require alternative means of communication for

program information (e.g., Braille, large print, audiotape, etc.), please contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

Supplemental Nutrition Assistance Program

For additional information dealing with Supplemental Nutrition Assistance Program (SNAP) issues, call either the USDA SNAP Hotline Number at (800) 221-5689, which is also in Spanish, or the State Information/Hotline Numbers (<http://directives.sc.egov.usda.gov/33085.wba>).

All Other Inquiries

For information not pertaining to civil rights, please refer to the listing of the USDA Agencies and Offices (<http://directives.sc.egov.usda.gov/33086.wba>).