

SOIL SURVEY

Wibaux County Montana



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

HOW TO USE THE SOIL SURVEY REPORT

THIS SURVEY of Wibaux County will help you plan the kind of farming and ranching 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 or Ranch on the Map

In using this survey, you start with the soil map, which consists of 31 sheets bound in the back of this report. These sheets, if laid together, make a large photographic map of the county as it looks from an airplane. You can see fields, roads, rivers, and many other landmarks on this map.

To find your land on the large map, you use the index to map sheets. This is a small map of the county on which numbered rectangles have been drawn to show where each sheet of the large map is located.

When you have found the map sheet for your farm or ranch, you will notice that boundaries of the soils have been outlined, and that there is a symbol for each kind of soil. All areas marked with the same symbol are the same kind of soil, wherever they appear on the map.

Suppose you have found an area marked with the symbol Mn. You learn the name of the soil this symbol represents by looking at the map legend. The symbol Mn identifies Morton silt loam, 4 to 7 percent slopes.

Learn About the Soils on Your Farm or Ranch

Morton silt loam, 4 to 7 percent slopes, and all the other soils are described in the section, Descriptions of Soils. Soil scientists walked over the fields and the grazing land. They dug holes and examined surface soils and subsoils; measured slopes with a hand level; noted differences in growth of crops, grass, brush, or trees; and, in fact, recorded all the things about the soils that they believed might affect their suitability for farming.

The scientists talked with people who use

the soils, studied experimental data, and placed each soil in a land capability group according to its relative fitness for crops, grazing, forestry, or wildlife.

How the soils differ from each other is discussed in the section, Differences in the Soils of Wibaux County. If you want to know in general about soil management turn to the section, Use and Management of Soils, wherein the treatment to fit the soils is discussed. Yields to be expected from the common crops are shown in table 1.

A rancher can turn to the section, Management of Rangeland, which describes range sites and suggests how to judge range condition. A brief discussion on woodland management is also included in the report.

If you want to know how soils are formed and classified, turn to the section, Formation and Classification of Wibaux County Soils. In the section, Soil Associations, a general soil map of the county is given, and the soil areas shown on it are described.

Make a Farm or Ranch Plan

For the soils on your farm or ranch, compare your yields and practices with those given in this report. Look at your fields and grazing lands for signs of runoff and erosion. Then decide whether or not you need to change your methods. The choice, of course, must be yours. This survey will aid you in planning new methods, but it is not a plan of management for your farm or any other farm in the county.

If you find that you need help in farm or ranch planning, consult the local technicians of the Soil Conservation Service or the county agricultural agent. Members of the staff of your State agricultural experiment station and others familiar with farming in your county will also be glad to help you.

Fieldwork for this survey was completed in 1943. Unless otherwise specifically indicated, all statements in the report refer to conditions in the county at that time.

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SOIL SURVEY OF WIBAUX COUNTY, MONTANA

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UNITED STATES DEPARTMENT OF AGRICULTURE IN COOPERATION WITH THE MONTANA AGRICULTURAL EXPERIMENT STATION

Know Your Soils and Plan Their Use and Management

This report is about the soils of Wibaux County, which is in eastern Montana and has an area of 568,960 acres. The North Dakota State line is on its eastern border (fig. 1). The county is bordered on the south by Fallon

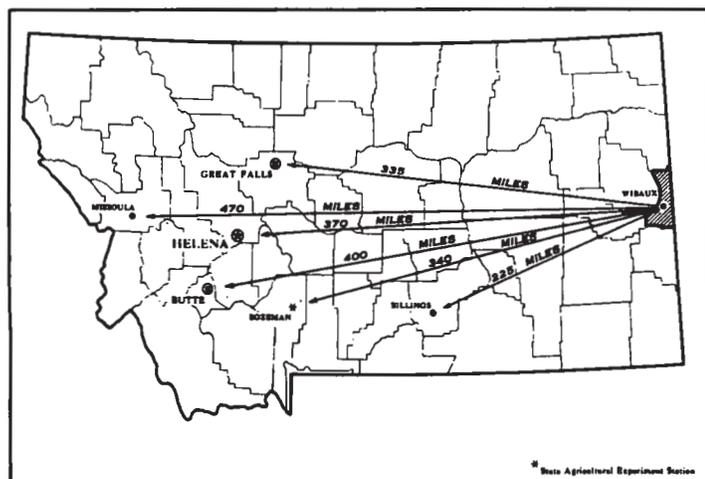


Figure 1.—Location of Wibaux County in Montana.

County, on the west by Prairie and Dawson Counties, and on the north by Richland County. The Yellowstone River forms the northwest corner boundary.

This is mainly an agricultural county—159,919 acres were used for crops and 365,605 acres were pastured in 1954. Wheat is the main cash crop. Permanent pasture would be a better use for much of the acreage in cultivated crops. Much of the cropland is subject to wind and water erosion. Like other northern Great Plains areas, the county has periods of drought. There are good years, or years of ample moisture, when crops may be above average, and some dry years when crops are produced only on the best sites.

Each soil mapped in the county needs to be used differently from most of the others if it is to give the best returns. What crops are best adapted to each soil? What treatment does each soil need? What is the erosion

problem? How much will each soil produce? This report attempts to answer these and other questions for the farmers, ranchers, and landowners of Wibaux County.

Farmers and ranchers in the county organized the Wibaux Soil Conservation District in 1939. The District helps farmers and ranchers get technical assistance from the United States Department of Agriculture on their soil and water conservation work. This survey of the soils in the county is part of that technical help.

Examine the Soil Map

Symbols and names of the soil.—The name and letter symbol of each soil mapped in Wibaux County is listed in the map legend. The letter symbol, for example, Ab or Mn, refers to the different soil units on the map. Each soil mapping unit is described in the section, Descriptions of Soils.

One of the first things to see in soils is their shape or form. Soils have area and thickness and occupy parts of the landscape. Figure 2 shows the shape of some soil bodies in the landscape. It is these bodies, or shapes, that are mapped in detail on the soil map.



Figure 2.—Bodies of soil in a landscape. Boundary lines have been drawn around some soils to show their shape and pattern.

How soils are named.—Each soil has a name that usually consists of three parts. The first part is taken from the place near which the soil series, or group of soils of a certain kind, was first mapped. The next part identifies the texture of the surface soil, such as loam or silt loam. The texture of the surface layer indicates the soil type. Finally, soil types are divided into phases, mainly on the basis of differences in slope or in other characteristics that affect their use for agriculture. For example, Morton silt loam, 4 to 7 percent slopes, is a slope phase of the silt loam type and is in the Morton series. The percentage of slope is the number of feet the land rises or falls in a distance of 100 feet. Slope phases suggest, among other things, where the hazards of erosion can be expected.

Differences in the Soils of Wibaux County

Soil can be defined briefly as a place where plants grow. How well the plant grows depends on the chemical and physical makeup of all layers of soil as deep as plant roots go, commonly 4 to 6 feet. Because we need to know what the soil is like in order to tell what it needs and how it can be used, the entire soil profile to a depth of several feet should be studied.

Dig a pit or look at a fresh road cut, and you can see layers differing from each other. If the pit or road cut is in Morton silt loam, the surface soil, about 8 inches thick, is dark colored, contains organic matter, and is made up of a mass of porous particles about the size of crumbs. The crumb structure indicates good tilth and fertility. This surface layer is called the A horizon. The next layer, extending from a depth of about 8 to 16 inches, has nearly the same color but is made up of small uneven blocks 1 to 3 inches across and about 8 inches thick. This is the B horizon, or subsoil. There may be upper subsoil and lower subsoil in some soils. Usually, below about 16 inches the subsoil is lighter in color. Whitish streaks and spots of lime and other salts frequently occur in this layer. It is the layer of lime accumulation and is less weathered than the layers above. It contains lime and possibly other calcium compounds. This is the C_{ca} layer.

Below about 28 inches, the layers in Morton silt loam consist of weathered yellow and gray silty soft shale or sandstone. This is the main C horizon, or soil parent material.

Soil is formed from parent material that has been weathered in the climate of the area and changed by the vegetation over a long period. A soil body has width, length, and thickness, and the different soils form patterns in the landscape. The whole soil profile of Morton silt loam is the one that is normal for a soil in Wibaux County that has developed on gentle slopes from soft silty shales. It is a soil that water, air, and roots can penetrate easily. Figure 3 illustrates the usual layers, or horizons, in Morton soils.

Each soil has one or more features that make it different from all the others. If a hole or pit is dug in Bainville silt loam, the layers, or horizons, will be different from those in Morton silt loam. The surface layer, or A

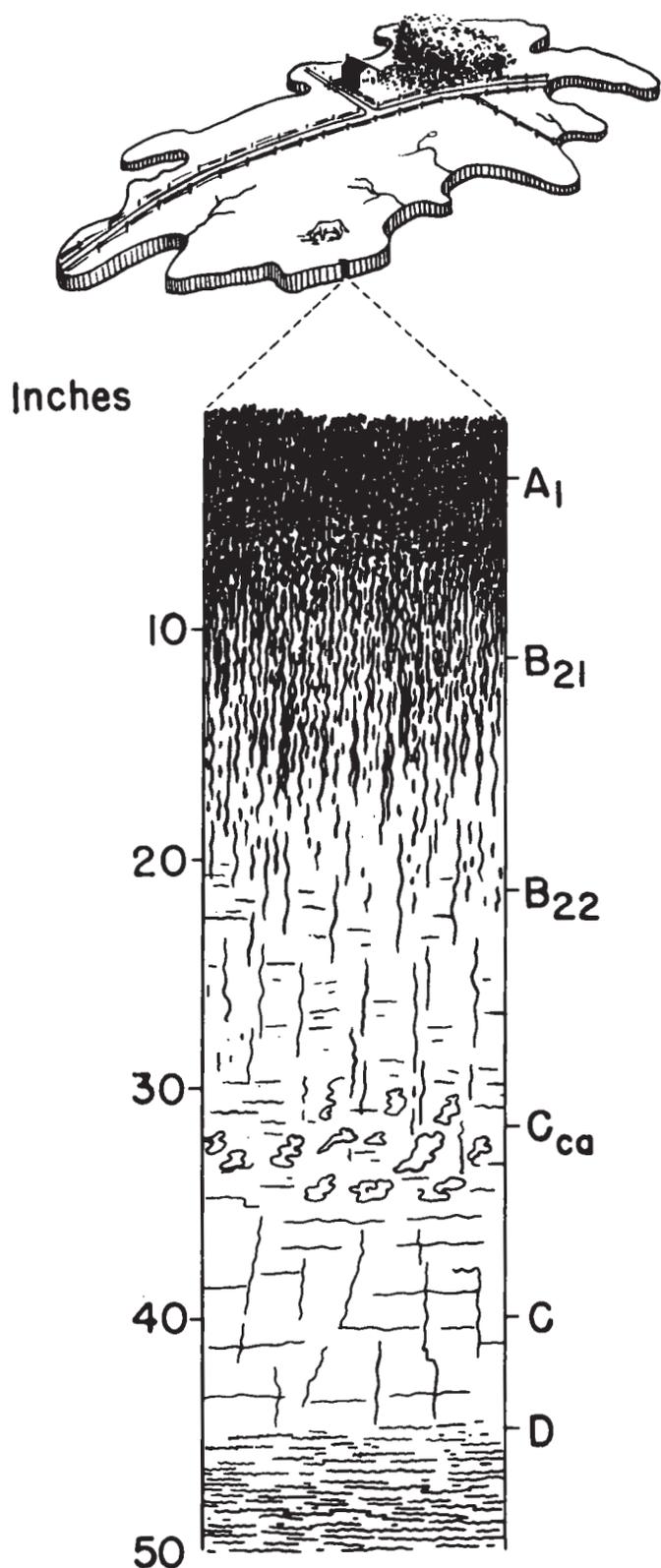


Figure 3.—Solid horizons, or layers, in Morton silt loam.

horizon, is only about 4 inches thick in the Bainville sample. The subsoil, extending from a depth of 4 to 12 inches, is yellowish brown and has no definite structure. Below this layer are beds of shale and sandstone. Bainville soil will act differently from Morton soil in the way it supplies nutrients, air, and moisture to plant roots. Bainville soils frequently occur on steep slopes, ridges, and bare knobs.

Variations occur within each mapping unit

All the soil in a given mapping unit may not be exactly alike. Usually, the thickness of the individual layers differs slightly from place to place. Many boundaries between soil units are not sharp, and soils merge one with another. The boundaries show major differences in their layers, or horizon makeup, and in degree of slope. The important variations in each mapping unit are discussed in the section, Descriptions of Soils. How some of the Wibaux County soils occur in relation to each other is shown in figure 4.

little soil forms is blown or washed away. In draws and streams the deposits move about too often to support much vegetation.

Organic-matter content, thickness, and structure of the surface layer

It is essential to maintain the organic matter, thickness, and favorable structure of the surface layer. This can be done by good management practices, such as adding organic matter or returning the sod cover. Organic matter is the main source and storehouse for most plant nutrients, including nitrogen. It affects the way soil holds moisture, seedbed preparation, and the air supply in the soil. Structure is one of the important factors in fertility.

The surface layer of the soils better suited to farming is high in organic matter, is about 6 to 8 inches thick, and has a crumb structure. The Morton soils have this kind of surface layer. Crumb structure means that the soil particles are shaped like crumbs and are porous.

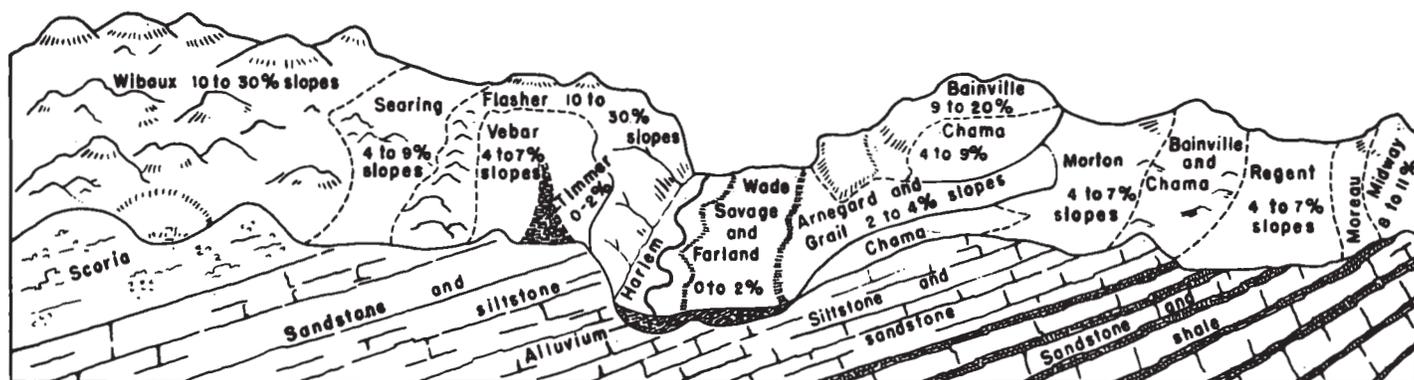


Figure 4.—How the soils common in Wibaux County occur in relation to each other. The percentage of slope is shown under the soil name.

Slopes and erosion hazards

As a rule, the hazards of water erosion are greater on the steeper slopes. Sheet and rill erosion are likely to occur on slopes stronger than 3 percent. Gully erosion can take place wherever water collects and runs downslope.

The more sandy the soil is, the more likely it is to drift and blow away. Most cultivated soils are subject to wind erosion. In Wibaux County the control of erosion caused by wind and water is a major problem.

Erosion on the range or pasture is less likely to occur if the native sod is in good to excellent condition. Pasture erode where native grasses are sparse or are weak because they were grazed too closely. In these places, plants seem to be elevated because the soil has been washed or blown away from their base. These plants usually have limited root systems. Strong widespread root systems anchor the soil and prevent erosion.

Normal, or geologic, erosion takes place on badland areas, rock outcrops, and riverwash sandbars. These areas are so steep, rocky, or exposed to water that what

The soils with such structure resist erosion and make good seedbeds. Some of the heavier soils, such as Grail silty clay loam, have granular structure in the surface layer. Granular structure means that the soil particles are somewhat rounded and are relatively nonporous. The granules act much like crumbs.

The way water and air penetrate the subsoil

Subsoil layers act as a storage place for moisture and as a reservoir for plant nutrients. Air and water should move readily through these layers. Permeability, which is the ability to let water and air penetrate, depends on the texture and structure of these subsoil layers. For instance, Morton and Arnegard soils have moderate permeability, whereas Midway and Moreau soils have slow permeability. Soils like the Moline or Wade have slow to very slow permeability. Sandy soils such as the Vebar and Valentine have moderately rapid and rapid permeability. There is no practical way to alter the

texture of agricultural soils, but their structure and permeability can be changed to some degree by cropping systems, cultivation, and subsoiling.

Workability of soils

The ease or difficulty of cultivation depends on many factors, such as slope, erosion, texture, structure, and amount of organic matter in the surface layers. Poor workability, as occurs in Wade soils, is related to the presence of alkali and a dense claypan. Steep slopes are costly to till. Tillage and seedbed preparation are easy in soils that have surface layers with crumb or granular structure. Cloddy structure helps to keep down wind erosion. Some heavy soils benefit by fall plowing.

Intensive cultivation over a long time by implements that crush, pulverize, and pack the soil has an adverse effect on tilth. For example, crumb structure tends to break down to single grain or massive structure. When this happens, a soil that was formerly friable and easy to work becomes compact.

Soil depth

Soils vary in depth to parent materials. Total soil depth affects moisture storage and root penetration. In the Wibaux series, baked shale, or scoria, occurs close to the surface. The Flasher series has sandstone layers at shallow depths. Most of the better farming soils on slopes have soft silty or clayey shales a few feet below the surface. A few soils, such as the Cheyenne and Gravelly terrace remnants, have gravelly silt substrata. Soils with clay shale parent material, such as Pierre and Lismas soils, have greatly restricted water and root penetration.

The treatment should fit the soil

The special makeup of each soil determines how plants grow. Although many things, such as texture and sub-surface features, are fixed, the surface soil can be protected and improved by using farming practices that will maintain the content of organic matter and the favorable crumb or granular structure. Methods to control wind and water erosion are known, and ways to help maintain a high content of organic matter and the supply of nitrogen and other plant nutrients are being tested. The soils of Wibaux County are young in years of use and are high in nutrients. After long use, the supply of substances plants need may be depleted; yields then decline, and erosion increases.

Range and pasture areas covered by good to excellent vegetation are protected from erosion. The cover also protects the soils during droughts; then when normal moisture prevails, yields are high again.

Use and Management of Soils

Some suggestions for use and management of groups of similar soils are given in this section. These groups are called capability units. Estimated yields under prevail-

ing management are given in tabular form. Some of the practices that are basic to good farming on most of the soils are outlined. Range and woodland management are also discussed in this section.

Compare Present Use With Suggested Use

Compare the way soils of the county are used now with the suggestions given for each capability unit in the pages that follow. The present use of each soil is mentioned in the section, Descriptions of Soils.

The suggestions for use must be interpreted with judgment. A soil cannot always be treated alone. It usually occurs in close association with other soils having different features. These soils are often farmed together. Some soils, for example, occupy steep slopes and are not suited to cultivation because of the risk of erosion. Nevertheless, some parts of these steep soils are farmed because they occur within areas of good cropland.

Not all soils that need strip-cropping or contour strip-cropping will receive these practices. The size of the fields, the lay of the land, and other features may prohibit these practices. On some fields only stubble-mulch tillage can be used to control erosion.

Obviously, the practices suggested for land use, kinds of crops, and control of erosion must be adjusted to the individual farm. Also to be considered is the way the soil has been cropped in the past, its future potential, and the nature of the soil itself.

Capability Groups of Soils

The soils of the county have been grouped in units within capability classes and subclasses. This is part of a nationwide system of capability grouping, in which there are eight land-capability classes, up to four subclasses, and units that are groups of similar soils within each class and subclass.

The eight general classes are based on the degree that natural features of each soil limit its use or cause risk of damage if it is used for crops, grazing, woodland, or wildlife. A soil is placed in one of the eight classes after study of the uses that can be made of it, the risks of erosion or other damage when it is used, and the need for practices to keep it suitable for use, to control erosion, and to maintain yields.

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 (none in Wibaux County) 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 practically 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, or they need more protection. Some class II soils are gently sloping and consequently need moderate care to prevent erosion; others may be slightly droughty or slightly wet, or somewhat limited in depth.

Class III soils can be cropped regularly but have a narrower range of use and need still more careful management.

In class IV are soils that should be cultivated only occasionally or only under very careful management.

In classes V, VI, and VII are soils that as a rule should not be cultivated for annual or short-lived crops but can be used for pasture, for range, or for woodland. Class V soils (none in Wibaux County) are nearly level or gently sloping but are droughty, wet, low in fertility, or otherwise unsuitable for cultivation.

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

Class VII soils provide only poor to fair yields of forage or forest products.

In class VIII are soils that have practically no agricultural use. Some of them have value as watersheds, wildlife habitats, or scenery.

The degree of limitation is about the same for the soils in any one capability class, but the kind of limitation may be different. Subclasses are used to show the main kind of limitation in classes II through VIII. There can be as many as four subclasses, each identified by a letter following the capability class number. The letter "e" indicates that the risk of erosion is what chiefly limits the uses of the soil; the letter "w" is used if the soil is too wet for general use and needs water control; the letter "s" shows that the soil is shallow, droughty, or unusually low in fertility; and the letter "c" is used to indicate that the climate is so hazardous that it limits uses of the soil.

Capability units are groups of similar soils within each class and subclass that have similar management requirements. An example is capability unit IIe-1.

Capability classes, subclasses, and units in Wibaux County follow.

Class II.—Soils that can be used for tilled crops under moderate risks of erosion or other moderate limitations.

IIe-1: Gently sloping, generally well drained soils.

Class III.—Soils that can be used for tilled crops under severe risks of erosion if not protected or that have other severe limitations.

IIIe-1: Moderately sloping soils.

IIIe-2: Soils moderately limited in water-holding capacity by coarse texture below surface soil.

IIIe-3: Sandy soils subject to severe risk of wind erosion.

IIIe-4: Deep friable soils in dry part of county.

Class IV.—Soils having limitations that restrict severely the choice of crops or of cropping system or soils that require very careful management if cultivated.

IVe-1: Moderately steep soils.

IVs-1: Claypan soils.

Class VI.—Soils generally better suited to pasture, range, woodland, or wildlife than to cultivation, and only moderately limited for one or more of those uses.

VIe-1: Silty, steep soils of the uplands.

VIe-2: Sands highly subject to wind erosion.

VIe-3: Thin breaks and shallow soils of steep uplands.

VIw-1: Overflow land, narrow irregular areas along stream channels.

VIs-1: Saline and wet flats.

VIIs-2: Saline uplands and claypan soils with slick spots.

Class VII.—Soils severely limited for grazing or for woodland use.

VIIIs-1: Very shallow steep soils with much rock outcrop.

VIIIs-2: Very steep shale and clay soils with much shale outcrop.

Class VIII.—Soils not suitable for crops, grazing, or trees; they may be useful for wildlife, recreation, or water supply.

VIIIIs-1: Badlands.

Capability units

A brief description of each capability unit, a list of the soils in the unit, and some suggestions for use and management are given in this section.

IIe-1: Gently sloping, generally well drained soils.—These are deep, gently sloping or nearly level, friable soils of the terraces, valley slopes, and uplands. They are good for crops but are subject to some risk of wind erosion. The soils are:

Arnegard silt loam, 0 to 2 percent slopes.
Cherry silt loam, 0 to 3 percent slopes.
Farland silt loam, 0 to 3 percent slopes.
Farland-Harlem complex, 0 to 3 percent slopes.
Grail silty clay loam, 2 to 4 percent slopes.
Morton-Arnegard silt loams, 0 to 3 percent slopes.
Regent silty clay loam, 2 to 4 percent slopes.
Savage silty clay loam, 0 to 3 percent slopes.
Savage-Wade complex, 0 to 3 percent slopes.

These soils can be used for a grain-fallow cropping system if they are protected by strip farming and stubble-mulch tillage. Slopes are gentle enough that contour strip farming is not needed.

All but two of the soils can be used for a grain-corn system, or for alfalfa, sweetclover, wheatgrasses, brome-grass, or native range grasses. Cherry silt loam, 0 to 3 percent slopes, is not so suitable for alfalfa as the other soils, and the Savage-Wade complex, 0 to 3 percent slopes, is not suitable for the grain-corn system or for alfalfa.

IIIe-1: Moderately sloping soils.—These are deep or moderately deep friable soils of the uplands. They are good to fair for crops but are subject to water and wind erosion and need to be protected. The soils are:

Arnegard silt loam, 3 to 7 percent slopes.
Chama silt loam, 4 to 7 percent slopes.
Cherry silt loam, 4 to 9 percent slopes.
Grail silty clay loam, 5 to 7 percent slopes.
Morton silt loam, 4 to 7 percent slopes.
Morton-Chama silt loams, 4 to 9 percent slopes.
Regent silty clay loam, 5 to 7 percent slopes.
Searing loam, 3 to 7 percent slopes.
Williams silt loam, 2 to 5 percent slopes.

Grain-fallow and grain-corn are suitable cropping systems. Strip farming and stubble-mulch tillage are needed to control erosion. On most slopes strips should be on the contour. All these soils are suitable for sweet-clover, wheatgrasses, brome-grass, and native range grasses.

IIIe-2: Soils moderately limited in water-holding capacity by coarse texture below surface soil.—These are deep or moderately deep loamy soils. The Cheyenne soil is on benches; the Glendive is mostly on slopes of alluvial

fans bordering bottom lands. Coarse subsoil limits the water-holding capacity. The soils of this capability unit are good or fair for crops and have a moderate risk of wind erosion. The soils are:

Cheyenne loam, 0 to 5 percent slopes.
Glendive fine sandy loam, 2 to 6 percent slopes.

The Cheyenne soil is suitable for the grain-fallow cropping system if farmed in strips and with stubble-mulch tillage. Both soils are good for the grain-corn system and for sweetclover, wheatgrasses, bromegrass, or native range grasses. The Glendive soil is suitable for alfalfa, and fallow is not needed for grain farming on it.

IIIe-3: Sandy soils subject to severe risk of wind erosion.—These are deep sandy soils of the nearly level and sloping uplands. Risk of blowing is severe. They are good to fair for crops if wind erosion can be controlled. The soils are:

Vebar fine sandy loam, 4 to 7 percent slopes.
Vebar-Flasher complex, 3 to 9 percent slopes.
Vebar-Timmer fine sandy loams, 0 to 3 percent slopes.

Grain-fallow and grain-corn are suitable cropping systems, if they are practiced with strip farming and stubble-mulch tillage. Strips on the sloping soils should be on the contour. Sweetclover, wheatgrasses, bromegrass, or native range grasses are suited to these soils. Vebar-Timmer fine sandy loams, 0 to 3 percent slopes, are suitable for alfalfa.

IIIe-4: Deep, friable soils in dry part of county.—These deep, nearly level to moderately sloping soils are in the southwestern part of the county. Effective rainfall there is less than in other parts of the county, and the risk of both wind and water erosion is moderate or severe. The soils are good or fair for crops. They are:

Cushman loam, deep variant, 0 to 3 percent slopes.
Cushman loam, deep variant, 4 to 7 percent slopes.

The grain-fallow cropping system is suitable if strip farming and stubble-mulch tillage are practiced. Strips on 4 to 7 percent slopes should be on the contour. The soils are suitable for sweetclover, wheatgrasses, bromegrass, and native range grasses.

Ive-1: Moderately steep soils.—These soils of the uplands are shallow or moderately deep over sandstone, siltstone, shale, or clayey shale. The risk of water erosion is severe, and the soils are subject to wind erosion. They are fair to poor for crops. The soils are:

Bainville silt loam, 6 to 9 percent slopes.
Chama-Bainville silt loams, 4 to 9 percent slopes.
Chama-Bainville silt loams, 10 to 14 percent slopes.
Flasher loamy fine sand, 4 to 9 percent slopes.
Midway-Moreau complex, 3 to 7 percent slopes.
Midway-Regent silty clay loams, 3 to 7 percent slopes.
Midway-Regent silty clay loams, 8 to 11 percent slopes.
Midway-Regent silty clay loams, 12 to 15 percent slopes.
Regent silty clay loam, 8 to 14 percent slopes.
Vebar fine sandy loam, 8 to 14 percent slopes.
Williams silt loam, 6 to 14 percent slopes.

Many of these soils occupy small areas within larger bodies of soils in class III or class II, and they are farmed along with the better soils. Strip farming and stubble-mulch tillage are needed. Strips should be on the contour on all but the most gentle slopes. The soils will be better managed and most of them will be more productive if they are used for hay or grazing rather than for grain. All these soils are suitable for wheatgrasses, bromegrass, and native range grasses. The Flasher soil, the Midway-

Regent silty clay loams on slopes up to 11 percent, and the Regent, Vebar, and Williams soils in this unit are also suitable for sweetclover.

IVs-1: Claypan soils.—This unit consists of one soil, Wade silty clay loam, 0 to 3 percent slopes. The clayey texture of the surface soil and the claypan (dense clay) subsoil make the soil difficult to work. Water enters the soil slowly. This soil is fair to poor for crops.

The soil of this capability unit can be used for the regular grain-fallow cropping system if strip farming and stubble-mulch tillage are practiced. It is suitable for sweetclover, wheatgrasses, bromegrass, or native range grasses.

Vie-1: Silty, steep soils of the uplands.—These soils are too steep, stony, or shallow for cultivation, but they make good ranges. They are in the Silty land range site, along with some of the other more farmable silty soils. The soils in this unit are:

Bainville silt loam, 10 to 14 percent slopes.
Bainville silt loam, 15 to 40 percent slopes.
Bainville-Chama silt loams, 15 to 30 percent slopes.
Bainville-Flasher complex, 6 to 14 percent slopes.
Chama stony silt loam, 4 to 9 percent slopes.
Chama stony silt loam, 10 to 30 percent slopes.
Midway-Moreau complex, 8 to 11 percent slopes.
Midway-Moreau complex, 12 to 30 percent slopes.
Zahl loam, 8 to 30 percent slopes.

Vie-2: Sands highly subject to wind erosion.—The one soil in this unit is Valentine fine sand, 5 to 15 percent slopes. It is suitable only for range but it is good for that purpose. It is in the Sands range site. Wind erosion is severe wherever the cover is not maintained.

Vie-3: Thin breaks and shallow soils of steep uplands.—These soils are too steep and erodible to be cultivated. They are good or fair for range. They are in the Thin breaks and Shallow land range sites. The soils are:

Bainville-Flasher complex, 15 to 40 percent slopes.
Bainville-Wibaux complex, 15 to 40 percent slopes.
Flasher loamy fine sand, 10 to 14 percent slopes.
Flasher loamy fine sand, 15 to 40 percent slopes.
Gravelly terrace remnants, 5 to 40 percent slopes.
Wibaux stony loam, 10 to 40 percent slopes.

VIw-1: Overflow land, narrow irregular areas along stream channels.—This soil consists of one miscellaneous land type, Alluvial land. It is not suitable for cultivation because of the risk of floods and of erosion or deposition caused by them. The range site is Overflow land.

VIs-1: Saline and wet flats.—These soils are too salty and wet to be cultivated. They are good for range. The range site is Saline lowlands. The soils are:

Cherry silt loam, saline, 0 to 3 percent slopes.
Cherry silt loam, saline, 4 to 9 percent slopes.
McKenzie-Hoven silty clays, 0 to 1 percent slopes.

VIs-2: Saline uplands and claypan soils with slick spots.—These soils are too salty for cultivation. Moisture enters them slowly, and the risk of erosion is high. They are fair for range and are in the Panspots range site. The soils are:

Moline clay loam, 2 to 4 percent slopes.
Moline clay loam, 5 to 7 percent slopes.
Rhoades clay loam, 4 to 7 percent slopes.
Rhoades-Moline complex, 8 to 11 percent slopes.
Rhoades-Moline complex, 12 to 20 percent slopes.

VIIIs-1: Very shallow steep soils with much sandstone outcrop.—These thin rough soils, mostly on sandstone, are not suitable for cultivation. They make fair to poor

range. The range site is Very shallow land. The soils are:

Rockland-Bainville complex, 15 to 50 percent slopes.
Rockland-Flasher complex, 15 to 50 percent slopes.

VIIIs-2: Very steep shale and clay soils with much shale outcrop.—These thin, steep soils on clay or shale are not suitable for cultivation. They make poor to very poor range. The range site is Shale and clay. The native vegetation includes some juniper. The soils are:

Lismas clay-Shale outcrop, 20 to 60 percent slopes.
Pierre-Lismas clays, 15 to 40 percent slopes.

VIIIs-1: Badlands.—This capability unit contains only one land type, Badlands. Vegetation grows only in the bottoms of drains, on benches, or on slopes where some soil accumulates, and it furnishes only a little grazing.

Management of Cropland and Seeded Pastures

Farming and ranching in Wibaux County involve mainly the production of feed for livestock, the use of pastures and range, and the growing of wheat and other cash crops. Cropping systems are designed to utilize the land for grazing and to produce grain and roughage for winter feed. On farms where growing of cash grain and raising of livestock is a combined operation, the most productive soils are used for feed crops. Some of the land, usually on gentle to moderate slopes, is available for cash crops. The steep slopes and hills are used for pasture and range. Owing to drought, rust, hail, insects, and other hazards, it is often necessary to change the use of the land to minimize or to avoid these risks.

On many farms it will be easy to develop good management for soils. Farms having large areas of Morton, Regent, Arnegard, or Farland soils may need little change in present practices. On farms with steep slopes and much intermingling of soils of different capability, the changes are usually complex. On such farms a good soil management system can be planned only after much study of the whole farm organization.

Credit

The farmers most successful in Wibaux County are those who have the largest reserves of feed or credit during the drier years. Low yields in the dry years impose a financial burden that must be offset by building up reserves in the good years. A plan of credit that would take into account the wide fluctuation in yields would benefit many farmers. Under the normal credit arrangement, payments are the same whether the years are wet or dry. Straight cash-grain farmers are affected sooner by dry periods than those who combine livestock raising and grain farming.

Fallowing

If land is left fallow, or free of crops and weeds for some time, moisture and nitrates accumulate in the soil to meet the needs of the next crop. To eliminate weeds, the land is plowed or worked with a one-way disk plow about the time the weeds or volunteer wheat start growing. The

one-way disk is fast and effective, but it tends to pulverize the soil too finely and to bury crop residues too completely. The blade, or sweep-type implement is best for later cultivation of fallow land. It leaves crop residues on the surface. Wide sweeps are preferable—24 inches or larger.

Fallow land is exposed to wind and water, so emergency tillage may be needed. Disking may be needed to check soil blowing and to reduce runoff during the next rain. Deep tillage can be used to reduce wind and water erosion and improve tilth, but for most of the soils, it has not been established that this practice is beneficial. Deep tillage has had favorable effects on the soils having plowsoles and claypans.

Natural fertility

The natural fertility of the soils suitable for crops is fairly high. Little effort has been made in Wibaux County to return plant nutrients to the soil through the use of legume crops, barnyard manure, or commercial fertilizers. Consequently, the fertility has slightly decreased. The serious decrease in fertility in some places is largely the result of erosion. Part of the loss of fertility is caused by the slow reduction of humus through oxidation in the surface soil. The decline in favorable soil structure, which also affects fertility, may have been caused by the lower humus content or by the packing and pulverizing effects of tillage. At some future time, fertility may be depleted seriously. The lowered yields will be noticed first on the soils having the least natural fertility.

Commercial fertilizers

The plant nutrients most lacking in Wibaux County are phosphorus and nitrogen. The use of commercial fertilizers on dry-farmed areas is of questionable value because yields are limited mainly by lack of moisture. More local tests should be made to find out what the results will be if fertilizer is applied under various soil conditions. More information is also needed on the time commercial fertilizer should be applied, on the rate and amount to be applied, and on the use of manure. You can obtain the latest information on fertilizers from the technicians of the Soil Conservation Service or from your county agent.

Burning stubble and mulch

Burning of stubble is unfavorable in the long run. The temporary improvement in yields brought about by burning is deceptive. If straw is turned under, yields are temporarily lowered because bacteria draw large supplies of moisture and nitrogen from the soil to decompose the straw. In contrast, if the stubble is burned, the bacteria use only a small part of the nitrogen in the soil, more nitrogen is available for crops, and there is a temporary increase in yields, partly because of the better supply of nitrogen and partly because better plowing is possible if the straw is out of the way. With burning, however, the crops remove nitrogen that is not replaced, the necessary tillage lowers the content of humus, and soil structure deteriorates. Then, yields decline and erosion increases.

Building and maintaining good soil structure

Productivity of dry-farmed land in Wibaux County can be maintained or improved by practices that favor good soil structure and tilth. The natural soil structure of the better agricultural soils is very good for plant growth. Destruction of the crumb and granular structure of the surface layers lowers productivity.

When the soil is tilled for a long time and not enough crop residues are left on the surface, the soil is exposed and the original crumb or granular structure breaks to fine particles or single grains. Such structure is susceptible to erosion by wind and water. The natural pores and channels for entrance of air and water tend to close, and the soil becomes baked.

Continued tillage at the same depth on some loamy and sandy loam soils results in a plowsole $1\frac{1}{2}$ to 3 inches thick. The plowsole is compact, dense, and hard; it checks water movement through the soil and the growth of plant roots. Subsoiling or plowing at different depths will increase the yields on such lands. The cost of this practice should be considered, however, in relation to the benefits to be obtained.

In order to have good soil structure and do the necessary cultivation for seedbeds and crops, implements should be used that disturb the natural soil structure as little as possible. Suggested implements are the duckfoot cultivator, one-way disk plow, rotary-rod weeder, and blade sweeps. Partly cover or turn under the surface sod or stubble—a practice called stubble-mulch tillage. Leave bits of stubble and clods on the roughened surfaces to check soil blowing. Favorable tillage can be maintained or renewed in many soils by stubble-mulch tillage or by planting the soils to permanent grasses.

The tilth of heavy soils is improved by fall plowing, as freezing and thawing naturally slake or soften the hard clods. Fall plowing is hazardous on some soils, however, because they have a tendency to blow. In general, the heavy soils are less subject to blowing in winter than loams and sandy loams.

Sandy soils are very subject to wind erosion. Their natural structure is very weak crumb or single grain, and these fine particles are moved easily by wind.

Over the years the productivity of claypan soils is increased by tillage. This improvement is brought about by the slow breaking up of the claypan and by spreading soil from the areas that have a more loamy surface over the pan spots. Claypan soils, such as the Wade, Moline, and Rhoades, need intensive stubble-mulch tillage and applications of all available crop residues. Straw and manure should be spread on the slick-spot areas.

The most beneficial practices are those that induce the most water to enter the soil. Most of the water used by plants must be absorbed from the earth. In order to do this, their root systems must be extensively developed. The total length of the roots of a single plant, such as wheat, can be very long.

In order to tell how much rain enters the soil, consider (1) humus content, texture, and pore space; (2) depth to a layer that can limit water penetration; (3) present condition of the surface soil and use of the land before tillage; (4) moisture content; and (5) duration, intensity, and time of rainfall.

Climate and other hazards

Insufficient moisture during the growing season is the primary factor limiting crop production in Wibaux County. Other hazards are hot periods during mid-summer, high winds, hail, rust, and insects. To cope with these problems, one should grow different kinds of crops or select improved plant varieties. Better and more timely tillage methods should be used. A season that promises to be poor for wheat may be favorable for corn. Choose crops with low water requirements or those that resist drought or mature early. Small grains are early maturing, whereas corn, flax, millet, and rye mature later and are moderately tolerant of dry spells.

Weathermen say there are no clear-cut cycles or rhythms in the weather. It is possible that long-term progressive changes in rainfall occur in cycles, but present records are too recent to show a definite pattern. Many studies have been made, but the results, for all practical purposes, are limited. They do not furnish enough detail for farmers to plan for a single season or a single year. They should try to reserve feed for the dry years; it is during this time that strawstacks are most valuable.

Cropping systems

Variations in moisture from year to year make it impractical to use a fixed rotation. Practices in years that are productive may not be suitable for dry years. The number of soil types that produce well is reduced during prolonged dry spells. The following rotations are suggested, although they do not apply to all soil types or in all years.

In 1951 the United States Northern Great Plains Field Station at Mandan, N. Dak., recommended a 3-year rotation of corn, wheat, and oats or barley. A rotation including summer fallow, followed by wheat, yielded 21 bushels of corn, plus forage and 17 bushels of wheat. These results were obtained at Mandan, more than a hundred miles east of Wibaux in a relatively higher rainfall belt.

Corn is usually grown on less than a third of the acreage in the county. Fallow is practiced on a third of the acreage. The acreage in corn varies greatly from year to year. The purpose of using an intertilled crop or summer fallow is to keep down weeds and to conserve the moisture for the benefit of the succeeding crop. In Wibaux County corn serves mainly as a substitute for fallow. Fallow is more efficient than intertilled crops for suppressing weed growth. The costs of tillage for summer fallow are low. The moisture reserve is built up, and the following year's crop is benefited, at least during the early stages of plant growth. The growing of an intertilled crop, however, has the advantage of producing a crop while weed control is in progress.

How and where soil erosion occurs

Erosion starts when rainwater falls faster than it can penetrate the soil. The rate of penetration is affected by many factors—some natural to the soil and others related to soil use.

Raindrops falling on bare soil make small gouges, and their splash effect can be seen on the leaves. The drops shatter clods and tend to break granules into particles. The weight of 1 inch of rainwater on an acre is more than 110 tons. The force of falling raindrops supplies the energy for erosion. How much soil will be detached by the splash effect will depend on soil structure, the content of organic matter and moisture, present tilth, and ground cover. The unfavorable effects are seen by puddling, sealing, compacting, and crusting. The need for plant litter to break the splash effect of falling raindrops indicates the value of stubble-mulch tillage as a basic farming practice.

Runoff gains energy as it travels downslope. It dislodges and transports soil. The first effect of runoff is hardly discernible because erosion occurs first as a thin sheet flow. Because the thickness of this flow is usually less than 0.1 inch, it is hard to see. The sheet erosion occurs on 95 percent of the area affected by runoff. The effects are gradual and may not be noticed until all the surface soil is gone. Erosion is greatest on the steepest slopes.

Sheet flow joins to form channel flow. Small rills a few inches wide are formed. They ordinarily can be obliterated by tillage. Rills grow into larger channels that deepen into gullies, some of which cannot be crossed by machinery. In time, erosion can cause complete loss of the surface soil on hilltops and slopes (fig. 5).

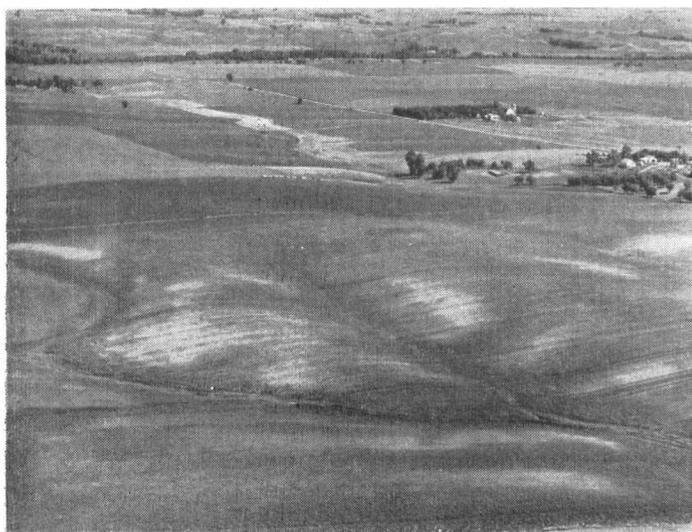


Figure 5.—Erosion has removed all of the surface soil and exposed the light-colored subsoil or parent material on the slopes.

Erosion control practices

In order to stop the loss of soil, erosion should be controlled so far as possible. Basic practices are the maintenance of good soil structure, protection of the surface soil by stubble-mulch tillage (fig. 6), planting of steep erodible slopes to permanent grass cover, and the maintenance of good grass cover on pastures. Other suggested practices are stripcropping on level or gently sloping areas, if the size of the area permits strips (fig. 7), and contour stripcropping on sloping areas, if the pattern of drainage and topography permit this practice.



Figure 6.—Stubble-mulch tillage protects the surface soil by retaining a large part of the residue from the preceding crop.



Figure 7.—Stripcropping on level and gently sloping areas for erosion control.

Stubble-mulch tillage is a good basic practice on all cultivated lands. If soils like the Bainville, Flasher, Midway, or Wibaux are cropped, intensive stubble-mulch tillage is particularly desirable, as well as the use of all possible crop residues, including straw and manure. It is often feasible to place areas of these soils in strips of grass when contour stripcropping is used. Remember that crop residues return nitrogen to the soil, add organic matter, and reduce erosion. They promote good tilth and soil structure that help to keep the surface soil porous.

Some soils like Vebar fine sandy loam and the Vebar-Timmer complex are particularly susceptible to wind erosion. Intensive stubble-mulch tillage and the use of all available crop residues are needed to control erosion. Where stripcropping is used, the strips should be narrower than those on other soils in the county. For most soils, the width of the strips should not exceed 20 rods.

Steep areas not suitable for tillage, or areas suitable only for limited or occasional cultivation, are often intermingled with soils well suited to cultivation. The use of these areas is determined by their size. Some of the

included areas are farmed with the better soils. If the acreage of these steep or thin soils is extensive, the best use for all the area would be for permanent grass.

Contour stripcropping with grass buffer strips is used to control erosion and to conserve fertility (fig. 8). The

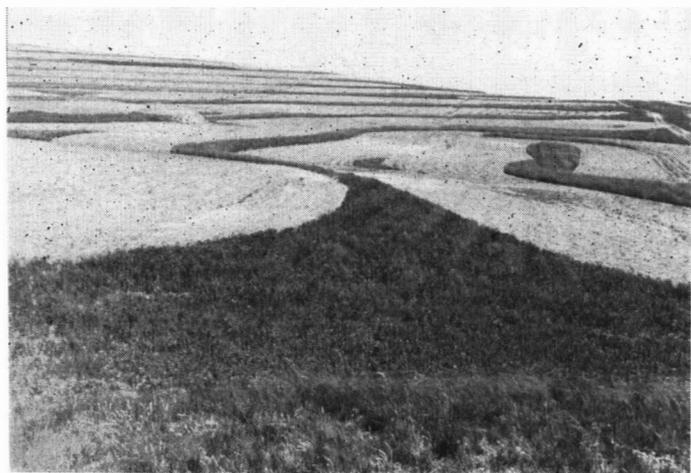


Figure 8.—Contour stripcropping with permanent grass or grass-legume buffers to control erosion on slopes.

grass can be cut for hay or used for pasture. Over a period of time, productivity is stabilized or possibly increased. In general, contouring is not effective on slopes of more than 7 or 8 percent.

Sod or grassed waterways should be established where runoff water concentrates. The waterways are beneficial even where contouring a field is not practical. On areas to be cleared, the vegetation should be left near the regular water channels. Trees, shrubs, and grass strips help to stabilize the waterways in time of runoff. The trees provide shade and shelter for livestock. The Farland-Harlem complex, which occupies low terraces or bottom lands, is typical of land where strips of native vegetation should be left near the regular water channels.

Recommendations on erosion control practices are given by technicians of the Soil Conservation Service and the county agent. They can help plan the management of your farm.

Seeding grass

Grasses are seeded on the native range to increase the yield of forage or on areas too steep for regular cultivation that need protection from erosion. Grass also rebuilds soil structure. It can be used on regular croplands for this purpose. A long-time rotation leaves the soil in grass for 6 to 8 years and in crops for an equal period, or longer.

The most satisfactory grasses for seeding are crested wheatgrass, intermediate wheatgrass, tall wheatgrass, slender wheatgrass, green needlegrass, and brome grass. Crested wheatgrass is the hardiest. Brome grass tends to become sod-bound and prefers moist sites. Intermediate wheatgrass is better for the more fertile or productive sites. Western wheatgrass ordinarily is not seeded, but on many of the heavier soils it frequently reseeds naturally if all of it has not been killed during tillage. It is particularly

good for grass waterways, where it should dominate the stand. Tall wheatgrass is often used on saline soils, such as Cherry silt loam, saline, or Wade soils.

The problem of reestablishing a good grazing crop on severely eroded and steep areas, where the native stand of grass has been destroyed by tillage, has not been solved satisfactorily. Seeding may not be practical in some places on the steep eroded areas. Some of these areas may seed back naturally if all the native grasses were not killed by cultivation. Broken raw slopes that have exposed shale and little or no soil are very difficult to revegetate.

Since new strains of grasses and legumes are being developed for the Great Plains areas, one should consult the county agent or Soil Conservation Service technicians or read the bulletins of the State agricultural experiment station for the latest information.

Because of the risk of losing stands of hay and of the grazing crop by winterkilling, drought, or other hazards, an annual forage crop should be established as a reserve. Small grains to be cut for hay, corn for grain or silage, and millet and rye are the most satisfactory.

Hay and pasture

Alfalfa is a hay crop that is not well suited to grazing. It is grown on nearly level to gently sloping soils where moisture can accumulate. It is deep rooted and draws heavily on soil moisture.

Sweetclover is used for hay and pasture. It is a biennial and will reseed itself and make a partial stand in later years. Yields are not as high as those of alfalfa. Sweetclover is used to supplement crested wheatgrass because it provides good midsummer grazing when crested wheatgrass is dormant. It can also be planted with brome grass for high production.

The wheatgrasses are suitable for hay and pasture. They are harder than alfalfa, which sometimes winterkills. Alfalfa or a legume should be planted with the wheatgrasses for heavy yields.

The best way to establish hay and grazing crops is to prepare the land by summer fallow or by growing an intertilled crop. Alfalfa and sweetclover are seeded without a nurse crop—a nurse crop competes with the permanent cover for food and moisture. The other hay and pasture crops should also be seeded without a nurse crop. Whatever hay crop is seeded, a small amount of legumes should always be planted with the grass for hay and pasture. The new pasture plants should not be grazed the first year because of the possibility of losing the stand.

Past history of the county as it affects agriculture

The history of a county and past records of its climate and productivity furnish some information that can be used as a guide to future plans for farming and ranching. Wibaux County is a part of the Great Plains. Lewis and Clark passed near its northern boundary in 1804–05 on their exploration of the Northwest. The Wibaux area was a land of grass, buffalo, and the Plains Indian.

From 1850 to 1904 it was part of a great cattle country. Severe winters began in 1880–81. The winter of 1886–87 was the worst on record; livestock losses ranged from 60

to 95 percent. After this disaster the stockmen realized the need of extra feed and began to produce hay.

The Northern Pacific Railway crossed the area in 1881. By 1904 farms were getting started, for settlers were coming in after the passage of the Homestead acts. Years of good rainfall began. More than three-fourths of the years from 1905 to 1916 were average or above normal in rainfall. An era of prosperity prevailed; wheat was the dominant crop. Wibaux County was formed in 1914.

Droughts came during 1917 to 1939 and nearly ended dryland farming. Rainfall in three-fourths of the years was below the long-time average. A very severe drought in the 1930's occurred at the same time as the Great Depression. This combination brought tax delinquencies, bank failures, and other financial misfortunes.

Rains came again in 1940-48, and production and prices were high. From 1949 to 1954 one-third of the years were dry and two-thirds had above-average rainfall in Wibaux County.

Farmers should realize that in years of abundant rainfall, even the poorer soils produce fair to good crops. In average years these same soils yield fewer bushels, whereas the better soils give about average yields. In the drier years, only the best soils produce crops. In the worst years, crops fail on nearly all soils. At least two or three droughts have occurred in the Great Plains since the 1880's. Stockmen should establish conservative levels of stocking and know their ranges. Ranges in good condition suffer less from drought than those grazed too closely.

Estimated Yields

High yields of crops are the result of good soil and good soil management. The soil that is used within its capabilities and is treated according to its needs will produce the best average yields. Low yields may be caused by using soils that have many severe limitations, by growing crops that are not suited to the soil, or by poor soil management. Droughts, hail, insects, or plant diseases also adversely affect the soils.

Many soil properties, such as depth, water penetration in subsoil layers, and content of organic matter cannot be changed much by farming practices. The risks of erosion caused by slope can be reduced by practices to control erosion, particularly by keeping crop residues at or near the surface.

The estimated yields of various crops are given in table 1. The first figure in the yield column is the estimated average yield for ordinary years; the second figure is the estimated average yield for better-than-ordinary years. These yields are for the principal crops growing under prevailing management. The prevailing management is not intensive, and systematic crop rotation is not practiced. No commercial fertilizers are applied because most of the soils will give good yields if they receive enough moisture. Some manure is available, but it is seldom used because it decays so slowly that it may reduce yields on cropland, especially the first year.

The yield estimates in table 1 were compiled from a number of sources, including information gained in talks with local farmers. Improved crop varieties, better use of fertilizers, and other good farming practices may make

it possible to increase yields by 20 to 40 percent above those given in the table. Ordinarily, good crops have been obtained about 2 years out of 5. Complete failure has occurred about once in 5 years.

The estimated yields in table 1 can be used to compare present production on your fields with those obtained in the past. If your yields are below the average, the management system and cropping practices probably should be changed. The 40 soils listed are those suited to cultivation.

Management of Rangeland

Almost three-fourths of the land in Wibaux County is in range and small pastures; large areas of range are in the north and southwest. Although range and small pastures continue to produce year after year, the grass and other plants will respond to good management. The kind and amount of vegetation on the range determine the number of cattle it can profitably carry.

Know your grasses and other plants

Farmers or ranchers should know the native grasses and plants on their land in order to plan its best use in range or pasture. Some grasses grow best in cool seasons; others make their best growth in warm weather. Some grow well in the lowlands; others are better suited to upland drier sites. Some reproduce by seed; others spread by underground stems. The grasses that grow best depend on the site, the soil, and the climate. The way the plants are grazed or managed affects the condition of the range and the plants on it.

Some of the native grasses in Wibaux County are as follows: blue grama (*Bouteloua gracilis*), a warm-season short grass that increases in relative amount as the range condition declines; western wheatgrass (*Agropyron smithii*), one of the most valuable grasses of the northern Great Plains, is a cool-season midgrass that spreads by means of underground stems and by seeds; needle-and-thread (*Stipa comata*), a midgrass and major cool-season forage plant; prairie junegrass (*Koeleria cristata*), an early season midgrass of bunch habit; threadleaf sedge (*Carex filifolia*), one of the first plants to provide green grazing in the spring; little bluestem (*Andropogon scoparius*), a vigorous warm-season forage of the slopes; and green needlegrass (*S. viridula*), a tall grass and important cool-season forage plant.

Some of the native plants that increase under heavy grazing on the range are fringed sagebrush (*Artemisia frigida*) silver sagebrush (*A. cana*), an important winter browse plant; and false-tarragon sagebrush (*A. dracunculoides*).

Range site and condition

Range site is defined as an area of range sufficiently uniform in climate, soil, and topography to result in a particular climax vegetation. Climax vegetation is the final stage of plant succession for a given natural environment; the stage at which the composition of the plant community remains unchanged and can reproduce itself

TABLE 1.—Estimated yields for the 40 principal soils suited to crops¹

[A=Average yields for ordinary years. B=Average yields for the years giving the best production]

Soil	Yields ² per acre of—													
	Wheat		Barley		Oats		Corn		Alfalfa		Native hay ³		Mixed hay ⁴	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons
Alluvial land.....	12	20	20	30	25	38	3	5	0.5	2	0.7	1	0.7	1.5
Arnegard silt loam, 0 to 2 percent slopes.....	10	15	17	26	21	33	2	4	1	2	.7	1	.7	1.5
Bainville silt loam, 6 to 9 percent slopes.....	4	9	6	11	7	11	1	2						
Chama silt loam, 4 to 7 percent slopes.....	8	14	15	23	19	32	2	4			.3	.5	.3	.8
Chama-Bainville silt loams, 4 to 9 percent slopes.....	5	10	6	11	8	12								
Chama-Bainville silt loams, 10 to 14 percent slopes.....	4	8	5	10	7	11								
Cherry silt loam, 0 to 3 percent slopes.....	10	16	17	27	21	34	2	4	1	2	.7	1	.7	1.5
Cherry silt loam, 4 to 9 percent slopes.....	6	11	7	11	10	13								
Cherry silt loam, saline, 0 to 3 percent slopes.....											.7	1	.7	1.5
Cherry silt loam, saline, 4 to 9 percent slopes.....											.3	.5	.3	.8
Cheyenne loam, 0 to 5 percent slopes.....	8	14	15	23	19	32	2	4	.5	1	.3	.5	.3	.8
Cushman loam, deep variant, 0 to 3 percent slopes.....	8	14	15	23	19	32					.3	.5	.3	.8
Cushman loam, deep variant, 4 to 7 percent slopes.....	7	12	12	23	15	26					.3	.5	.3	.8
Farland silt loam, 0 to 3 percent slopes.....	10	16	17	27	21	34	2	4	1	2	.7	1	.7	1.5
Farland-Harlem complex, 0 to 3 percent slopes.....	10	16	17	27	21	34	2	4	1	2	.7	1	.7	1.5
Flasher loamy fine sand, 4 to 9 percent slopes.....	6	10	9	11	8	13								
Glendive fine sandy loam, 2 to 6 percent slopes.....									1	2	.7	1	.7	1.5
Grail silty clay loam, 2 to 4 percent slopes.....	11	17	18	28	22	35	2	4	1	2	.7	1	.7	1.5
Grail silty clay loam, 5 to 7 percent slopes.....	9	15	16	26	21	33	2	4			.3	.5	.3	.8
McKenzie-Hoven silty clays, 0 to 1 percent slopes.....											.7	1	.7	1.5
Midway-Moreau complex, 3 to 7 percent slopes.....	5	10	6	11	7	12								
Midway-Regent silty clay loams, 3 to 7 percent slopes.....	5	10	7	11	8	12								
Midway-Regent silty clay loams, 8 to 11 percent slopes.....	5	10	6	11	7	12								
Morton silt loam, 4 to 7 percent slopes.....	9	15	16	26	20	33	2	4			.3	.5	.3	.8
Morton-Arnegard silt loams, 0 to 3 percent slopes.....	11	17	18	28	22	35	2	4	1	2	.7	1	.7	1.5
Morton-Chama silt loams, 4 to 9 percent slopes.....	8	14	15	25	19	32	2	4			.3	.5	.3	.8
Regent silty clay loam, 2 to 4 percent slopes.....	11	17	18	28	22	35	2	4	1	2	.7	1	.7	1.5
Regent silty clay loam, 5 to 7 percent slopes.....	9	15	16	26	20	33	2	4			.3	.5	.3	.8
Regent silty clay loam, 8 to 14 percent slopes.....	6	11	10	16	11	23								
Savage silty clay, 0 to 3 percent slopes.....	10	16	17	27	21	34	2	4	1	2	.7	1	.7	1.5
Savage-Wade complex, 0 to 3 percent slopes.....	8	14	15	23	19	32	2	4	.5	1	.3	.5	.3	.8
Searing loam, 3 to 7 percent slopes.....	8	14	15	25	19	32	2	4			.3	.5	.3	.8
Vebar fine sandy loam, 4 to 7 percent slopes.....	8	14	15	25	19	32	2	4			.3	.5	.3	.8
Vebar fine sandy loam, 8 to 14 percent slopes.....	6	10	8	11	9	13								
Vebar-Flasher complex, 3 to 9 percent slopes.....	8	14	15	23	19	32	2	4			.3	.5	.3	.8
Vebar-Timmer fine sandy loams, 0 to 3 percent slopes.....	10	16	17	27	21	34	2	4	1	2	.7	1	.7	1.5
Wade silty clay loam, 0 to 3 percent slopes.....	4	9	6	11	8	9								
Williams silt loam, 2 to 5 percent slopes.....	8	14	15	25	19	32	2	4			.3	.5	.3	.8
Williams silt loam, 6 to 14 percent slopes.....	6	11	10	16	11	23								

¹ Soils not suited to crops have been omitted from this table. Leaders indicate that the crop is not commonly grown on the soil.

² Approximate average acre yields obtained without the use of amendments.

³ For dominant grasses on the soils, see the section, Management of Rangeland.

⁴ Mixed hay consists of timothy, alsike clover, red clover, redtop, alfalfa, and other suitable grasses.

as long as the environment remains unchanged. Range sites are named from one or more prominent features of the soil or topography. Examples are Overflow land, Saline lowland, and Silty land.

Range condition, an indirect measure of past grazing management, is determined by comparing the kind and amount of present vegetation with the original. It is estimated in this way because the original combination of native grasses is usually the most productive for the range site. Range condition classes are excellent, good, fair, and poor.

Usually three or four kinds of native grasses were

dominant in the climax vegetation of a range site. For example, the silty land range site had a general cover of green needlegrass, needle-and-thread, western wheatgrass, and slender wheatgrass, with an understory of blue grama. Little bluestem and threadleaf sedge were common on exposed knobs and steeper slopes. Many other grasses grew, but the four that were dominant made up more than 75 percent of the total forage on the site. If the Silty land range site is grazed so that the needle-and-thread and wheatgrasses remain abundant, the site is probably producing the maximum amount of forage. Figures 9, 10, 11, and 12 show the grasses on the Silty

land range site under four range conditions. The same principle of climax vegetation holds true for the original cover on other sites.

If the range site is closely grazed, the plants will change in kind and quantity. Western wheatgrass, needle-and-thread, and prairie junegrass will increase at first. If the range is continuously overgrazed, short grasses and shrubby plants will increase. Among the principal short grasses are blue grama and sandberg bluegrass, and the



Figure 9.—Silty land range site in excellent range condition. Principal grasses: green needlegrass, needle-and-thread, western wheatgrass, prairie sandreed, and junegrass. Note heavy mulch, luxuriant plant growth, and large amount of forage. Rainfall soaks into the ground and there is little or no erosion.



Figure 10.—Silty land range site in good range condition. Principal grasses: needle-and-thread; western wheatgrass; blue grama, green needlegrass, sandberg bluegrass. Note ground is well covered and plants are vigorous.



Figure 11.—Silty land range site in fair range condition. Principal plants: bluegrass, threadleaf sedge, sandberg bluegrass, western wheatgrass, needle-and-thread. Note ground cover and low production of forage.



Figure 12.—Silty land range site in poor range condition. Principal plants and grasses: cactus, annuals, blue grama, remnant of western wheatgrass in cactus. Note ground is poorly protected; plants look spindly and weak. There can be much loss of rainfall, and wind erosion will occur.

shrubby plants are fringed sagebrush, pricklypear, snow-berry, and big sagebrush. Weeds, grasses, and shrubs that will invade areas grazed closely for long periods are Kentucky bluegrass, curlycup gumweed, broom snake-weed, foxtail barley, rabbitbrush, and false-tarragon sagebrush.

The soils of Wibaux County have been grouped under various range sites to help ranchers in the proper stocking of their ranges. The range site, the soil, or soils, in each, and the dominant vegetation when the range is in excellent condition are as follows:

Overflow land: Soils that receive extra moisture from higher areas or from stream overflow. Dominant vegetation: Western wheatgrass, switchgrass, and big bluestem.

- Alluvial land.
- Arnegard silt loam, 0 to 2 percent slopes.
- Arnegard silt loam, 3 to 7 percent slopes.
- Cherry silt loam, 0 to 3 percent slopes.
- Farland silt loam, 0 to 3 percent slopes.
- Farland-Harlem complex, 0 to 3 percent slopes.
- Glendive fine sandy loam, 2 to 6 percent slopes.
- Graill silty clay loam, 2 to 4 percent slopes.
- Graill silty clay loam, 5 to 7 percent slopes.
- Morton-Arnegard silt loams, 0 to 3 percent slopes.
- Regent silty clay loam, 2 to 4 percent slopes.
- Savage silty clay loam, 0 to 3 percent slopes.
- Savage-Wade complex, 0 to 3 percent slopes.
- Vebar-Timmer fine sandy loams, 0 to 3 percent slopes.

Saline lowland: More or less salty soils that receive moisture from higher areas or from stream overflow. Dominant vegetation: Alkali cordgrass, alkali sacaton, saltgrass, and sedges.

Cherry silt loam, saline, 0 to 3 percent slopes.
Cherry silt loam, saline, 4 to 9 percent slopes.
McKenzie-Hoven silty clays, 0 to 1 percent slopes.
Wade silty clay loam, 0 to 3 percent slopes.

Sands: Deep, loose, coarse-textured soils. Dominant vegetation: Green needlegrass, switchgrass, prairie sandreed, needle-and-thread, little bluestem, and big bluestem.

Valentine fine sand, 5 to 15 percent slopes.

Sandy land: Normal sandy loams, deep to medium depth. Dominant vegetation: Green needlegrass, switchgrass, prairie sandreed, needle-and-thread, little bluestem, and big bluestem.

Flasher loamy fine sand, 4 to 9 percent slopes.
Vebar fine sandy loam, 4 to 7 percent slopes.
Vebar fine sandy loam, 8 to 14 percent slopes.
Vebar-Flasher complex, 3 to 9 percent slopes.

Silty land: Normal silt loams, deep to medium depth. Dominant vegetation: Western wheatgrass, little bluestem, green needlegrass, needle-and-thread, and slender wheatgrass.

Bainville silt loam, 6 to 9 percent slopes.
Bainville silt loam, 10 to 14 percent slopes.
Bainville silt loam, 15 to 40 percent slopes.
Bainville-Chama silt loams, 15 to 30 percent slopes.
Bainville-Flasher complex, 6 to 14 percent slopes.
Chama silt loam, 4 to 7 percent slopes.
Chama stony silt loam, 4 to 9 percent slopes.
Chama stony silt loam, 10 to 30 percent slopes.
Chama-Bainville silt loams, 4 to 9 percent slopes.
Chama-Bainville silt loams, 10 to 14 percent slopes.
Cherry silt loam, 4 to 9 percent slopes.
Cheyenne loam, 0 to 5 percent slopes.
Cushman loam, deep variant, 0 to 3 percent slopes.
Cushman loam, deep variant, 4 to 7 percent slopes.
Morton silt loam, 4 to 7 percent slopes.
Morton-Chama silt loams, 4 to 9 percent slopes.
Searing loam, 3 to 7 percent slopes.
Williams silt loam, 2 to 5 percent slopes.
Williams silt loam, 6 to 14 percent slopes.
Zahl loam, 8 to 30 percent slopes.

Clayey land: Normal silty clay loams, deep to medium depth. Dominant vegetation: Western wheatgrass, plains reedgrass, and green needlegrasses.

Midway-Moreau complex, 3 to 7 percent slopes.
Midway-Moreau complex, 8 to 11 percent slopes.
Midway-Moreau complex, 12 to 30 percent slopes.
Midway-Regent silty clay loams, 3 to 7 percent slopes.
Midway-Regent silty clay loams, 8 to 11 percent slopes.
Midway-Regent silty clay loams, 12 to 15 percent slopes.
Regent silty clay loam, 5 to 7 percent slopes.
Regent silty clay loam, 8 to 14 percent slopes.

Panspots: Claypan soils with slick spots. Dominant vegetation: Western wheatgrass, needle-and-thread, and blue grama.

Moline clay loam, 2 to 4 percent slopes.
Moline clay loam, 5 to 7 percent slopes.
Rhoades clay loam, 4 to 7 percent slopes.
Rhoades-Moline complex, 8 to 11 percent slopes.
Rhoades-Moline complex, 12 to 20 percent slopes.

Thin breaks. Dominant vegetation: Western wheatgrass, little bluestem, and prairie sandreed.

Bainville-Flasher complex, 15 to 40 percent slopes.
Bainville-Wibaux complex, 15 to 40 percent slopes.
Gravelly terrace remnants, 5 to 40 percent slopes.

Shallow land. Dominant vegetation: Western wheatgrass, prairie sandreed, and side-oats grama.

Flasher loamy fine sand, 10 to 14 percent slopes.
Flasher loamy fine sand, 15 to 40 percent slopes.
Wibaux stony loam, 10 to 40 percent slopes.

Very shallow land. Dominant vegetation: Threadleaf sedge, blue grama, stonyhills muhly, and western wheatgrass.

Rockland-Bainville complex, 15 to 50 percent slopes.
Rockland-Flasher complex, 15 to 50 percent slopes.

Shale and clay. Dominant vegetation: Blue grama, threadleaf sedge, western wheatgrass, and juniper.

Lismas clay-Shale outcrop, 20 to 60 percent slopes.
Pierre-Lismas clays, 15 to 40 percent slopes.

How to plan range use

First, identify your soils on the maps in the back of this report. Then refer to the range sites previously listed to find in which site your soils are located and the plants that are dominant when the range is in excellent condition. Next, examine your range to check the plants now growing on it. On the basis of this comparison, and by finally considering the vigor of the plants and the number of weeds, you can estimate the condition of your range.

The number of livestock can be adjusted from season to season according to the amount of vegetation. When half the growth has been grazed off, move the animals to another pasture, market them, or provide feed.

Technicians of the Wibaux Soil Conservation District will help you to determine the different kinds of range sites on your land. They can help you measure the range condition and plan management practices for best range production.

Principles of range management

Four main principles of management apply in the proper use of any range site. They are:

1. *Proper number of livestock.*—The stocking rate during the growing season should permit utilization of about one-half of the annual growth of the taller high-producing grasses. The number of livestock should be balanced against the time they will be on the range and the condition of the grasses. If the balance is good and the proper amount of forage is left on the ground, the cover will (a) serve as a mulch that aids in the greater intake and storage of water; (b) permit greater root development and better utilization of stored moisture; (c) protect the soil from erosion by wind and water; (d) allow grass to crowd out weeds and thereby further improve range conditions; (e) enable plants to store more food in their roots for growth in the following year; (f) aid in holding snow in place and in providing a more even distribution of moisture; and (g) provide a greater feed reserve for winter grazing.

2. *Proper distribution of grazing.*—Many pastures are overgrazed in some areas and undergrazed, or not grazed at all, in others (fig. 13). This problem can be overcome by a better distribution of salt and water and a careful location of fences. Salt should be placed on areas that are lightly grazed. It should not be put on sandy or eroded spots such as occur on Flasher or Valentine soils. Special care should be taken to avoid trampling on Vebar and Timmer soils. Watering places should be developed over the entire pasture, if possible, so that the stock do not have to walk too far. Fences should be located to provide pasture for all classes of livestock that will run on the range in summer and also to furnish pastures for winter use. Wherever possible, place fences on the boundaries between range sites.

3. *Proper season of use.*—The time of grazing can often be arranged by placing pasture fences so that livestock will graze cool-season grasses early in the spring and warm-season grasses in the summer. Range site and its condition help to determine the best time for grazing. A pasture in poor to fair condition should be rested until fall or



Figure 13.—Effect of grazing on root and top growth on two grasses. Samples dug the same day from the same soil, on opposite sides of fence. Left, blue grama (A) after many years of close grazing; (B) under normal production. Right, needle-and-thread (A) closely grazed; (B) grazed on the principle of "take half-leave half."

winter to permit the better grasses to seed and to spread by underground stems.

4. *Proper kind of grazing animals.*—The people of Wibaux County have learned that cattle are best suited to their farm and ranch operations. In this section of the Great Plains the grasses, soil, and climate are suitable for either cattle or sheep.

Management of Woodlands

Generally woodlands are growing on areas not suited to other crops. Protection from fire and control of grazing are important management problems.

Natural woodlands

In 1945 Wibaux County had 5,436 acres of natural woodland.¹ Evergreen species make up about a fifth of the acreage. The rest of the woodland consists of mixed stands of deciduous trees. Scattered stands of ponderosa pine and juniper are in the rougher areas of the southwestern part of the county. Because juniper is a durable wood, it has been cut repeatedly for fence posts. The deciduous or broadleaf species are on the river bottoms and along streams and drainageways.

Along Beaver Creek the native vegetation consists of deciduous trees and brush and grass on many open areas. The trees are mostly second-growth cottonwood, green ash, American elm, boxelder, and willow. Scattered

¹ BROWN, C. W., and HODGE, W. C. FOREST RESOURCES OF NORTHERN MONTANA. U. S. Forest Serv., Northern Rocky Mountain Forest and Range Expt. Sta., Sta. Paper 13. 1948.

thickets of hawthorn, dogwood, wildrose, wildplum, and chokecherry and expanses of buffaloberry are common.

The wooded areas were important to the early settlers who depended upon them for building materials, fuel, food, and shelter. Although the natural woodlands have a limited commercial use, they are increasingly valued as watersheds and for wildlife and recreation.

Woodland and windbreak plantings

The advantages to be derived from planting woodlands should be considered. Trees and shrubs add beauty to the farm (fig. 14). Windbreaks protect the house and



Figure 14.—Windbreaks and woodland plantings protect buildings and beautify the home.

also reduce its heating costs by shielding it from the elements. A house exposed to wind moving 20 miles per hour will use more than twice as much fuel as it would if exposed to a wind moving 5 miles per hour. Windbreaks also provide shelter for livestock. The feeding requirements of the animals can be lowered if they are shielded from wind and storm. Technical assistance on what, when, and how to plant can be given by representatives of the Soil Conservation Service and the county agent.

Planting sites

The soils of Wibaux County can be placed into three groups, called planting sites, which can be used in a general way to determine the adaptability of an area for windbreak plantings. Before a windbreak is planned, some areas may need further investigation to determine their suitability for certain kinds of trees.

PLANTING SITE 1

Planting site 1 consists of soils generally well adapted to woodland plantings for farmstead or field windbreaks. They are as follows:

- Alluvial land.
- Arnegard silt loam, 0 to 2 percent slopes.
- Arnegard silt loam, 3 to 7 percent slopes.
- Bainville silt loam, 6 to 9 percent slopes.
- Chama silt loam, 4 to 7 percent slopes.
- Chama-Bainville silt loams, 4 to 9 percent slopes.
- Chama-Bainville silt loams, 10 to 14 percent slopes.
- Cherry silt loam, 0 to 3 percent slopes.
- Cherry silt loam, 4 to 9 percent slopes.

Cheyenne loam, 0 to 5 percent slopes.
 Cushman loam, deep variant, 0 to 3 percent slopes.
 Cushman loam, deep variant, 4 to 7 percent slopes.
 Farland silt loam, 0 to 3 percent slopes.
 Farland-Harlem complex, 0 to 3 percent slopes.
 Flasher loamy fine sand, 4 to 9 percent slopes.
 Glendive fine sandy loam, 2 to 6 percent slopes.
 Grail silty clay loam, 2 to 4 percent slopes.
 Grail silty clay loam, 5 to 7 percent slopes.
 Midway-Moreau complex, 3 to 7 percent slopes.
 Midway-Regent silty clay loams, 3 to 7 percent slopes.
 Midway-Regent silty clay loams, 8 to 11 percent slopes.
 Midway-Regent silty clay loams, 12 to 15 percent slopes.
 Morton silt loam, 4 to 7 percent slopes.
 Morton-Arnegard silt loams, 0 to 3 percent slopes.
 Morton-Chama silt loams, 4 to 9 percent slopes.
 Regent silty clay loam, 2 to 4 percent slopes.
 Regent silty clay loam, 5 to 7 percent slopes.
 Regent silty clay loam, 8 to 14 percent slopes.
 Savage silty clay loam, 0 to 3 percent slopes.
 Savage-Wade complex, 0 to 3 percent slopes.
 Searing loam, 3 to 7 percent slopes.
 Valentine fine sand, 5 to 15 percent slopes.
 Vebar fine sandy loam, 4 to 7 percent slopes.
 Vebar fine sandy loam, 8 to 14 percent slopes.
 Vebar-Flasher complex, 3 to 9 percent slopes.
 Vebar-Timmer fine sandy loams, 0 to 3 percent slopes.
 Williams silt loam, 2 to 5 percent slopes.
 Williams silt loam, 6 to 14 percent slopes.

On planting site 1 the following species are commonly used: Caragana, green ash, American elm, Chinese elm, Russian-olive, and buffaloberry. Other species probably can be used successfully.

The cottonwood and willow should be limited to areas that are subirrigated or have sufficient run-in water. Ponderosa pine, Colorado spruce, and Rocky Mountain juniper are also useful evergreen plantings. Ash is subject to attack by the wood borer.

Practices for establishing windbreaks include fallow previous to planting, fencing to exclude livestock, and cultivation to keep down weeds. A cultivated strip around the planting is desirable for storing moisture and for protection from fire. Runoff should be diverted to the planting site wherever possible. Snow fences are useful for trapping snow to provide moisture during the early growth periods. Deep mulching is not a substitute for clean cultivation. Protect the young trees from rodent damage, insects, and disease. On sloping lands, plant and cultivate on the contour where practicable (fig. 15).

On the very sandy soils, such as Valentine fine sand, 5 to 15 percent slopes, the hazard from wind erosion is very great.

The rows of trees should be clean cultivated, but part



Figure 15.—Windbreak planted on the contour.

of the space between rows should be planted to cover crops to control wind erosion.

PLANTING SITE 2

Planting site 2 consists of saline and wet areas and claypan soils. Plantings on this site should be limited to salt-tolerant species. Saline soils with a high salt content, or pH above about 8.5, are not suitable for trees. Slightly saline soils or nonsaline alkali soils are suitable for cottonwood, Russian-olive, buffaloberry, golden willow, and white willow. The following mapping units are included in this planting site:

Cherry silt loam, saline, 0 to 3 percent slopes.
 Cherry silt loam, saline, 4 to 9 percent slopes.
 McKenzie-Hoven silty clays, 0 to 1 percent slopes.
 Moline clay loam, 2 to 4 percent slopes.
 Moline clay loam, 5 to 7 percent slopes.
 Rhoades clay loam, 4 to 7 percent slopes.
 Rhoades-Moline complex, 8 to 11 percent slopes.
 Rhoades-Moline complex, 12 to 20 percent slopes.
 Wade silty clay loam, 0 to 3 percent slopes.

PLANTING SITE 3

Planting site 3 consists of very steep slopes, shallow soils, and very heavy clay soils. This site is generally not adapted to trees, although some spots can be successfully planted. Thorough investigation should be made before trees are planted on these areas. The following mapping units are included in planting site 3:

Bainville silt loam, 10 to 14 percent slopes.
 Bainville silt loam, 15 to 40 percent slopes.
 Bainville-Chama silt loams, 15 to 30 percent slopes.
 Bainville-Flasher complex, 6 to 14 percent slopes.
 Bainville-Flasher complex, 15 to 40 percent slopes.
 Bainville-Wibaux complex, 15 to 40 percent slopes.
 Chama stony silt loam, 4 to 9 percent slopes.
 Chama stony silt loam, 10 to 30 percent slopes.
 Flasher loamy fine sand, 10 to 14 percent slopes.
 Flasher loamy fine sand, 15 to 40 percent slopes.
 Gravelly terrace remnants, 5 to 40 percent slopes.
 Lismas clay-Shale outcrop, 20 to 60 percent slopes.
 Midway-Moreau complex, 8 to 11 percent slopes.
 Midway-Moreau complex, 12 to 30 percent slopes.
 Pierre-Lismas clays, 15 to 40 percent slopes.
 Rockland-Bainville complex, 15 to 50 percent slopes.
 Rockland-Flasher complex, 15 to 50 percent slopes.
 Wibaux stony loam, 10 to 40 percent slopes.
 Zahl loam, 8 to 30 percent slopes.

Wildlife

In pioneer times the settlers hunted and fished for their immediate use. The exploitation of wildlife continued long after the supply of domestic animals was adequate. We are now, however, beginning to realize the value of conserving wildlife.

Wibaux County supports many kinds of wildlife including deer (fig. 16), antelope, mink, beaver, muskrat, raccoon, skunk, rabbit, ground squirrel, coyote, prairie dog, and badger. Upland birds include the sharptailed grouse, sage hen, ring-necked pheasant, horned lark, tree sparrow, meadowlark, robin, blackbird, mourning dove, and other insect-eating birds. Birds of the lakes and marshes include ducks, herons, coots, terns, gulls, killdeers, sandpipers, and geese. Crappies, black bass, bluegills, bullheads, catfish, and walleyed pike abound in the waters of the county.

The Lamesteer National Wildlife Game Refuge has been established by the United States Fish and Wildlife Service in the southwestern part of the county.



Figure 16.—Fawn; it will lose its spots before long.

Some kinds of wildlife are valuable for controlling insects and rodents. Birds, hawks, owls, and insect-eating animals, such as skunks, moles, and shrews, naturally belong on the land. All kinds of wildlife can live on the farm or ranch if food, cover, and water are present.

Many natural wildlife habitats already exist in the county. They should be protected from burning and grazing; brushy areas and coulees should be fenced out, and protection afforded around small ponds. Almost every farm and ranch has areas where food, cover, and water could be provided for wildlife.

A general plan for developing and improving wildlife habitats will include some of the following minimum practices:

1. Prepare the site, if necessary, and cultivate the woody and shrub plantings to get them started.
2. Protect the site from burning and grazing.
3. Plant species that will furnish food and cover, including shrubs and trees.
4. Plant and cultivate on the contour on sloping lands.
5. Give particular attention to gully and stream-bank plantings, fence rows, ditchbanks, roadsides, hedges, and windbreaks.
6. Develop a complete conservation plan; provide food, cover, and water for wildlife during the entire year.

Wibaux County has many reservoirs that can be stocked with fish. Because the reservoirs vary in depth and some are dry during part of the year, care should be taken in stocking them.

Technical assistance in developing habitats and in stocking reservoirs can be obtained from your local Soil Conservation Service technician, from the State Fish and Game Department, and the United States Fish and Wildlife Service, the State or Federal forester, or the county agent.

Soil Associations

A knowledge of the general distribution of soils is important. The large-scale colored map in the back of this report shows generalized soil associations in Wibaux

County. The map has been drawn from the detailed maps and only dominant soils are shown.

This section broadly describes the land use and gives the principal soil series in the designated areas. The 11 soil associations are as follows.

Rhoades-Flasher-Cushman

This association is in the southwestern part of the county. It consists principally of grazing land, but local dryland farming areas are on Cushman soils. The landscape on which this association occurs is apparently geologically older than the rest of the county. Most areas of this association are rolling to steep, but a few are smooth. Exposures of Hell Creek and Fox Hills sandstone formations occur. Included is a small sandhill section of Valentine soils. Some areas of Badlands occur, which, for the most part, are used for grazing. Hay is cut on local creek bottoms on the Glendive and Alluvial soils. Extensive areas of Rhoades soils pit the area. They have a dense claypan.

Pierre-Lismas-Rhoades-Moline

This distinct soil association, like the Rhoades-Flasher-Cushman, is in the southwestern part of the county. The soils are closely related to broad exposures of dense clay shale of the Bearpaw formation. This landscape is also very old geologically. The heavy clay soils support a sparse cover of grasses. Thin to heavy stands of Rocky Mountain juniper occur on parts of this soil association. The juniper trees are a local source of fence posts. The topography is smooth to rolling and steep. The association provides sparse grazing and a refuge for wildlife.

Badlands-Bainville-Flasher-Midway

This association occurs in the southwestern part of the county and borders the Pierre-Lismas-Rhoades-Moline association. It also occurs in the northern and northwestern parts of the county. It is a fairly distinct area of rough land. Much of the area consists of Badlands. This association is dominantly a range area that has steep eroding breaks and an intricate stream pattern. In the far north, Zahl and Williams soils are on smoother remnants of a glaciated landscape on the eroded uplands. No Midway soils occur in the far north.

Moreau-Midway-Regent

This association is in the southern part of the county. It consists generally of moderately heavy soils. It is a mixed farming and grazing area. The topography is mostly sloping, and there are intermingled steep areas of Bainville and Flasher soils. On the gentle slopes the soils are very productive. Some Grail soils are associated with those of the Regent series.

Farland-Savage-Harlem

This distinct association of soils is on the bottom lands and low terraces of Beaver Creek and its main tributaries.

The farmlands occurring on it are in many places highly productive. In a few areas, claypans of the Wade series occur. Cheyenne soils are on some of the high benches. Along the Yellowstone River and Smith Creek in the northern part of the county, the association includes isolated areas of the Badlands-Bainville-Flasher-Midway soil association.

Flasher-Vebar

This association consists of scattered areas where sandy soils are predominant. It is only fairly distinct, since, sandy soils occur throughout the county. Intermingled are areas of silt loam soils of the Morton and Chama series as well as other soils. Soils in this association have the greatest hazard from wind erosion. The topography is smooth to steep, and sandstone outcrops are common in the road cuts. Much of the area is farmed, but native grasses grow in places.

Bainville-Chama-Flasher

This association includes much of the land north of the town of Wibaux. It is dominantly a good range country made up of silty soils having moderately steep to steep slopes. A few of the better soils on the gentler slopes are cultivated. The steeply sloping areas were once farmed, but they have largely been abandoned. Hay is cut on the Cherry soils, which occur in the larger stream valleys.

Bainville-Wibaux-Chama

This association consists dominantly of scoria buttes. Most of the area is steep and hilly, but a few places have gentle slopes suited to farming. This association is fairly good for range.

Morton-Arnegard-Chama

This distinct soil association occurs in the eastern part of the county. It is dominantly level to gently sloping but includes a few intermingled areas of steeper slopes and scoria buttes. Some of the best farming land in the county is in the Morton-Arnegard-Chama association.

Wibaux-Morton-Chama-Bainville-Searing

This distinctive soil association is characterized by the scoria knobs that occur in association with Wibaux soils. The topography ranges from sloping to hilly. Mixed farming and grazing prevail on many of the soils. The smoother slopes are occupied by Morton, Chama, and Searing soils.

Chama-Morton-Bainville-Flasher

This association is composed of many kinds of soils and slopes. The soil patterns are very complex. It is a mixed farming-grazing area. Small areas of Wibaux and Midway soils are included.

Descriptions of Soils

This section describes the soil series (groups of soil) and single soils (mapping units) of Wibaux County. Here is the method followed:

The soil series is described first, and in detail. An important part of this description is the soil profile, a record of what the soil surveyor saw and learned when he dug into the ground. The profile for each series was taken at a given location within one of the mapping units belonging to that series. It is called a "typical" profile, because, aside from minor variations, it is the kind of profile that will be found in all soils of a given series.

Each of the mapping units, or soils, in a series is described next. The description for each soil is brief, because all the soils in one series are basically the same. For a single soil in a series, the emphasis is on those characteristics it has that other soils of the same series do not have, or have in a different degree. Slope, erosion, and similar properties that affect management are pointed out in the description of the single soils.

The location and distribution of the single soils, or mapping units, are shown on the soil map at the back of this report. Their approximate acreage and proportionate extent are shown in table 2. Figure 4 shows the topographic position of several soils important in the county. It will be helpful to refer to the section, Soil Survey Methods and Definitions, for definition of "series," "phases," and other special terms used in describing soils.

Soil horizons believed to contain free carbonates have been tested with a few drops of dilute hydrochloric acid. Bubbles of carbon dioxide show that carbonates, usually calcium carbonate, are present. Soils that effervesce when dilute acid is dropped on them are described as effervescing slightly, strongly, etc. A horizon described as "strongly calcareous" will effervesce strongly.

Alluvial land

Alluvial land (Aa).—Narrow irregular strips of this miscellaneous land type are mapped along the channels of the various creeks in the county. These strips make a considerable acreage, which is used almost entirely for a pasture. They are usually subject to flooding one or more times each year. Alluvial land has great variation in texture and drainage—many areas have silty, wet, or sandy soils, and a few have loose, sandy, and droughty soils. Stream channels and sand and gravel bars are included.

The surface is usually very hummocky and uneven. Soil development is limited because the material generally consists of recent stream deposits of silts and sands. The soils are usually deep. The quantity of grasses, shrubs, and trees is variable.

Because of the hazard of flooding and the irregularity of the areas, this miscellaneous land type is suitable chiefly for pasture and grazing. It provides very good grazing. A few areas could be improved by clearing and planting grasses and legumes. Clearing should not be too close to regular stream channels, however. Shrubs, trees, and grass strips should be left to stabilize the channelways and to provide shade and shelter for livestock.

Capability unit, VIw-1; range site, Overflow land.

TABLE 2.—Approximate acreage and proportionate extent of the soils

Soil	Acre	Percent	Soil	Acre	Percent
Alluvial land.....	10,396	1.8	Midway-Moreau complex, 8 to 11 percent slopes.....	2,307	0.4
Arnegard silt loam, 0 to 2 percent slopes.....	5,271	.9	Midway-Moreau complex, 12 to 30 percent slopes.....	13,294	2.3
Arnegard silt loam, 3 to 7 percent slopes.....	955	.2	Midway-Regent silty clay loams, 3 to 7 percent slopes.....	9,871	1.7
Badlands.....	35,556	6.2	Midway-Regent silty clay loams, 8 to 11 percent slopes.....	2,306	.4
Bainville silt loam, 6 to 9 percent slopes.....	5,492	1.0	Midway-Regent silty clay loams, 12 to 15 percent slopes.....	650	.1
Bainville silt loam, 10 to 14 percent slopes.....	7,692	1.4	Moline clay loam, 2 to 4 percent slopes.....	3,972	.7
Bainville silt loam, 15 to 40 percent slopes.....	10,409	1.8	Moline clay loam, 5 to 7 percent slopes.....	8,190	1.4
Bainville-Chama silt loams, 15 to 30 percent slopes.....	68,174	12.0	Morton silt loam, 4 to 7 percent slopes.....	45,018	7.9
Bainville-Flasher complex, 6 to 14 percent slopes.....	1,270	.2	Morton-Arnegard silt loams, 0 to 3 percent slopes.....	14,022	2.5
Bainville-Flasher complex, 15 to 40 percent slopes.....	16,391	2.9	Morton-Chama silt loams, 4 to 9 percent slopes.....	4,000	.7
Bainville-Wibaux complex, 15 to 40 percent slopes.....	16,243	2.9	Pierre-Lismas clays, 15 to 40 percent slopes.....	12,399	2.2
Chama silt loam, 4 to 7 percent slopes.....	65,879	11.6	Regent silty clay loam, 2 to 4 percent slopes.....	2,444	.4
Chama stony silt loam, 4 to 9 percent slopes.....	477	.1	Regent silty clay loam, 5 to 7 percent slopes.....	19,385	3.4
Chama stony silt loam, 10 to 30 percent slopes.....	426	.1	Regent silty clay loam, 8 to 14 percent slopes.....	4,959	.9
Chama-Bainville silt loams, 4 to 9 percent slopes.....	1,121	.2	Rhoades clay loam, 4 to 7 percent slopes.....	1,334	.2
Chama-Bainville silt loams, 10 to 14 percent slopes.....	5,942	1.0	Rhoades-Moline complex, 8 to 11 percent slopes.....	5,628	1.0
Cherry silt loam, 0 to 3 percent slopes.....	5,556	1.0	Rhoades-Moline complex, 12 to 20 percent slopes.....	2,305	.4
Cherry silt loam, 4 to 9 percent slopes.....	1,661	.3	Rockland-Bainville complex, 15 to 50 percent slopes.....	48,308	8.5
Cherry silt loam, saline, 0 to 3 percent slopes.....	1,500	.3	Rockland-Flasher complex, 15 to 50 percent slopes.....	8,134	1.4
Cherry silt loam, saline, 4 to 9 percent slopes.....	500	.1	Savage silty clay loam, 0 to 3 percent slopes.....	4,043	.7
Cheyenne loam, 0 to 5 percent slopes.....	1,317	.2	Savage-Wade complex, 0 to 3 percent slopes.....	2,314	.4
Cushman loam, deep variant, 0 to 3 percent slopes.....	1,500	.3	Searing loam, 3 to 7 percent slopes.....	3,797	.7
Cushman loam, deep variant, 4 to 7 percent slopes.....	2,000	.4	Valentine fine sand, 5 to 15 percent slopes.....	1,367	.2
Farland silt loam, 0 to 3 percent slopes.....	7,901	1.4	Vebar fine sandy loam, 4 to 7 percent slopes.....	9,718	1.7
Farland-Harlem complex, 0 to 3 percent slopes.....	5,989	1.0	Vebar fine sandy loam, 8 to 14 percent slopes.....	3,245	.6
Flasher loamy fine sand, 4 to 9 percent slopes.....	1,515	.3	Vebar-Flasher complex, 3 to 9 percent slopes.....	2,000	.4
Flasher loamy fine sand, 10 to 14 percent slopes.....	6,446	1.1	Vebar-Timmer fine sandy loams, 0 to 3 percent slopes.....	540	.1
Flasher loamy fine sand, 15 to 40 percent slopes.....	6,761	1.2	Wade silty clay loam, 0 to 3 percent slopes.....	2,349	.4
Glendive fine sandy loam, 2 to 6 percent slopes.....	541	.1	Wibaux stony loam, 10 to 40 percent slopes.....	4,647	.8
Grail silty clay loam, 2 to 4 percent slopes.....	3,067	.5	Williams silt loam, 2 to 5 percent slopes.....	397	.1
Grail silty clay loam, 5 to 7 percent slopes.....	800	.1	Williams silt loam, 6 to 14 percent slopes.....	863	.2
Gravelly terrace remnants, 5 to 40 percent slopes.....	4,209	.7	Zahl loam, 8 to 30 percent slopes.....	2,245	.4
Lismas clay-Shale outcrop, 20 to 60 percent slopes.....	12,399	2.2	Roads, railroads, gravel pits, riverwash, building and town sites.....	5,868	1.0
McKenzie-Hoven silty clays, 0 to 1 percent slopes.....	206	(¹)			
Midway-Moreau complex, 3 to 7 percent slopes.....	1,479	.3	Total.....	568,960	100.0

¹ Less than 0.1 percent.

Arnegard series

The Arnegard soils occur mostly in the northern and eastern parts of the county. They occupy valley flats, swales, and a few broad basins in the uplands. Nearby, on the upland slopes, are usually Morton and Chama soils. Nearly all of the Arnegard soils are under cultivation.

Arnegard soils have developed from the silty wash of local alluvium. The fairly level to gentle slopes receive some runoff from higher areas, and the soil layers that

have developed are well marked. The surface soil is a dark-colored silt loam and has strong crumb structure. The subsoil layers have blocky to prismatic structure. Below a depth of 2 feet the silty soil parent material is streaked with an accumulation of lime. A dense cover of grass has contributed to the dark color and fertility of Arnegard soils.

The high content of organic matter in the thick surface layers, moderate permeability of the subsoils to air and water, and good workability are significant in Arnegard soils.

Typical profile: Arnegard silt loam; location, 100 feet SW. of NE. corner, sec. 1, T. 14 N., R. 60 E.:

- A_{1p} 0 to 7 inches
Dark grayish-brown (10YR 4/2, dry)² to very dark grayish-brown (10YR 2/1.5, moist) heavy silt loam with strong fine crumb structure; friable when moist, slightly hard when dry; lower boundary abrupt.
- A₁ 7 to 12 inches
Dark grayish-brown (10YR 4/2, dry) to grayish-brown (10YR 5/2, moist) heavy silt loam with moderate fine granular structure breaking to strong fine crumb structure; friable when moist; slightly hard when dry; lower boundary gradual.
- B₂₁ 12 to 18 inches
Very dark grayish-brown (10YR 3/2, moist) silty clay loam with moderate medium and fine blocky structure; firm when moist; plastic and sticky when wet; lower boundary gradual.
- B₂₂ 18 to 24 inches
Dark grayish-brown (10YR 4/2, moist) silty clay loam with weak medium prismatic breaking to moderate medium and fine blocky structure; firm when moist, plastic and sticky when wet; lower boundary gradual.
- B₃ 24 to 36 inches
Dark grayish-brown (10YR 4/2, moist) light silty clay loam; massive breaking to weak fine crumb structure; firm when moist, plastic and sticky when wet; effervesces strongly; lower boundary diffuse.
- C_{ca} 36 to 54 inches
Grayish-brown (2.5Y 5/2, moist) heavy silt loam; massive breaking to weak fine crumb structure; friable when moist, slightly plastic and slightly sticky when wet; effervesces strongly; lime spots set apart or segregated.
- D 54 to 60 inches
Pale-olive (5Y 6/3, moist) heavy silt loam of weathered silty shale.

Arnegard silt loam, 0 to 2 percent slopes (Ab).—This soil has the profile described for the Arnegard series. The hazard of water erosion is at a minimum, but the bare soil is subject to wind erosion. In some years, wet spots may delay cultivation. This soil is good for crops and very good for range.

Capability unit, IIe-1; range site, Overflow land.

Arnegard silt loam, 3 to 7 percent slopes (Ac).—This soil has a profile like that described for the Arnegard series. Only a few areas occur, usually near the more nearly level Arnegard soil. Water erosion is a greater hazard on this soil than on Arnegard silt loam, 0 to 2 percent slopes. The bare soil is subject to wind erosion. This soil is good for crops, and very good for range.

Capability unit, IIIe-1; range site, Overflow land.

Badlands

Badlands (Ba).—This miscellaneous land type is mapped in large areas in the northern and southwestern parts of the county. Badlands occupy steep, stream-cut areas where soft bedrock of shale and sandstone are widely exposed. Runoff is very rapid, and permeability is very slow. Erosion is active, and little true soil development has taken place. Vegetation is limited to the bottom of draws, smooth benchlike areas, or slopes where soil can form or has not been removed by erosion. The steep topography makes grazing difficult. Badlands are used chiefly for wildlife and for watersheds. They are usually fairly well watered by seeps and springs.

On the soil map, the distinction between Badlands and the Rockland-Bainville complex and the Rockland-Flasher complex is very general. The difference is based largely on degree of slope, amount of stream dissection, and presence of rock outcrop.

The development of springs, the building of roads, and the most advantageous location of fences and salt would help to improve areas of this land type. Before making these improvements, farmers should consider the cost in relation to the value of the grazing to be obtained. They should also know the range condition of the native pastures.

Capability unit, VIIIs-1; not classified in a range site.

Bainville series

Bainville soils are mapped in many places in the county. Where mapped in complex with other soils, they are mostly in sections of grazing land. Where mapped alone, they are located mostly on the farms and to a smaller extent on the ranges. Bainville soils are associated with many soils that are better for farming, as the Morton, Chama, and Regent soils. They are not suited to tillage. If the slopes above 9 percent are farmed, they are soon eroded to shale. About half the areas are in native range; they should be left in this use if possible.

The Bainville soils are thinly developed over soft siltstone and sandstone (fig. 4). Shale outcrops are common. Surface soils are thin (4 inches or less) and are silty to slightly sandy. Runoff is mostly rapid. The grass cover varies from sparse to dense.

The content of organic matter in Bainville soils is low. The permeability to air and moisture of subsoil layers is moderate to moderately slow. Workability is usually fair to poor, chiefly because of lack of organic matter, shallowness of profile, and presence of parent material within plow depth. Bainville soils are subject to severe water erosion; they are susceptible to wind erosion on exposed knobs and hills.

In many places this soil is farmed with other soils that are better for crops, and the same practices are used on all areas. In most of these areas, Bainville soils should be planted to permanent grass by seeding crested wheat-grass or other suitable grasses for pasture or hay.

Typical profile: Bainville silt loam:

- A₁ 0 to 4 inches
Dark grayish-brown (10YR 4/2, moist) silt loam with strong fine crumb structure; friable when moist; effervesces strongly; lower boundary clear.
- B 4 to 11 inches
Yellowish-brown (10YR 5/4, moist) silt loam with shale fragments; friable when moist; effervesces strongly.
- C 11 to 36 inches
Light-brown (2.5Y 6/3, moist) bedded and weathered silts; many prominent very coarse yellowish-brown mottles.
- D 36 to 42 inches
Unweathered soft siltstone with thin strata of sandstone in places; hard when dry.

Bainville silt loam, 6 to 9 percent slopes (Bb).—This soil has the profile described for the Bainville series. It occurs mainly within larger areas of soils that are better suited to crops. A moderate area is in crops; a smaller area is in native sod. Erosion by wind and water is severe on tilled areas. The soil is suitable for only limited

²Symbols represent Munsell color notation.

or occasional cultivation because it erodes easily. Soils in native cover make good range.

Capability unit IVE-1; range site, Silty land.

Bainville silt loam, 10 to 14 percent slopes (Bc).—This soil has a profile like that described for the Bainville series. It occurs mainly as small areas within other soils that are better suited to crops. The total area in crops is moderate; smaller areas are in native sod. The steep slopes cause severe erosion and limit the use of this soil for cultivation. The areas in native sod make good range.

Capability unit, VIe-1; range site, Silty land.

Bainville silt loam, 15 to 40 percent slopes (Bd).—This soil has a profile similar to that described for the Bainville series. Some of the steep areas of this soil are in fields with better croplands. The individual areas are small, but the total acreage in the county is considerable. Most areas formerly used for crops have been seeded to permanent grasses. This soil is not suited to cultivation, because it erodes easily. Sod areas provide good to fair range. Shale outcrops with little or no grass cover are common.

Capability unit, VIe-1; range site, Silty land.

Bainville-Chama complex

In areas where Bainville and Chama soils are so closely associated or intermixed that it was not possible to separate them on a map of the scale used, they are mapped as a soil complex. Typical Bainville and Chama soils are described elsewhere in this report. This complex occurs generally throughout the county but is chiefly in the northern and western parts. Areas are hilly and steep and are used for grazing. In a few places they are cultivated, mostly as small steep tracts within fields that are better suited to crops (see fig. 4).

The Bainville soil is thinly developed on soft siltstone and sandstone. Runoff is medium to rapid, and permeability is moderate. The surface soil is only a few inches thick. Below this layer is the subsoil, which merges with the parent shale at shallow or very shallow depths. The grass cover ranges from sparse to dense.

The Chama soil is moderately deep over the soft shale. The surface soil has moderate crumb structure. The structure of the subsoil layers is weakly prismatic or blocky. Usually there is a thin, streaked, and whitish accumulation of lime and other salts in the subsoil at the place where it merges with parent soft shale. The native grass is usually dense.

Bainville-Chama silt loams, 15 to 30 percent slopes (Be).—The soils of this complex are variable. From 5 to 15 percent of the total area may have slopes of broken shale. Because of its steepness and broken slopes, this complex is not suited to cultivation. It comprises, however, some of the most extensive areas of good grazing in the county.

Capability unit, VIe-1; range site, Silty land.

Bainville-Flasher complex

Areas of Bainville silt loam and Flasher loamy fine sand that are too closely intermingled to separate on the soil map of the scale used are mapped together as a com-

plex. Bainville and Flasher soils are described elsewhere in this report. The Bainville-Flasher soil complex is widely scattered over the county. Steeply sloping range accounts for the largest areas; the tilled area is small.

Bainville soil is thinly developed on soft siltstone, or in some places over a thin strata of siltstone and sandstone; whereas Flasher soil is thinly developed over sandstone. The surface layers in both soils are only a few inches thick. The subsoil merges with the parent shale or sandstone at shallow or very shallow depths. The stand of grass varies from sparse to dense.

The content of organic matter in the surface soils is low. Runoff is medium to rapid. Permeability to air and water is moderate to moderately rapid in the subsoil layers of this complex. Because of the steepness of the slopes, these soils are subject to severe erosion and are unsuited to cultivation. Soils in this complex, however, are good for grazing.

Bainville-Flasher complex, 6 to 14 percent slopes (Bg).—The individual soils in this complex have been previously described. The complex is inextensive and is interspersed with areas of other soils that are better suited to crops. A few areas remain in native grasses. Because of the hazard of erosion, this soil complex is not suited to cultivation.

Capability unit, VIe-1; range site, Silty land.

Bainville-Flasher complex, 15 to 40 percent slopes (Bh).—The soils of this complex occupy steep areas of good rangeland. A very small area is tilled. This complex is not suited to cultivation, because it is steep and easily eroded.

Capability unit, VIe-3; range site, Thin breaks.

Bainville-Wibaux complex

Where Bainville and Wibaux soils are so intermingled that they cannot be separated on a map of the scale used, they are mapped together as a complex. The soils that make up the complex are described elsewhere in this report. The complex occurs in scattered areas, chiefly in the northwestern part, where it occurs on large areas of hilly scoria rangeland. A very small acreage is tilled, but this consists of other soils that were included in mapping this complex.

The Bainville soils have developed over relatively soft siltstone and sandstone, and the Wibaux soils, over scoria or burned, hard-baked shale. Both have a thin surface soil and subsoil and merge with the underlying rock at shallow or very shallow depths. Outcrops of shale and scoria are common on the steep slopes. The soils are moderately permeable; runoff is medium to rapid. They support a fairly sparse to dense cover of grasses and other plants. The content of organic matter in the surface layer of Wibaux and Bainville soils is low; the thickness of the layer averages about 3 to 4 inches. The total moisture-holding capacity is limited by the shallow depth of the Wibaux soils and, to some extent, by that of the Bainville soils.

Bainville-Wibaux complex, 15 to 40 percent slopes (Bk).—The shallow upland soils of this complex are subject to moderate erosion. They are not suited to cultivation, but they furnish good to fair grazing. They are moderate in extent in the county.

Capability unit, VIe-3; range site, Thin breaks.

Chama series

The soils of the Chama series are mapped in many places throughout the county. They occur alone and in association with Bainville, Morton, and other soils (fig. 4). About a third of this soil series is tilled. Large areas occur locally as patches in sections of rangeland. Most Chama soils are fair for crops.

Chama soils have developed on soft siltstone and sandstone. They are usually moderately sloping, and runoff is medium. The surface soil usually has moderate crumb structure. Subsoil layers have weakly prismatic to blocky structure. A thin whitish layer occurs in the lower part of the subsoil where lime has accumulated. The subsoil merges with underlying yellow and drab-colored shales and sandstone. The soils have developed under a dense grass vegetation.

The content of organic matter in the surface layer is medium. Although the thickness of the surface layer varies, it is usually about 6 inches. Permeability of the subsoil to air and water is moderate. Workability is good, except for stony types, which usually are not tilled but are suitable for range. Chama soils are subject to moderate wind and water erosion on exposed slopes.

Included with Chama soils are small spots that are usually lower in productivity or are otherwise different. For example, some of these areas are severely eroded; some are on slopes that are much steeper than the rest of the unit; or some have an occasional shale outcrop. There are also small included patches of Bainville or Midway soils.

Chama soils are typically 2 or 3 feet deep over unweathered shale. In many areas of Chama soils, the surface soil is thin and light colored. In some places this change is caused by erosion; in others, by an inclusion of Bainville soils. Some of the included soils are 16 inches thick, whereas others are 4 feet thick over the shale. The variation in depth to shale is the result of different rates of soil development, or the merging of Chama soil with Bainville or Morton soils. In places it is the result of erosion. Where Chama soil merges with Flasher soil, the texture is often a fine sandy loam. Where the Chama soils are closely associated with Midway or Moreau soils, they approach a silty clay loam in texture.

Typical profile: Chama silt loam; location, SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 26, T. 17 N., R. 59 E.:

A _p	0 to 5 inches	Very dark grayish-brown (10YR 3/2, moist) silt loam with moderate fine crumb structure; soft when dry, friable when moist; lower boundary abrupt.
B ₂	5 to 10 inches	Dark grayish-brown (10YR 4/2, moist) silt loam with weak coarse prismatic structure; friable when moist, soft when dry; lower boundary clear.
B _{30a}	10 to 17 inches	Grayish-brown (2.5Y 5/3, moist) silt loam with weak coarse prismatic structure; friable when moist, soft when dry; strongly calcareous; lower boundary gradual.
C _{0a}	17 to 30 inches	Light olive-brown (2.5Y 5/4, moist) silt loam with weak coarse blocky structure; friable when moist, slightly hard when dry; strongly calcareous; lower boundary gradual.
C	30 to 42 inches	Light olive-brown (2.5Y 5/4, moist) silt loam; massive; friable when moist, soft when dry.
D	42 inches +	Pale-yellow (2.5Y 7/4, moist) soft silty shale.

Chama silt loam, 4 to 7 percent slopes (Ca).—This soil has the profile described for the Chama series. It is usually on the undulating to rolling upper slopes in association with Morton and Bainville soils. The Morton soil is on the gentler slopes, and the Bainville soil is on the hilltops or steep slopes. Where it is associated only with the Bainville soils, this soil occupies the lower gentle slopes below the Bainville soils (fig. 4). Chama silt loam, 4 to 7 percent slopes, is fair for crops.

Capability unit, IIIe-1; range site, Silty land.

Chama stony silt loam, 4 to 9 percent slopes (Cb).—This soil contains stone and pieces of petrified wood; otherwise its profile resembles that described for the Chama series. The fragments range from small to large and are scattered on the surface and throughout the profile. Their presence usually makes the soil unsuited to cultivation. Most of the very limited area of this soil is in range grasses. In places the stone has been removed; these areas, now classed with nonstony lands, are cultivated. Chama stony silt loam, 4 to 9 percent slopes, is good for range grazing. Most of this soil is in the southwestern part of the county.

Capability unit, VIe-1; range site, Silty land.

Chama stony silt loam, 10 to 30 percent slopes (Cc).—This soil has a profile similar to that previously described for Chama soils, but the slopes are usually steep and the soil is stony and not suited to cultivation. Fragments of petrified wood of various size are scattered on the soil and throughout the profile. Limited areas of this soil occur in the southeastern part of the county. The soil is suitable for range.

Capability unit, VIe-1; range site, Silty land.

Chama-Bainville complex

Chama-Bainville silt loams, the soils of this complex, occur over most of the county. The largest areas are in the northern part, where they are interspersed with areas of steeper soils used for range. A few areas are surrounded by soils that are better suited to crops. The individual soils of this complex have been described previously in this report.

The Bainville soils are thinly developed on soft siltstone and sandstone. Runoff is medium to rapid. The surface soil and subsoil are each only a few inches thick. The subsoil merges with parent shale at shallow or very shallow depths. The grass cover ranges from sparse to dense.

The Chama soils are better developed than the Bainville and deeper over the soft shales. The surface soil has moderate crumb structure, but the subsurface layers have weakly prismatic or blocky structure. The lower part of the subsoil usually contains white streaks and spots of accumulated lime just above the parent soft siltstone. The native grass vegetation is usually dense.

Chama-Bainville silt loams, 4 to 9 percent slopes (Cd).—The individual soils that make up this complex have been previously described. These soils are used for crops and range. They are poor to fair for crops and good for grazing. Cultivation is limited by the susceptibility of the soils to erosion.

Capability unit, IVe-1; range site, Silty land.

Chama-Bainville silt loams, 10 to 14 percent slopes (Ce).—Individual soils in this complex have been previously described. This complex is mostly in native

grasses, although a few areas are tilled. Because of severe erosion, these soils are suited only to limited cultivation, and their value for crops is fairly low.

Capability unit, IVE-1; range site, Silty land.

Cherry series

Cherry soils are chiefly in the northern part of the county, where they occupy sloping terraces, fans, and foot slopes in the narrow valleys and along the borders of the wider valleys. Some areas of these soils are tilled, but much of the acreage is left in grass and used for range or wild hay. Some of the Cherry soils are salty.

Cherry soils have developed on local silty alluvium. The usual surface soils have a weak crumb structure. The subsoil layers have weak prismatic to weak blocky structure and merge indistinctly with the parent silty alluvium that is without structure. Runoff ranges from medium on the lower slopes to rapid on the moderate slopes. The grass cover is mostly dense.

Saline phases of Cherry soils have developed from alluvium washed from areas where the shale and sandstone naturally carry alkali salts. Development of soil layers is very weak.

Organic-matter content of Cherry soils is medium. The usual surface soil depth is about 6 inches. Permeability of the subsoil to air and water is moderate. Workability is good. These soils are moderately susceptible to wind and water erosion. Under native grasses the soils are good for range.

Typical profile: Cherry silt loam; location, NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 32, T. 19 N., R. 60 E.:

- A₁ 0 to 4 inches
Very dark grayish-brown (10YR 3/2, moist) silt loam with strong fine crumb structure; friable when moist; lower boundary clear.
- B₂ 4 to 9 inches
Very dark gray (10YR 3/1, moist) silt loam; weak medium prismatic structure breaking to moderate fine blocky structure; friable when moist; lower boundary abrupt.
- B₃ 9 to 16 inches
Dark grayish-brown (10YR 4/2, moist) silt loam; weak medium prismatic structure breaking to moderate fine blocky structure; friable when moist; effervesces strongly; lower boundary gradual.
- C 16 to 44 inches
Light olive-brown (2.5Y 5/4, moist) silt loam; weak coarse blocky or very coarse prismatic structure; friable when moist; effervesces violently.

Typical profile: Cherry silt loam, saline; location, 660 feet NE. of S $\frac{1}{4}$ corner, sec. 8, T. 18 N., R. 60 E.:

- A_p 0 to 6 inches
Very dark grayish-brown (10YR 3/2, moist) silt loam; weak coarse platy structure breaking to weak fine crumb structure; slightly hard when dry, friable when moist; white salt efflorescence forms on the surface in places as the soils dry; effervesces slightly; lower boundary abrupt.
- A₃ 6 to 9 inches
Very dark grayish-brown (10YR 3/2, moist) silt loam; weak coarse blocky structure; slightly hard when dry, friable when moist; effervesces strongly; lower boundary clear.
- C 9 to 48 inches
Light yellowish-brown (2.5Y 6/4, moist) silt loam; massive; slightly hard when dry, friable when moist; faint fine white streaks of lime and other salts throughout this layer; effervesces strongly.

Cherry silt loam, 0 to 3 percent slopes (Cg).—This soil has the profile previously described as typical for the Cherry series. It is of moderate extent, and a part is under cultivation. Many areas are used for wild hay or are in native grass range. The soil is good for crops or range.

Capability unit, IIe-1; range site, Overflow land.

Cherry silt loam, 4 to 9 percent slopes (Ck).—This soil has a profile similar to that previously described as typical for the Cherry series. It is of small extent and is used about equally for cultivation and for pasture or range. This soil is poor to fair for crops, but it makes good rangeland. It is suitable only for limited or occasional cultivation because of severe erosion hazard.

Capability unit, IIIe-1; range site, Silty land.

Cherry silt loam, saline, 0 to 3 percent slopes (Ch).—This soil has a profile previously described for saline soils of the Cherry series. It is not extensive and occurs chiefly along C. S. Creek and its tributaries in the northern part of the county. The wash from saline shales has contributed to the makeup of this soil. Saltgrass is common, and in the fall, roadside cuts show an accumulation of white salt in the profile. This soil usually is not suited to cultivation because of its salt content, but it is good for wild hay and range. The soil may include narrow strips of local stream bottoms and brushy areas.

Capability unit, VI_s-1; range site, Saline lowland.

Cherry silt loam, saline, 4 to 9 percent slopes (Cm).—This soil has a profile similar to that previously described for saline soils of the Cherry series. It is located chiefly along C. S. Creek and its tributaries in the northern part of the county. The wash from saline shales has contributed to the makeup of this soil. Saltgrass is apparent. This soil is not suitable for cultivation because of salt and the hazard of severe erosion. It makes good range. Practically all of the limited area of this soil is in native grasses.

Capability unit, VI_s-1; range site, Saline lowland.

Cheyenne series

Cheyenne soils occupy terrace and bench remnants on the uplands, chiefly along Beaver Creek Valley, and a few isolated sections at some distance from the valley (fig. 4). Most of the soils are nearly level to gently sloping. The area in cropland and pasture, or range, is about the same. Cheyenne soils are fair to good for crops and good for range.

The soils of this series are moderately well developed from gravelly and fine materials in old alluvium. There is little or no runoff. Surface soil layers have weak crumb structure. The upper subsoil layers have moderate prismatic or blocky structure and gravelly loam texture. The deeper subsoil is more gravelly and contains a whitish or streaked zone of lime. This lime accumulation merges to gravelly loam parent material, which in places includes some soft shale fragments. Depth of gravel over shale and sandstone varies from 6 to 15 feet. The grass cover is moderate to dense.

The content of organic matter in the surface soil is usually medium to high. The surface soil is about 6 inches thick. The subsoil and substrata vary from gravelly to slightly gravelly. Moisture-holding capacity is slightly limited in Cheyenne soils because of their coarse

lower layers. A few areas have a surface texture of fine sandy loam, and some areas have semicemented limy gravelly layers in the subsoil.

Typical profile: Cheyenne loam; location, 1,000 feet W. of NE. corner, sec. 7, T. 15 N., R. 60 E.:

- A₁₁ 0 to 4 inches
Very dark grayish-brown (10YR 3/2, moist) loam; weak fine and medium crumb structure; friable when moist; lower boundary clear.
- A₁₂ 4 to 6 inches
Very dark brown (10YR 2/2, moist) coarse silt loam; weak fine and medium blocky structure; friable when moist.
- B₂ 6 to 12 inches
Very dark grayish-brown (10YR 3/2, moist) coarse silt loam containing some gravel; moderate medium prismatic structure breaking to weak medium blocky structure; friable to firm when moist, slightly hard when dry.
- C_{ca} 12 to 20 inches
Dark grayish-brown (2.5Y 4/2, moist) gravelly coarse silt loam with weak medium blocky structure; friable when moist; strongly calcareous.
- C 20 to 40 inches
Grayish-brown (2.5Y 5/3, moist) gravelly sandy loam; massive; friable when moist; strongly calcareous.
- D 40 to 58 inches
Light brownish-gray (2.5Y 6/3, moist) heavy silt loam; massive; strongly calcareous.

Cheyenne loam, 0 to 5 percent slopes (Cn).—This soil has the profile described for the Cheyenne series. It is deep to medium deep. The hazard of wind erosion is moderate when the soil is tilled. Permeability to air and water is moderate.

Capability unit, IIIe-2; range site, Silty land.

Cushman series

The Cushman soils occur in limited areas in the somewhat drier, southwestern part of the county. Most slopes are nearly level to gentle, although moderate slopes occur in a few places. The soils of this series are fair as cropland and good as rangeland. A large part is cultivated.

Cushman soils have formed on a fine-textured mixture of windblown silt and old valley alluvium. They are well developed. The surface soil has a weak crumb structure. The subsoil layers are usually strongly developed and have prismatic structure. Runoff generally is slight but is moderate on some of the slopes. The grass cover is moderate to dense.

The organic-matter content is medium, and the surface soil is from 4 to 6 inches thick. Permeability of subsoil layers to air and water is moderate. Cushman soils are subject to wind erosion and to some water erosion if cultivated. They occur in an area where droughts are a little more frequent than in the rest of the county. The nearby Badlands and areas of Lismas and Pierre soils probably contribute to hot, droughty conditions at times.

Typical profile: Cushman loam; location, NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 19, T. 12 N., R. 58 E.:

- A_p 0 to 9 inches
Very dark grayish-brown (10YR 3/2, moist) loam; weak coarse blocky breaking to moderate very fine crumb structure; friable when moist; lower boundary abrupt.

- B₂ 9 to 24 inches
Very dark grayish-brown (10YR 3/2, moist) silty clay loam with strong medium prismatic breaking to strong medium blocky structure; friable when moist, slightly sticky and slightly plastic when wet; lower boundary clear.
- B₃ 24 to 28 inches
Brown (10YR 5/3, moist) silty clay loam; strong coarse prismatic breaking to strong coarse blocky structure; friable when moist, slightly sticky and slightly plastic when wet.
- C_{ca} 28 to 40 inches
Grayish-brown (2.5Y 5/3, moist) silt loam with prominent medium-sized white lime mottles; massive; effervesces violently.
- C 40 to 66 inches
Fine sandy loam and loamy fine sand; effervesces strongly.

Cushman loam, deep variant, 0 to 3 percent slopes (Co).—This soil has the profile previously described as typical for the Cushman series. A great part is under cultivation.

Capability unit, IIIe-4; range site, Silty land.

Cushman loam, deep variant, 4 to 7 percent slopes (Cp).—This soil has a profile that is deeper but otherwise similar to that previously described for the Cushman series. Most areas are in native range. Textures vary from silt loam to fine sandy loam in places, and this sandy texture increases the hazard of wind erosion on cultivated areas.

Capability unit, IIIe-4; range site, Silty land.

Farland series

Farland soils are on low terraces bordering Beaver Creek. Most areas are under cultivation, but some remain in pasture or range.

Farland soils have developed from silty alluvium deposited by the larger drainage systems, such as Beaver Creek. The surface soil has moderate and strong crumb structure; the subsoil layers have moderate prismatic structure. The substrata layers consist of silty materials and have a well-developed whitish or streaked zone where lime has accumulated. If not cultivated, Farland soils support a dense grass cover.

The content of organic matter is high in the Farland soils. They are moderately permeable to air and water and have good moisture-holding capacity. Workability is good. There is some hazard of wind erosion in cultivated areas.

Typical profile: Farland silt loam; location, NE $\frac{1}{4}$ sec. 26, T. 13 N., R. 60 E.:

- A_{1p} 0 to 5 inches
Very dark brown (10YR 2/2, moist) silt loam; strong medium crumb structure; friable when moist; lower boundary abrupt.
- B₂ 5 to 12 inches
Very dark grayish-brown (10YR 3/2, moist) silt loam; moderate medium prismatic structure breaking to moderate medium and fine blocky structure; friable when moist; lower boundary abrupt.
- B₃ 12 to 16 inches
Dark grayish-brown (10YR 4/2, moist) silt loam; friable when moist; effervesces strongly; lower boundary gradual.
- C_{ca} 16 to 24 inches
Dark grayish-brown (2.5Y 4/2, moist) loam; abundant lime spots; weak subangular blocky structure; friable when moist; effervesces violently; lower boundary gradual.

- C 24 to 36 inches
Dark grayish-brown (2.5Y 4/2, moist) loam; friable when moist; effervesces strongly.

Farland silt loam, 0 to 3 percent slopes (Fa).—Much of this soil is under cultivation, but some areas remain in pasture or range. This is one of the good cropland soils of the county. It is very good for range. On the nearly level to gentle slopes, runoff is low or nearly absent. The usual thickness of the surface layer is about 6 inches.

Capability unit, IIe-1; range site, Overflow land.

Farland-Harlem complex

This soil complex occurs mainly on the low terraces and bottom lands bordering Beaver Creek. It consists of areas of Farland and Harlem soils that are too closely intermingled to separate on a map of the scale used. They are therefore mapped together. The development of the soil profile layers varies. The Farland soil has well-developed layers, and the Harlem soil has little or no development or layering. The surface soils vary in depth but are usually thick. A typical profile of the Farland soil has been described for the Farland series. The following profile is typical of the Harlem soil in the complex.

Profile of Harlem silt loam; location, NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 26, T. 15 N., R. 59 E.:

- A_{1p} 0 to 8 inches
Very dark grayish-brown (2.5Y 3/2, moist) silt loam with strong medium and fine crumb structure; friable when moist; effervesces slightly; lower boundary abrupt.
- A-C 8 to 16 inches
Dark grayish-brown (2.5Y 4/2, moist) very fine sandy loam with weak very coarse prismatic structure; friable when moist; effervesces strongly.
- C 16 to 36 inches
Stratified loam and fine sandy loam; loose to friable when moist; effervesces strongly.

Farland-Harlem complex, 0 to 3 percent slopes (Fb).—Much of this complex is under cultivation, but some small isolated areas along Beaver Creek are in native pasture. Some areas of Alluvial land are included with this complex. Runoff is variable, but the surface drainage is generally good. A few areas near the stream channels may be flooded at times. These areas are small and irregular. Grasses and shrubs grow abundantly; in places there are a few trees.

Capability unit, IIe-1; range site, Overflow land.

Flasher series

Flasher soils are scattered throughout the county and occupy a fairly large total area. Part of this sandy acreage is tilled, but most of it is in native grasses.

These soils are thinly developed on sandstone and sandy shale. Runoff is restricted because the very sandy texture permits rapid intake of water. The surface soil is thin and has very weak crumb structure. The subsoil layers are equally thin and have weak blocky structure. In many places the parent sandstone lies within a foot of the surface. These subsoil and parent material are stratified and were derived from highly variable broken sandstone and soft siltstone.

The fields are hummocky where sandstone lies at or

near the surface. Drainage is irregular. Like Bainville soils, Flasher soils are low in organic-matter content. Permeability of the subsoil to air and water is moderately rapid. Moisture capacity is mostly limited by shallow soil depths. Workability is fair to poor. The soils are subject to severe wind erosion if tilled.

Typical profile: Flasher loamy fine sand; location, 200 feet E. of NE. corner, sec. 8, T. 13 N., R. 59 E.:

- A₁ 0 to 2 inches
Very dark grayish-brown (10YR 3/2, moist) loamy fine sand; wind stratified; very friable when moist; effervesces slightly; lower boundary abrupt.
- B 2 to 7 inches
Very dark grayish-brown (10YR 3/2, moist) light fine sandy loam; weak coarse blocky structure; stratified; very friable when moist; effervesces slightly; lower boundary clear.
- C_{ca} 7 to 20 inches
Dark grayish-brown (10YR 4/2, moist) loamy fine sand; very weak blocky structure; stratified; very friable when moist; effervesces violently; lower boundary gradual and broken.
- D 20 to 48 inches
Discontinuous broken bands of hard sandstone that rest on weathered soft sandstone at various depths; effervesces violently.

Flasher loamy fine sand, 4 to 9 percent slopes (Fc).—This soil has the profile described as typical for Flasher soils. Many of the areas are under cultivation, but some still remain in native grass. This soil is not well suited to cultivation, because the risk of wind erosion is great. Many areas of this soil are near Vebar soils that have a similar hazard. This soil makes good range.

Capability unit, IVE-1; range site, Sandy land.

Flasher loamy fine sand, 10 to 14 percent slopes (Fd).—This soil has a profile similar to that previously described for the Flasher series. A few areas are tilled, but most of this soil remains in grass. This soil is not suitable for cultivation; it has steep slopes and is subject to wind erosion. Areas in native grass make good range.

Capability unit, VIe-3; range site, Shallow land.

Flasher loamy fine sand, 15 to 40 percent slopes (Fe).—This soil occupies steep range areas. Very little if any is under cultivation. It has a profile similar to that previously described for the Flasher series. It has, however, more sandstone outcrop and a more limited grass cover. Areas of this soil are fair to good for grazing.

Capability unit, VIe-3; range site, Shallow land.

Glendive series

Glendive soils occur in a few narrow areas, chiefly on alluvial fan slopes bordering bottom lands along Glendive Creek in the southwestern part of the county. Some small included areas of alluvial soils are subject to flooding at times.

The Glendive soils are developing in sandy local alluvium. The surface layer has weak crumb structure. Surface and subsoil layers merge indistinctly and range in texture from sandy to very sandy. The grass cover is dense.

The organic-matter content in these sandy soils varies, but it is mostly medium to low. Permeability of subsoil layers to air and water is rapid, and the soils are often droughty. Workability ranges from good to poor.

Typical profile: Glendive fine sandy loam:

- A₁ 0 to 8 inches
Grayish-brown (dry) fine sandy loam; weak crumb structure; friable.
- B₁ 8 to 14 inches
Light brownish-gray (dry) loamy fine sand; loose to slightly coherent.
- B_{2ca} 14 to 23 inches
Light brownish-gray (dry) loamy fine sand; effervesces moderately.
- C 23 to 40 inches
Stratified incoherent gray sand, loam, and very fine sandy loam; effervesces moderately.

- moist, slightly sticky and plastic when wet; lower boundary diffuse.
- B₂ 18 to 28 inches
Very dark grayish-brown (10YR 3/2, moist) silty clay loam; moderate medium prismatic structure breaking to strong fine blocky structure; firm when moist, slightly sticky and plastic when wet; lower boundary diffuse.
- B₃ 28 to 34 inches
Very dark grayish-brown (10YR 3/2, moist) silty clay loam; moderate medium prismatic structure breaking to strong fine blocky structure; firm when moist, slightly sticky and slightly plastic when wet; effervesces slightly; lower boundary diffuse.
- C 34 to 42 inches
Dark grayish-brown (10YR 4/2, moist) silty clay loam; weak medium blocky structure; friable when moist, slightly sticky and plastic when wet; effervesces strongly.

Glendive fine sandy loam, 2 to 6 percent slopes (Ga).—This soil has the profile described for the Glendive series. Practically all of it is used for hay and pasture. This soil is only fair for crops. It is subject to wind erosion and occurs in small, isolated, and irregular areas. It is good for range. Productivity depends on the range condition. If this soil is cultivated, dryland grasses may be seeded, such as crested wheatgrass, for pasture or hay. A few of the better areas may grow alfalfa or sweetclover.

Capability unit, IIIe-2; range site, Overflow land.

Grail series

The soils of the Grail series are mostly in the southern part of the county on valley flats, swales, gentle slopes, and a few broad basins in the uplands. Nearby on the upland slopes are Morton and Midway soils (fig. 4).

Soils of the Grail series have developed from a silty-clayey mixture of local alluvium. Surface layers have moderate granular structure. Subsoil layers have the moderate prismatic structure typical of well-developed soils. The lower subsoil has whitish splotched or streaked layers where lime and possibly other salts accumulate. The entire profile is moderately fine textured. Runoff on the nearly level to gentle slopes is slow to medium. Grasses grow densely on this soil.

Grail soils have a high organic-matter content. The average thickness of surface soil layers is 7 inches. Permeability of subsoil layers to air and water is moderate or moderately slow. Workability is fair. The soils can be worked best under a fairly narrow range of moisture conditions. If tilled, the sloping areas are subject to water erosion. If cultivated, the gentle slopes are subject mainly to wind erosion.

Typical profile: Grail silty clay loam; location, NW corner of sec. 16, T. 12 N., R. 59 E.:

- A₁₁ 0 to 2 inches
Very dark grayish-brown (10YR 3/2, moist) silty clay loam; strong fine crumb structure; friable when moist, slightly sticky and plastic when wet; lower boundary clear.
- A₁₂ 2 to 8 inches
Black (10YR 2/1, moist) silty clay loam; weak fine prismatic structure breaking to moderate fine and medium granular structure; friable when moist, slightly sticky and plastic when wet; lower boundary gradual.
- B₁ 8 to 18 inches
Black (10YR 2/1, moist) silty clay loam; moderate fine prismatic structure breaking to moderate fine blocky and medium granular structure; friable when

Grail silty clay loam, 2 to 4 percent slopes (Gb).—This soil has a profile similar to that described for the Grail series. It is good for crops and very good for range. Most of the soil is under cultivation, but a few areas remain in pasture. Included in this mapping unit are a few patches in the southeastern part of the county where the soil texture is silty clay. These patches are in level basins and are somewhat imperfectly drained. However, they are usually cropped except in the very wettest years.

Capability unit, IIe-1; range site, Overflow land.

Grail silty clay loam, 5 to 7 percent slopes (Gc).—This soil has a profile similar to that described for the Grail series. The areas are very limited in extent and are mainly in pasture. This soil is suitable for cultivation. It is fair to good for crops and is good for range.

Capability unit, IIIe-1; range site, Overflow land.

Gravelly terrace remnants

Gravelly terrace remnants, 5 to 40 percent slopes (Gd).—This miscellaneous land type is on steep benches on the uplands bordering the valley of Beaver Creek. It consists of remnants of ancient bench lands that are being cut away by natural erosion.

This land type is a mixture of shallow and gravelly soils that cannot be separated on the map of the scale used in this report. The soils are thinly developed on soft siltstone. They are mixed with other soils associated with gravelly fine earth deposited in ancient times on benches. Runoff ranges from slow to medium.

Soils of this miscellaneous land type have thin surface layers and a low content of organic matter. In places they are shallow over droughty gravel layers. The thickness of the gravel over the underlying shale and sandstone is highly variable. Much of this land type consists of Bainville soils, described elsewhere, and of included Beaverton soils not described separately in this survey.

Because of steep and broken slopes, Gravelly terrace remnants, 5 to 40 percent slopes, is not suited to cultivation, although it supplies good to fair grazing. The few acres now under cultivation should be planted to permanent grass or seeded to pasture. Drought-resistant grasses, such as crested wheatgrass, are well suited.

Capability unit, VIe-3; range site, Thin breaks.

Lismas clay-Shale outcrop complex

This complex is extensive in the extreme southwestern part of the county. It consists of areas of Lismas clay and Shale outcrop and occupies rolling to rough stream-dissected areas. The slopes are mostly steep.

Lismas clay is thinly developed over heavy clay shale. Runoff is very rapid. The thin surface soil consists, for the most part, of grayish-brown silty clay. Olive-brown, dense, massive clay mixed with parent shale is a few inches to about a foot below the surface. The native vegetation is chiefly a sparse cover of western wheatgrass, shrubs, and a savannahlike growth of Rocky Mountain cedar.

Profile description of Lismas clay; location, large uniform areas in the southwestern part of the county:

- A₁ 0 to 2 inches
Grayish-brown, loose, silty clay; usually noncalcareous.
- A₂ 2 to 7 inches
Olive-brown, dense, massive clay.
- C 7 inches +
Partly decomposed, olive-brown or gray clay shale.

Lismas clay-Shale outcrop, 20 to 60 percent slopes (La).—The content of organic matter is low in the surface soil of this complex. Permeability to air and water in the subsoil is very slow, although some water enters through the large cracks in the soil. Erosion is severe. This soil complex is very poor for grazing and is not suited to cultivation.

Capability unit, VIIs-2; range site, Shale and clay.

McKenzie-Hoven complex

McKenzie and Hoven soils are so closely associated in Wibaux County that it is difficult to separate them on a map of the scale used. They are therefore mapped together as a single unit. A very small part is cultivated; most areas are in native grass.

The soils of this complex occupy small basinlike areas in the uplands. Surface drainage is to the center of the basins, and the soils are poorly drained. Drainage outlets for the basins are not well established, and the areas are ponded a part of each year.

The McKenzie soils occupy the lower, most poorly drained parts of the basins. Their surface layers are heavy silty clay. Subsoil layers are dense, blocky, and grayish-mottled clays that show evidence of poor internal drainage.

Profile of McKenzie silty clay; location 924 feet N., 264 feet W. of SE. corner, sec. 14, T. 13 N., R. 60 E.:

- A₁ 0 to 14 inches
Very dark gray heavy silty clay; alkaline.
- B₂ 14 to 28 inches
Dark-gray dense clay; brown mottles occur at a depth of 20 inches.
- C₂ 28 inches +
Gray clay; massive; soil cracks to depths of 2 or 3 feet when dry.

The Hoven soils occupy flat benchlike rims or borders of the larger basins and the entire area of some of the basins where the soils are ponded for relatively short periods. They have thin, leached, light-colored surface layers. Their strong columnar-prismatic subsoils distinguish them from the darker, more massive or coarse blocky subsoils of the McKenzie series.

Profile of Hoven silt loam:

- A₁₁ 0 to 1 inch
Grayish-brown (10YR 5/2, dry) to very dark brown (10YR 2/2, moist) silt loam; soft when dry, very friable when moist; moderate fine granular structure; lower boundary clear.
- A₁₂ 1 to 4 inches
Light-gray (10YR 7/1, dry) to dark-gray (10YR 4/1, moist) silt loam; soft when dry, very friable when moist; moderate fine platy structure; lower boundary abrupt.
- B₂ 4 to 10 inches
Very dark gray (10YR 3/1, moist) silty clay; extremely hard when dry, very firm when moist; strong fine and medium columns with distinctly rounded tops; lower boundary gradual.
- B_{2s} 10 to 20 inches
Color and texture as in horizons above; moderately calcareous and with moderate amounts of salt visible; very firm when moist; weak medium angular blocky structure; lower boundary gradual.
- C 20 to 42 inches
Very dark gray (10YR 3/1, moist) moderately calcareous silty clay; very firm when moist.

Soluble salts occur at some depth in both of these soils. Local spots may have white salt crusts on the surface when the soils are dry. The Hoven soil is further characterized by small blowout spots, where the gray surface soil has been removed by wind and the clay subsoil is exposed.

The native vegetation on this complex is wheatgrass, saltgrass, and sedges. Some rushes grow in a few of the wettest places, and salt-tolerant annuals grow in spots where the soils are strongly alkaline.

McKenzie-Hoven silty clays, 0 to 1 percent slopes (Ma).—The few areas of this complex are in the southeastern and southwestern parts. Permeability of the subsoil horizons to air and water is slow to very slow. Workability is poor because of heavy texture, dense claypan, and poor surface drainage in both soils. This complex is not suited to cultivation.

Capability unit, VI_s-1; range site, Saline lowland.

Midway-Moreau complex

Midway and Moreau soils are so closely intermingled that it is not possible to separate them on a map of the scale used, therefore they are mapped together as a soil complex. This complex occupies moderately extensive areas in the southern part of the county. It is on slopes and hilltops, usually associated with Regent soils but to some extent with Morton and Chama soils. Slope and position on the landscape are similar to those of the Bainville soils (fig. 4). The soils of this complex differ from the Bainville soils chiefly in having heavier texture.

Midway and Moreau soils developed from clayey shales. Where they are so closely associated as in this complex, their surface soils are about the same color. The surface soil of the Midway is thinner, however, and grades rather abruptly into the gray clayey parent material and into the weathered shale at 6 to 14 inches below the surface.

Surface soil textures vary from silty clay loam to silty clay in both of these soils. The subsoils range from silty clay to heavy silty clay loam. Grass vegetation ranges from sparse on the thinnest areas of Midway soils to moderately dense on the Moreau soils.

The content of organic matter in the surface layers of this soil complex ranges from medium to low. The dark surface layers are mostly thin. Permeability of subsoil layers to air and water is mostly slow. Workability is fair to poor. Poor workability is caused partly by lower content of organic matter and by the clayey texture of the plow layer. Soils of this complex are likely to be severely eroded under cultivation.

Profile of Midway silty clay; location, 1,320 feet W. and 200 feet N. of S.E. corner of sec. 16, T. 13 N., R. 60 E.:

- A_p 0 to 3 inches
Grayish-brown (2.5Y 5/2, moist) heavy silty clay loam or silty clay with strong fine crumb structure; very hard when dry, very firm when moist, very plastic and sticky when wet.
- C₁ 3 to 10 inches
Olive-gray (5Y 4/2, moist) clay with weak subangular blocky structure; very hard when dry, very firm when moist, very plastic and sticky when wet.
- C₂ 10 to 16 inches
Olive-gray (5Y 4/2, moist) clay with shale-like fragmental structure; very hard when dry, very firm when moist, very plastic and sticky when wet; no effervescence.
- C₃ 16 to 24 inches
Olive-gray (5Y 4/2, moist) clay and partly weathered shale; very hard when dry, very firm when moist, very plastic and sticky when wet; effervesces strongly; has segregated lime spots.
- D 24 to 30 inches
Dark-gray (5Y 4/1, moist) clay shale; effervesces slightly.

The Moreau soils are 16 to 30 inches deep over shale and have moderately developed prismatic and blocky subsoils.

Profile of Moreau silty clay loam; location, sec. 12, T. 12 N., R. 59 E.:

- A₁₁ 0 to 1 inch
Grayish-brown (2.5Y 5/3, moist) silty clay loam; moderate thin platy and fine crumb structure; firm when moist, plastic when wet.
- A₁₂ 1 to 5 inches
Dark grayish-brown (10YR 4/2, moist) silty clay loam or light silty clay; weak coarse platy structure breaking to moderate medium crumb; slightly firm to friable when moist, plastic when wet.
- B₂ 5 to 10 inches
Dark grayish-brown (10YR 4/2, moist) silty clay with moderate medium and coarse blocky structure; firm when moist, very plastic when wet; effervesces weakly in the lower part.
- C_{ca} 10 to 30 inches
Olive-brown (2.5Y 4/3, moist) silty clay with numerous coarse white lime and gypsum mottles; weak subangular blocky breakage; effervesces violently.
- D 30 to 36 inches
Partly weathered, bedded, olive-colored calcareous clayey shale.

Midway-Moreau complex, 3 to 7 percent slopes (Mb).—The Midway and Moreau soils in this complex have profiles as previously described. Many areas are in grass; a few are tilled, particularly those associated with Regent or other soils that are better suited to cultivation. Soils of this complex are moderately heavy to heavy textured.

This soil complex is poor to fair for crops. It is suited to only limited cultivation because of its relatively shallow depth to shale and the hazard of erosion on the stronger slopes. In native grass, it makes good range.

Capability unit, IVe-1; range site, Clayey land.

Midway-Moreau complex, 8 to 11 percent slopes (Mc).—Profiles of the Midway and Moreau soils in this complex have been previously described. Most of the

areas are in grass, although a few are cultivated. Soils of this complex are moderately heavy to heavy textured. They are not suited to cultivation, because of their shallow depth to shale and the hazard of sheet erosion. They are mostly good for range.

Capability unit, VIe-1; range site, Clayey land.

Midway-Moreau complex, 12 to 30 percent slopes (Md).—Soils in this complex have profiles like those described as typical of Midway and Moreau soils. Most areas are in native range; very little is tilled. These soils are moderately heavy to heavy textured. They are not suited to cultivation, because of shallow depth to shale and steepness of slope. They generally make good range.

Capability unit, VIe-1; range site, Clayey land.

Midway-Regent complex

Midway and Regent silty clay loams are so closely associated in some areas that it is difficult to separate them on a map of the scale used. They are therefore mapped together as a soil complex. A typical Regent soil is described under the Regent series, and Midway soils are described with the Midway-Moreau complex.

Soils of this complex occupy moderately large areas in the southern part of the county. They are associated with Regent silty clay loam and Morton and Chama soils (fig. 4). Most areas are in pasture or grass, but others are cultivated where they are associated with better soils. The grass, chiefly wheatgrass, is fairly abundant on Regent soils but less plentiful on the Midway soils.

Midway soils occupy the narrow ridgetops and slopes, where the soils are quite shallow over the parent clayey shale and the dark surface layers are thin. They are calcareous to the surface in most areas and have little structure development below the granular surface soil. The content of organic matter is medium to low in the surface layers. Permeability is slow, and workability is generally poor.

Regent soils usually occupy the smoother, longer slopes and the broader ridges. They have a relatively thicker dark surface layer and upper subsoil layer than the Midway soils. Regent soils are leached of lime to a depth of 12 inches or more. The subsoil has a moderate to strong blocky structure and a lime horizon in the lower part. The organic-matter content is moderately high, and workability is fair.

The hazard of water erosion is high on the steep slopes of Midway and Regent soils and moderate on those slopes having lower gradients. If cropped, this soil complex is subject to wind erosion.

Midway-Regent silty clay loams, 3 to 7 percent slopes (Me).—Many areas of this complex are in native grass and are used for pasture. Some are under cultivation. Soils of this complex are poor to fair for crops but good for range. Because of the erosion hazard, they are suited only to limited or occasional cultivation.

Capability unit, IVe-1; range site, Clayey land.

Midway-Regent silty clay loams, 8 to 11 percent slopes (Mg).—Most areas of this complex are in native grass or are used for pasture. Very few areas are tilled. Soils of this complex are poor to fair for crops, but because of the hazard of erosion, they are suited to limited or occasional cultivation. Their best use is for range.

Capability unit, IVe-1; range site, Clayey land.

Midway-Regent silty clay loams, 12 to 15 percent slopes (Mh).—The soil profiles in this complex are on the average somewhat thinner over shale than the profiles described for typical Midway and Regent soils. Practically all areas are in native grass. The soils of this complex are not suited to cultivation but make good range sites.

Capability unit, IVc-1; range site, Clayey land.

Moline series

The soils of the Moline series are in the southern part of the county. Their greatest part is in native range. Very few areas are cultivated.

Moline soils developed from clayey local alluvium on slopes. The surface is characterized by slick spots. The surface layers of these heavy soils are thin and have a platy structure. Immediately below, the subsoil layer is dense clay that has a strong columnar structure. Salty layers usually underlie this dense claypan. Weathered material from clayey shales occur generally below 3 feet. Slick spots are common where wind has removed the thin surface and exposed the dense compact claypan. Grass ranges from sparse or none on the slick spots to fairly dense on the main, or interspot, areas.

The organic-matter content of the surface soil is low. Runoff is usually medium to rapid. Permeability of the subsoil to air and water is slow to very slow. Moline soils are subject to severe wind erosion if overgrazed. They generally are not suitable for cultivation. On the whole, they are fair for grazing.

Typical profile: Moline clay loam; location, 1,056 feet S. of center of sec. 4, T. 12 N., R. 58 E.:

- A₁ 0 to 5 inches
Dark grayish-brown (2.5Y 4/2, moist) clay loam; platy structure; lower boundary abrupt.
- A₂ 5 to 5½ inches
Light olive-gray (2.5Y 6/2, moist) floury material, which caps the columns immediately below; medium to strongly acid; lower boundary abrupt.
- B₂ 5½ to 10 inches
Grayish-brown (2.5Y 5/2, moist) dense clay in well-developed columns 4/5 to 1 inch in diameter; strongly alkaline.
- B₃ 10 to 16 inches
Dark olive-gray (5Y 4/2, moist) silty clay; indistinct prismatic structure; effervesces in lower part.
- C 16 to 30 inches
Calcareous, olive-gray (5Y 5/3, moist) parent material consisting of sediments brought down from higher areas of weathered shale.

Moline clay loam, 2 to 4 percent slopes (Mk).—This soil has the profile described for the Moline series. Most areas are in native grass; very few are cultivated.

Some areas may be seeded to crested wheatgrass, tall wheatgrass, or other dryland grasses. Under continued cultivation the pan layer tends to break down, but it is a long and difficult process to change the soil. The tilled areas are small and are generally included in soils that are better suited to agriculture. Continued cultivation, stubble-mulch tillage, and use of all available crop residues benefit the soil and make it more workable. Practices suggested for other soils, such as the Morton or Regent, can be applied to this soil.

Capability unit, VIc-2; range site, Pan spots.

Moline clay loam, 5 to 7 percent slopes (Mm). This soil has a profile like that previously described for the

Moline series. Practically all of it is in range. The small areas in crops are generally included with soils better suited to tillage. Continued cultivation, stubble-mulch tillage, and use of all available crop residues will help to make the soil more workable and productive. The practices suggested for the Morton and Regent soils can be used on this soil.

Capability unit, VIc-2; range site, Pan spots.

Morton series

The soils of the Morton series have developed from soft siltstone and sandy shale. Runoff is medium on the slopes. These soils receive some runoff from soils that occupy higher slopes, such as the Chama and Bainville. The surface soils have moderate crumb structure. The upper subsoil layers have weak to moderate prismatic structure. Whitish streaks and spots of accumulated lime occur in a band in the lower part. This subsoil layer merges with silty shale parent material, generally below 3 feet. The dense grass cover has contributed to the development of the relatively thick and dark-colored upper horizons.

Areas of Bainville, Midway, Chama, and Rhoades soils that were too small to be shown on a map of the scale used are included with the Morton soils.

Morton soils are characterized by a relatively high content of organic matter. The dark surface soil is 6 to 8 inches thick, but the dark color continues into the upper subsoil. Permeability of subsoil to air and water is moderate. The Morton soils have good workability. Areas that have been cropped are subject to moderate wind and water erosion, particularly where Bainville and Midway soils are included. Morton soils are fair to good for crops and good for range.

Profile of Morton silt loam; location, just east of NW. corner of NE¼NE¼ of sec. 30, T. 14 N., R. 59 E.:

- A_p 0 to 8 inches
Very dark grayish-brown (10YR 2.5/2, moist) silt loam; moderate fine crumb structure; friable when moist.
- B₂ 8 to 11 inches
Very dark grayish-brown (10YR 2.5/2, moist) silt loam; weak to moderate prismatic structure breaking to moderate medium and fine blocky structure; friable when moist.
- B₃ 11 to 16 inches
Dark grayish-brown (2.5Y 4/2, moist) silt loam with weak medium and fine blocky structure; friable when moist; effervesces strongly in the lower part.
- C_{ca} 16 to 28 inches
Light olive-brown (2.5Y 5/4, moist) silt loam with white lime spots; weak medium and coarse blocky structure; friable when moist; effervesces violently.
- C 28 to 60 inches
Light olive-brown (2.5Y 5/4, moist) heavy silt loam with white lime spots; massive; friable when moist; effervesces violently.

Morton silt loam, 4 to 7 percent slopes (Mn).—This soil is the common soil of Wibaux County on the gentle to moderate slopes. Its position in relation to other soils is shown in figure 4. It occupies large areas in the farming section of the county, particularly in the central, southern, and eastern parts. Most of the soil is under cultivation, although a few scattered areas remain in native grass.

Capability unit, IIIe-1; range site, Silty land.

Morton-Arnegard complex

In some areas Morton and Arnegard silt loams are so closely intermingled that it is difficult to separate them on the map. They are therefore mapped together in these areas as a single unit, or soil complex. Typical Arnegard and Morton soils have been described previously. Nearly all areas of this complex are tilled, although a small part is used for pasture.

The layers, or horizons, of Arnegard and Morton soils are very similar. The chief difference is that the various layers of Arnegard silt loam are thicker than those of Morton silt loam. The Arnegard soil is always nearly level to gently sloping; the Morton soil is on somewhat stronger slopes.

The surface soils are dark-colored silt loams with strong crumb structure. The subsoil layers have blocky to prismatic structure. Below 2 or 3 feet the silty parent material is streaked and splotched with lime and possibly with some other salts. The parent material of the Morton soil is soft siltstone; that of the Arnegard soil was washed from the slopes or consists of local alluvial silts. The original dense grass vegetation has contributed to the development of the dark color and the fertility of Morton and Arnegard soils.

The soils in this complex are characterized by a high content of organic matter in the thick surface layers, moderate permeability of the subsoils to air and water, and good workability. Little runoff occurs on these soils. There is only slight water erosion hazard, but where the soils are tilled the hazard from wind erosion is moderate.

Morton-Arnegard silt loams, 0 to 3 percent slopes (Mo).—This soil complex occurs mainly in a few large individual areas, chiefly in the eastern and southeastern parts of the county. It is good for crops and very good for range and pasture. Areas of Bainville, Midway, Chama, and Rhoades soils, too small to show on the map of the scale used, are included.

Capability unit, IIe-1; range site, Overflow land.

Morton-Chama complex

In some areas in the county the Morton and Chama silt loams are so closely intermingled that it is difficult to separate them on a map of the scale used. In these areas they are mapped together as a soil complex. Typical soil profiles of Morton and Chama silt loams have been previously described. These soils occupy gentle to moderate slopes. Morton soil is usually on the lower more gentle slopes, whereas Chama soil occurs on the low ridges or steeper slopes (fig. 4). Nearly all of these soils are tilled.

Both soils of this complex have developed from silty shales under moderately dense to dense grass. The chief differences are that Morton soils have thicker surface soils and more blocky, darker, and better developed upper subsoil layers than the Chama soils. The Chama soils usually occur on steeper slopes than Morton soils. The parent shale lies at greater depths in the Morton soils than in the Chama.

The content of organic matter is moderately high in Morton soils and medium in the Chama soils. Permeability of the subsoil to air and water is moderate in both soils. Both have good workability.

Morton-Chama silt loams, 4 to 9 percent slopes (Mp).—This soil complex occupies fairly large areas in the southern, central, and eastern parts of the county. It includes a few small areas of Bainville, or of similar shallow soils, that are usually lower in productivity. Other inclusions are small clay spots, small severely eroded areas, and slope breaks that are steeper than the rest of the complex.

Soils in this complex are subject to wind and water erosion if they are cultivated. Morton-Chama silt loams are fair to good for crops. The few areas in native grass make good range sites.

Capability unit, IIIe-1; range site, Silty land.

Pierre-Lismas complex

Pierre and Lismas clays occur extensively in the southwestern part of the county on rolling to rough, stream-dissected areas. They are mapped together as a soil complex. The slopes are mostly steep.

Pierre and Lismas soils are developing on heavy clay shale. The Pierre soil is more deeply developed than the Lismas. The surface layer of the Pierre soil consists of about 10 inches of grayish-brown heavy clay. The subsoil layer is indistinct and merges with partly weathered olive-gray shale within depths of 1½ to 2 feet. The vegetation on Pierre soil consists chiefly of a rather sparse to fairly dense cover of western wheatgrass, blue grama, and other grasses, and a few Rocky Mountain cedars. In the Lismas soil, the parent shale is within a foot of the surface. In many places it occurs at or near the surface.

A typical Lismas clay has been previously described. A description of Pierre clay follows.

Profile of Pierre clay; location, large uniform areas in southwestern part of the county:

- A₁ 0 to 6 inches
Grayish-brown heavy clay with weak blocky and moderate medium granular structure below a surface layer that is merely a 1-inch platy crust.
- B₂ 6 to 15 inches
Olive-gray heavy clay; coarse irregular blocky structure; very hard when dry; very plastic when wet.
- C 15 inches +
Olive-gray clay and partly weathered clay shale passing into unaltered or slightly modified shale within 2 feet.

The soils in this complex have surface soils that are low in organic-matter content. Permeability of the subsoil layers to air and water is slow to very slow. Runoff is rapid to very rapid.

Pierre-Lismas clays, 15 to 40 percent slopes (Pa).—The soils are susceptible to severe sheet erosion if they are overgrazed. They are not suited to cultivation and are mostly poor for grazing.

Capability unit, VIIs-2; range site, Shale and clay.

Regent series

Regent soils are extensive, particularly in the southern part of the county. They occupy gentle and moderate slopes on the uplands in association with Moreau, Midway, Morton, and Chama soils (fig. 4). A large part of Regent soils is under cultivation, and significantly large areas are in native grass or pasture.

These soils have developed from clayey to silty shales. The surface layer has strong crumb structure. The upper subsoil has moderate prismatic structure. The lower subsoil usually contains white streaks and spots where lime and other salts have accumulated. This layer merges with the parent soil material—partly weathered clayey shales that are usually 2 to 3 feet below the surface. Grass was once dense on these soils.

Regent soils have a high content of organic matter. The surface layer is about 6 inches thick. The subsoil is moderately permeable to air and water. Workability is fair. Runoff is medium to low. These soils are subject to water erosion on the steeper slopes. Wind erosion is a hazard on areas left bare for a long time.

Included with the Regent series are small soil areas having inferior productivity, such as severely eroded spots, short and much steeper slopes, and, in places, small areas of Midway, Moreau, Bainville, and Chama soils.

Typical profile: Regent silty clay loam; location, NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 16, T. 12 N., R. 59 E.:

- A_{1p} 0 to 4 inches
Very dark grayish-brown (10YR 3/2, moist) silty clay loam; strong fine crumb structure; friable when moist, slightly sticky and plastic when wet; lower boundary clear.
- B₂₁ 4 to 11 inches
Very dark grayish-brown (10YR 3/2, moist) silty clay; moderate fine prismatic structure breaking to moderate fine blocky structure; friable when moist, sticky and plastic when wet; lower boundary clear.
- B₂₂ 11 to 15 inches
Dark grayish-brown (2.5Y 4/2, moist) silty clay loam; moderate medium prismatic structure breaking to moderate blocky structure; firm when moist, sticky and plastic when wet; lower boundary abrupt.
- C_{oa} 15 to 24 inches
Grayish-brown (2.5Y 5/2, moist) silty clay loam; massive; friable when moist; effervesces violently.
- C 24 to 36 inches
Thinly bedded weathered silty and clayey shale; colors range from grays to yellowish browns; effervesces violently.

Regent silty clay loam, 2 to 4 percent slopes (Ra).—This soil has the profile described for the Regent series. It is not extensive. Most areas are in crops but a few remain in grass. This soil is good for crops and very good for range.

Capability unit, IIe-1; range site, Overflow land.

Regent silty clay loam, 5 to 7 percent slopes (Rb).—This soil has a profile like that described for the Regent series. Moderately large areas are under cultivation, although some remain in grass. This soil is fair to good for crops and makes good range sites.

Capability unit, IIIe-1; range site, Clayey land.

Regent silty clay loam, 8 to 14 percent slopes (Rc).—This soil has the typical profile previously described for the Regent series. Some areas are tilled, but most of the soil remains in grass. This soil is suited to limited or occasional cultivation because of hazard of erosion on the steep slopes. It is fair to poor for crops but makes good range.

Capability unit, IVe-1; range site, Clayey land.

Rhoades series

Rhoades soils occupy a fairly large total area in the southwestern part of the county. The soil occurs on undulating land that has many slick spots and small surface

depressions. The slick spots indicate the presence of claypan subsoils near the surface.

Rhoades soils have developed from sandy and clayey shales. The thin surface layers have a platy structure. The upper subsoil, a claypan, has strong columnar structure. Clayey shales are 2 to 3 feet below the surface. The grass cover ranges from none or sparse around the slick spots to dense on the interspot areas.

The organic-matter content of the Rhoades soils is low. Surface soils are thin, varying from 1 to 4 inches over the claypan layer. Runoff is moderate to rapid. Erosion is moderately severe. Permeability to air and water of subsoil layers is slow to very slow. The slick spots are common where wind has removed the thin surface layers and exposed the dense, compact claypan.

Typical profile: Rhoades clay loam; location, 660 feet N., 264 feet W. of SE. corner, sec. 7, T. 12 N., R. 60 E.:

- A₁ 0 to 4 inches
Dark grayish-brown (2.5Y 4/2, moist) platy loam and clay loam; lower boundary abrupt.
- A₂ 4 to 5 inches
Light brownish-gray (2.5Y 6/2, moist) floury silt loam; slightly to medium acid; lower boundary abrupt.
- B₂ 5 to 9 inches
Very dark grayish-brown (2.5Y 3/2, moist) dense clay; well developed columns 1 inch or more in diameter; strongly alkaline; lower boundary clear.
- B₃ 9 to 14 inches
Dark grayish-brown (2.5Y 4/2, moist) silty clay; weak prismatic structure; effervesces in lower part.
- C 14 inches +
Highly calcareous, dark grayish-brown (2.5Y 4/2, moist) platy weathered shale or bedded clay and shaly sandstone parent material.

Rhoades clay loam, 4 to 7 percent slopes (Rd).—This soil has the profile described as typical for the Rhoades series. It is not usually suitable for cultivation, but it is fair for range sites. Nearly all of it is used for range.

Capability unit, VI_s-2; range site, Pan spots.

Rhoades-Moline complex

The Rhoades-Moline complex occupies moderately large areas in the southwestern part of the county. Where these soils are so closely intermingled that it is not possible to separate them on a map of the scale used, they are mapped as a complex. Rhoades and Moline soils are described elsewhere in this report.

The Moline soils developed from clayey local alluvium on slopes. The Rhoades soils developed from sandy and clayey shales and resemble Moline soils in many characteristics. The Moline soils occur on the colluvial-alluvial slopes, and the Rhoades soils are on the hills.

The organic content of the surface soil of this complex is low. Permeability of subsoils to air and water is slow to very slow. Runoff is usually moderate to rapid. These soils are subject to severe wind erosion when overgrazed. They are not suitable for cultivation. On the whole, they are fair for grazing.

Rhoades-Moline complex, 8 to 11 percent slopes (Re).—This soil complex has the profiles previously described for typical Rhoades and Moline soils. Practically all of it is in range and pasture.

Capability unit, VI_s-2; range site, Pan spots.

Rhoades-Moline complex, 12 to 20 percent slopes (Rg).—The characteristics of the two soils in this complex

have been previously described. All areas are in range and pasture.

Capability unit, VI_s-2; range site, Pan spots.

Rockland-Bainville complex

This mapping unit consists of strongly rolling and steep areas of Bainville soil interspersed with rough stream-dissected areas where rock outcrop is prevalent. Rockland consists of exposures of silty shale and sandstone having little or no soil development. The Bainville soil has been described elsewhere in this report. Some small areas of Badlands are mapped with this complex.

Rockland-Bainville complex, 15 to 50 percent slopes (Rh).—This complex covers large areas in the county. It is poor to fair for grazing. Grazing, however, is limited by the steep slopes and severe erosion hazard. Because of its rough terrain, this complex is not readily accessible to livestock.

Capability unit, VII_s-1; range site, Very shallow land.

Rockland-Flasher complex

In this mapping unit are strongly rolling and steep areas of Flasher soil interspersed with rough stream-dissected areas where rock outcrop is prevalent. Some areas of Bainville soil and Badlands are included. The Rockland consists of exposures of sandstone and silty shale having little or no soil development. The Flasher soil has been described previously.

Rockland-Flasher complex, 15 to 50 percent slopes (Rk).—This complex covers large areas, chiefly in the northern part and, to some extent, in the western part of the county. Its use for grazing is severely limited by steep topography and severe erosion. Livestock have limited access to it because of the steep slopes and rough terrain.

Capability unit, VII_s-1; range site, Very shallow land.

Savage series

Savage silty clay loam occurs in the southern part of the county, chiefly along Beaver Creek and the larger streams. It is one of the major soils in the county for crops.

Savage soils have developed from mixed silty-clayey alluvium on stream terraces. They are nearly level and runoff is slow. The soil profile is well developed. The surface layer has moderate granular structure. The subsoil layer has weak to moderate prismatic structure. A layer streaked and splotched with white indicates where lime and other salts have accumulated in the lower subsoil. This layer merges with silty clay loam stratified alluvium of the parent material. Grass growth has been abundant.

The surface soil, about 6 inches thick, has a high content of organic matter. Workability is fair because of its good granular structure. Savage soils work best under favorable moisture conditions. They are moderately permeable to air and water. They are subject to wind erosion if they are bare during high winds.

Typical profile: Savage silty clay loam; location, NE. corner, sec. 1, T. 12 N., R. 59 E.:

A ₁	0 to 6 inches	Very dark gray (10YR 3/1, moist) silty clay loam; weak medium platy structure breaking to moderate medium and fine granular; friable when moist; lower boundary clear.
B ₂₁	6 to 12 inches	Very dark grayish-brown (10YR 3/2, moist) silty clay loam; weak fine prismatic structure breaking to strong fine subangular blocky; slightly plastic when wet, firm when moist, slightly hard when dry; lower boundary clear.
B ₂₂	12 to 17 inches	Very dark grayish-brown (2.5Y 3/2, moist) silty clay loam; weak fine prismatic structure breaking to strong medium and fine blocky; firm when moist, hard when dry, plastic when wet; lower boundary clear.
B ₃	17 to 21 inches	Dark grayish-brown (10YR 4/2, moist) silty clay loam; weak fine prismatic structure breaking to strong medium and fine blocky; friable when moist, hard when dry, slightly plastic when wet; effervesces strongly; lower boundary clear.
C _{oa}	21 to 27 inches	Grayish-brown (2.5Y 5/3, moist) silty clay loam with abundant, distinct, fine white lime and salt mottles; moderate medium prismatic structure breaking to moderate coarse blocky; friable when moist, slightly plastic when wet; effervesces violently; lower boundary clear.
C	27 to 50 inches	Grayish-brown (2.5Y 5/3, moist) silty clay loam; massive; friable when moist, slightly plastic when wet; effervesces violently.

Savage silty clay loam, 0 to 3 percent slopes (Sa).—This soil has the profile described for the Savage series. Most of it is cultivated, although some areas are used for pasture and range. This is a good soil for crops and a very good soil for range.

Capability unit, II_e-1; range site, Overflow land.

Savage-Wade complex

Savage and Wade soils are so closely intermingled that it is difficult to separate them on a map of the scale used. They are therefore mapped together as a complex. This soil complex occurs in somewhat limited areas in the southern part of the county, chiefly along Beaver Creek and the larger streams. It is nearly level. Many of the areas are in range or pasture, but a significant acreage is tilled. The Savage and Wade series are described elsewhere in this report.

The Savage soils comprise 60 to 70 percent of the soils of this mapping unit. They have developed on silty-clayey alluvium of the low terraces. The well-developed soil profile shows granular surface layers and prismatic subsoil horizons. Whitish streaked and splotched lower subsoils show where lime and other salts have accumulated.

Wade soils have developed from clayey alluvium under slow surface drainage and conditions favoring accumulation of alkali salts. The surface soil is thin and has a thin platy structure. Immediately below the thin surface soil, the subsurface layer has strong columnar or strong prismatic structure. Salty horizons usually underlie this dense columnar claypan.

Areas of Wade soils have slick spots. These slick spots are common where wind has removed the surface layers

and exposed the dense, compact claypan. Wade soils, in places, include puff spots, where the surface material is loose, very friable, and strongly saline. These spots lack the columnar claypan structure of the typical Wade soil profile.

In many places the subsoil of the Wade soils is slowly to very slowly permeable to water. Workability is poor because the exposed areas of claypan tend to puddle when wet and to become very hard when dry. The wind erosion hazard is moderate to very high.

Savage soils have high organic-matter content and good surface soil depth. Workability is fair. The soils are subject to wind erosion.

Savage-Wade complex, 0 to 3 percent slopes (Sb).—This complex is good to fair for crops because it contains a fairly large area of the friable Savage soils. It is good for range.

Capability unit, IIe-1; range site, Overflow land.

Searing series

Soils of the Searing series occur on gentle and moderate slopes on uplands in or near scoria hills. They have a characteristic reddish color that distinguishes them from other soils of the county. Many of the areas are in crops, but a significant acreage remains in native grasses.

Searing soils have developed from materials weathered in place and from some alluvium wash from burned reddish shale and siltstone or scoria beds. The soils are deep to moderately deep over the parent shales.

Surface layers have moderate crumb structure. Subsoil layers usually have moderate prismatic structure. A whitish or spotted layer, where lime and other salts accumulate, is in the lower subsoil. More or less baked silty shales and scoria fragments characterize the parent soil material and are scattered throughout the profile. The grass cover is dense.

Searing soils have a fairly high content of organic matter. The surface layer is about 6 inches thick. Runoff is medium and in some places rapid. Permeability of subsoil layers to air and water is moderate. Workability is good. Where the steeper slopes are farmed, Searing soils are subject to water erosion. Wind erosion is moderate if the soils are left bare.

Mapped with the Searing soils are small areas of soils of inferior productivity. These inclusions are small severely eroded areas, areas on short and much steeper slopes, and small areas of Bainville, Wibaux, and Flasher soils.

Typical profile: Searing loam:

- | | |
|-----------------|--|
| A ₁₁ | 0 to 2 inches
Dark-brown (7.5YR 3/2, moist) loam; weak fine platy structure breaking to strong fine crumb; soft when dry, friable when moist; a few fragments of the red and brown burned shale are scattered over the surface and throughout the soil; lower boundary clear. |
| A ₁₂ | 2 to 5 inches
Dark-brown (7.5YR 3/2, moist) loam with weak medium prismatic structure breaking to strong fine crumb; slightly hard when dry, friable when moist; lower boundary clear. |
| B ₂ | 5 to 10 inches
Dark reddish-brown (5YR 3/4, moist) heavy loam; moderate medium prismatic structure breaking to moderate fine blocky; slightly hard when dry, friable when moist; lower boundary clear. |

- | | |
|-----------------|--|
| B _{3a} | 10 to 20 inches
Yellowish-red (5YR 4/6, moist) loam; weak coarse prismatic structure breaking to weak fine blocky and moderate medium crumb; friable when moist, slightly hard when dry; effervesces violently; lower boundary gradual. |
| C _{ca} | 20 to 40 inches
Dark-red (2.5YR 3/6, moist) loam; fine crumb structure; very friable when moist, soft when dry; effervesces strongly; contains gypsum crystals; lower boundary gradual. |
| C | 40 to 60 inches
Reddish-brown (5YR 5/4, moist) loam or very fine sandy loam; friable when moist; effervesces strongly. |

Searing loam, 3 to 7 percent slopes (Sc).—This soil has the profile just described. It is fair to good for crops and good for range. A few areas are on steep slopes that are not well suited to cultivation. They are mostly poor to fair for crops.

Capability unit, IIIe-1; range site, Silty land.

Valentine series

Valentine soils occur in a few small to relatively large areas in the southwestern part of the county. They occupy areas on sandhills and are all under native grass.

These soils have developed in windblown sand. They have little or no runoff and no well-defined drainage channels. The surface layer consists of thin, slightly dark-colored fine sand. This layer merges with the sand parent material, which in most places is very deep over sandstone and shale. The growth of grass is dense in some areas.

The content of organic matter in the surface soil is low. Permeability to air and water is rapid. Valentine soils are subject to very severe wind erosion if the grass cover is destroyed. Valentine soils are good for grazing. They are not suitable for cultivation, because of wind erosion.

Typical profile: Valentine fine sand:

- | | |
|----------------|---|
| A ₁ | 0 to 3 inches
Dark grayish-brown (10YR 3.5/2, moist) fine sand; loose; lower boundary clear. |
| C | 3 to 28 inches
Dark grayish-brown (10YR 4/2, moist) fine sand; wind stratified; loose; lower boundary clear. |
| A _b | 28 to 34 inches
Very dark brown (10YR 2/2, moist) fine sandy loam, single grained; very friable when moist. |

Valentine fine sand, 5 to 15 percent slopes (Va).—This soil has the profile described for the Valentine series. It is a good soil for grazing. It is not suitable for cultivation, because of wind erosion.

Capability unit, VIe-2; range site, Sands.

Vebar series

Soils of the Vebar series are widely distributed over the county; the larger areas are generally southwest of Wibaux. Most areas are undulating and rolling; a few are moderately steep. These sandy soils (fig. 17) are used mainly for crops, but some areas are in pasture and range.

Vebar soils have developed in materials weathered from sandstone and sandy shale, and locally they have been partly reworked by wind. The surface soil has weak crumb structure and is about 6 to 8 inches thick. The subsoil has weak blocky structure and generally merges



Figure 17.—Profile of Vebar fine sandy loam.

with the underlying sandy material or sandstone. The virgin soils support a dense cover, chiefly of tall grasses.

The organic-matter content of the surface layers in Vebar soils is medium. Runoff is slow, and the soil absorbs most of the rainfall. Permeability to air and water is moderately rapid in the subsoil. Workability is good. When tilled, this soil is subject to moderate to severe wind erosion.

Included with the Vebar soils are small areas of lower productivity. These are shallow Flasher soils, rock outcrop, severely eroded spots, and short slopes that are much steeper than is normal for the series.

Typical profile: Vebar fine sandy loam:

- A_{1p} 0 to 8 inches
Very dark grayish-brown (10YR 3/2, moist) light fine sandy loam; weak medium and fine crumb structure; very friable when moist; effervesces slightly; lower boundary abrupt.
- B 8 to 16 inches
Dark grayish-brown (10YR 3.5/2, moist) light fine sandy loam; weak very coarse blocky structure; very friable when moist; effervesces strongly; lower boundary abrupt.
- C₁ 16 to 25 inches
Grayish-brown (2.5Y 5/3, moist) loamy fine sand with weak very coarse blocky structure; very friable when moist; effervesces strongly; lower boundary diffuse.
- C₂ 25 to 36 inches
Grayish-brown (2.5Y 5/3, moist) loamy fine sand; loose or very friable when moist; effervesces strongly.

Vebar fine sandy loam, 4 to 7 percent slopes (Vb).— This soil has the profile described for the Vebar series.

Most of the areas are under cultivation, but some remain in native grass. This soil is fair to good for crops and good for range. The wind erosion hazard is very high.

Capability unit, IIIe-3; range site, Sandy land.

Vebar fine sandy loam, 8 to 14 percent slopes (Vc).— This soil occurs on a few of the more steeply sloping areas. Most of this sandy soil is in grass, although some areas are cultivated. This soil is suitable for only limited or occasional cultivation because of severe wind erosion. It is good for range.

Capability unit, IVe-1; range site, Sandy land.

Vebar-Flasher complex

Where Vebar and Flasher soils are so closely intermingled that it is difficult to show them separately on a map of the scale used, they are mapped together as a soil complex. These sandy soils are mostly under cultivation, but some areas are in native grass. Typical Vebar and Flasher soils are described in detail elsewhere in this report.

Flasher soils are on the steeper slopes and on low hilltops where the sandstone is near the surface or may outcrop in places. Both Vebar and Flasher soils are particularly subject to severe wind erosion if tilled.

Vebar-Flasher complex, 3 to 9 percent slopes (Vd).— This soil complex occurs in limited areas in association with Vebar soils. It is fair for crops and good for range. Permeability to air and water is moderately rapid.

Capability unit, IIIe-3; range site, Sandy land.

Vebar-Timmer complex

Vebar and Timmer soils (fig. 4) are so closely mixed in some areas that it is difficult to separate them on a map of the scale used. In these areas they are mapped together as a soil complex. Most of the areas are in crops, but some are in native grass. Virgin areas support a dense stand of tall grasses.

Timmer soils have developed from material that has been mixed as it moved downslope from areas of sandy shales and sandstone. They are on the lower slope position favorable for the accumulation of runoff from higher soil areas. There is practically no runoff. The surface layer has weak crumb structure. Subsoil layers have weak prismatic structure. A whitish or spotted layer usually occurs in the lower subsoil; it shows where lime has accumulated. This layer merges with the loose sandy parent material or, in places, with soft sandstone.

Vebar soils resemble Timmer soils in many respects. They have developed from similar parent materials, but probably more directly from soft sandstone. Vebar soils occur on undulating to nearly level uplands and low rounded knolls. The surface layer has weak crumb structure. Subsoil layers have blocky structure. The whitish zone of lime accumulation usually occurs in the deep subsoil layers. The grass is moderately dense on the virgin areas.

The organic-matter content of Vebar and Timmer soils is mostly high. The surface layer ranges from 6 to 10 inches in thickness. Permeability of subsoil layers to air and water is moderately rapid. Workability is

good. These soils are subject to moderately severe wind erosion under cultivation.

Included with the Vebar soils are small areas of Bainville and Flasher soils, soils on short steep slopes, and severely eroded spots.

Vebar soils have been previously described. A Timmer soil is as follows.

Typical profile: Timmer fine sandy loam; location, NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 36, T. 14 N., R. 60 E. (in swales):

- A_{1p} 0 to 8 inches
Very dark brown (10YR 2/2, moist) fine sandy loam; weak medium and fine crumb structure; very friable when moist; lower boundary abrupt.
- B₂ 8 to 17 inches
Very dark grayish-brown (10YR 3/2, moist) fine sandy loam; moderate coarse prismatic structure; very friable when moist.
- B₃ 17 to 22 inches
Very dark grayish-brown (10YR 3/2, moist) fine sandy loam; weak very coarse blocky structure; very friable when moist.
- C_{oa} 22 to 36 inches
Dark grayish-brown (10YR 4/2, moist) loamy fine sand; effervesces strongly.

Vebar-Timmer fine sandy loams, 0 to 3 percent slopes (Ve).—This soil complex is of limited extent in the county. It occupies a few nearly level areas in the southeastern part. It is fair to good for crops and good for range.

Capability unit, IIIe-3; range site, Overflow land.

Wade series

Soils of the Wade series are in the southern part of the county, mostly along Beaver Creek and its tributaries. Some areas are cultivated, although many remain in pasture or range.

These soils have developed on clayey alluvium under slow surface drainage and conditions favoring accumulation of alkali salts. The surface soils are 4 to 6 inches thick and have thin platy structure. Immediately below is the strong columnar claypan subsoil. Salty, moderately clayey horizons usually underlie this dense claypan.

Areas of Wade soils are characterized by occasional to frequent blowouts or slick spots where wind has removed the surface soil and exposed the claypan. In some places Wade soils show salty puff spots where salt has accumulated at the surface.

Permeability of the claypan to air and water is slow to very slow. Workability of the soils is poor because of the exposed heavy, dense claypan spots which become puddled when wet and very hard when dry. Wind erosion is moderate to severe.

Typical profile: Wade silty clay loam:

- A₁ 0 to 6 inches
Dark grayish-brown (2.5Y 3/2, moist) friable silty clay loam; lower boundary abrupt.
- B 6 to 12 inches
Very dark olive-gray (5Y 3/1, moist) clay; dense, massive; prismatic or columnar; strongly alkaline.
- C₁ 12 to 26 inches
Dark olive-gray (5Y 4/2, moist) silty clay loam having white spots of salt accumulation; more friable than horizon above; effervesces strongly.
- C₂ 26 to 40 inches
Light brownish-gray stratified silty and clayey old alluvium.

Wade silty clay loam, 0 to 3 percent slopes (Wa).—This soil is generally poor for crops. However, it is fair for crops where the surface soil is thickest and only a few blowout spots are present. It is fairly good for range, chiefly because of the dense vegetation on the areas between blowout spots.

Capability unit, IVs-1; range site, Saline lowland.

Wibaux series

This soil occurs throughout the county but is chiefly in the central and southern parts. The topography is strongly rolling to rough. Much of this soil occupies cone-shaped hills, knobs, and ridges that have considerable scoria outcrop (fig. 4). Nearly all areas are in grass, but a few that are associated with better agricultural soils are cultivated.

Wibaux soils are developing over reddish shaly materials, or scoria, which was produced by heating and partial fusing of clays during the burning of former coal and lignite beds. The surface layer has weak crumb structure. Within a foot this layer merges with scoria that has been altered only slightly by weathering. Scoria occurs at or near the surface and ranges to depths of 2 or 3 feet where Searing soils are included. Scoria outcrop is common.

The content of organic matter in the thin surface layers is low. Runoff is medium. Permeability of subsoil layers to air and water is moderate, but because of shallow depth to bedrock, Wibaux soils are more or less droughty.

Typical profile: Wibaux stony loam:

- A₁ 0 to 5 inches
Dark reddish-brown (5YR 3/3, moist) friable stony loam containing an abundance of angular scoria fragments; commonly calcareous.
- C 5 inches +
The remainder of the section, below a thin light reddish-brown transition layer, is almost pure scoria that has been unaltered or only slightly altered by weathering; colors range from bright red to reddish yellow; some areas are calcareous and others non-calcareous.

Wibaux stony loam, 10 to 40 percent slopes (Wb).—This soil has the profile described for the Wibaux series. It is not suited to cultivation but is fair to good for range sites.

Capability unit, VIe-3; range site, Shallow land.

Williams series

Williams soils occupy inextensive areas in the extreme northern part of the county. Most of this soil is in native grasses, although small areas are cultivated. The soils are on gentle to moderately steep slopes in association with Bainville soils.

Williams soils have developed on glacial drift from a mixture of gravel and fine earth deposited by glaciers. The surface soil has moderate crumb structure. Subsoil layers have weak blocky to prismatic structure. The lower subsoil normally has a whitish or splotched layer in which lime has accumulated. Parent glacial drift occurs below the subsoil. Thickness of the drift over shale

and sandstone ranges from 2 to several feet. Grass has been fairly abundant on Williams soils.

The organic-matter content of the surface layers is high. Runoff, depending on steepness of slope, ranges from medium to rapid. Permeability of subsoil to air and water is moderate. If cropped, Williams soils are subject to water erosion on the steeper slopes. Wind erosion is moderate on exposed slopes when the land is left bare.

Typical profile: Williams silt loam:

- A₁ 0 to 5 inches
Very dark grayish-brown (10YR 3/2, moist) heavy loam; weak medium platy structure breaking to moderate medium crumb; friable when moist.
- B₂ 5 to 9 inches
Very dark grayish-brown (10YR 3/2.5, moist) heavy loam; weak medium and fine blocky structure breaking to moderate coarse crumb; friable when moist.
- B_{2ca} 9 to 20 inches
Brown (10YR 4/3, moist) heavy loam; weak medium and fine blocky structure breaking to moderate coarse crumb; friable when moist; effervesces violently.
- B₃ 20 to 27 inches
Brown (10 YR 4/3, moist) clay loam; weak coarse prismatic structure breaking to weak coarse blocky; friable when moist; slightly plastic when wet; effervesces violently.
- C 27 to 40 inches
Brown (10YR 4/3, moist) clay loam till; massive; friable when moist, slightly plastic when wet; effervesces violently.

Williams silt loam, 2 to 5 percent slopes (Wc).—This soil has the profile described for the Williams series. It is not extensive. Most areas are in pasture. This soil is fair to good for crops and makes good range.

Capability unit, IIIe-1; range site, Silty land.

Williams silt loam, 6 to 14 percent slopes (Wd).—The profile of this soil is similar to that described for the Williams series. The soil is fair to poor for crops; it tends to erode badly under cultivation on the steeper slopes. Much of this soil occurs as small areas on the ridge crests in hilly and broken areas. Few areas are large enough to make farming practical.

Capability unit, IVe-1; range site, Silty land.

Zahl series

The soils of the Zahl series are in the extreme northern part of the county, mainly on steep slopes. They occupy areas within shale uplands, most of which are in native grasses. Very few areas are tilled.

These thin soils developed on glacial drift—a mixture of gravel, stone, shale, and fine earth deposited by glaciers. The surface soil is thin and has weak crumb structure. It merges with subsoil layers of glacial drift.

The grass cover is variable but is generally dense. The content of organic matter in the surface layers is low. Runoff on the steep topography is mostly rapid. Permeability of subsoil layers to air and water is moderate.

Typical profile: Zahl loam:

- A₁ 0 to 4 inches
Very dark grayish-brown (10YR 3/2, moist) friable loam with fine crumb structure; few boulders; small stones and pebbles are common in the soil and on the surface; commonly calcareous at or near the surface.
- A₂ 4 to 8 inches
Olive-brown (2.5Y 4/3, moist) loam; calcareous.
- C 8 to 26 inches
Yellowish-brown (2.5Y 5/4, moist) friable calcareous loam or clay loam till; contains various amounts of stone and pebbles, including sandstones or shale fragments.

Zahl loam, 8 to 30 percent slopes (Za).—This soil has the profile described for the Zahl series. It is not suited to cultivation, because of strong slopes and the hazard of erosion. It is good for range sites.

Capability unit, VIe-1; range site, Silty land.

Formation and Classification of Wibaux County Soils

This section deals with the formation and classification of the different soil series recognized in the county. Some of the factors that affect soil formation are discussed. The soil series, classified by higher categories, and some of the factors that have contributed to soil morphology, are shown in table 3.

TABLE 3.—Classification of the soil series of Wibaux County by higher categories, and some of the factors that have contributed to the morphology of the soils ¹

ZONAL SOILS

Great soil group and soil series	Parent material	Topography and drainage	Climate	Vegetation	Special characteristics
Chestnut: Arnegard.....	Alluvial-colluvial, silty...	Narrow valleys and low slopes; moderately well drained.	Semiarid.....	Grass.....	
Chama.....	Sandstone and shale.....	Undulating to rolling; well drained.	Semiarid.....	Grass.....	
Cherry.....	Alluvial fans and terraces, silty.	Fans and terraces, level to sloping; moderately well drained.	Semiarid.....	Grass.....	
Cheyenne.....	Old alluvium, gravelly fine earth.	Undulating high terraces; well drained.	Semiarid.....	Grass.....	
Farland.....	Alluvial terraces, silty.....	Nearly level; well drained.	Semiarid.....	Grass.....	
Grail.....	Alluvial-colluvial, silty-clayey.	Narrow valley and low slopes; moderately well drained.	Semiarid.....	Grass.....	
Moreau.....	Shale.....	Undulating to rolling; well drained.	Semiarid.....	Grass.....	

See footnote at end of table.

TABLE 3.—Classification of the soil series of Wibaux County by higher categories, and some of the factors that have contributed to the morphology of the soils ¹—Continued

ZONAL SOILS—Continued

Great soil group and soil series	Parent material	Topography and drainage	Climate	Vegetation	Special characteristics
Chestnut—Con. Morton.....	Sandstone and shale.....	Undulating to rolling; well drained.	Semiarid.....	Grass.....	Flatter positions.
Regent.....	Shale.....	Same.....	Semiarid.....	Grass.....	
Savage.....	Alluvial terraces, silty-clayey.	Nearly level, well drained.	Semiarid.....	Grass.....	
Searing.....	Scoria, sandstone, and shale.	Undulating to sloping; well drained.	Semiarid.....	Grass.....	
Timmer.....	Sandstone and wind deposits.	Undulating; well drained.	Semiarid.....	Grass.....	
Vebar.....	Same.....	Undulating to rolling; well drained.	Semiarid.....	Grass.....	
Williams.....	Glacial drift.....	Same.....	Semiarid.....	Grass.....	
Brown: Cushman, deep variant.	Ancient alluvium and wind deposits over shale.	Undulating to sloping; well drained.	Dry, semiarid...	Grass.....	
Glendive.....	Alluvial and colluvial fine sandy materials.	Level to sloping; moderately well drained.	Dry, semiarid...	Grass.....	
Pierre.....	Clay shale.....	Sloping to rolling; excessively drained.	Dry, semiarid...	Grass.....	

INTRAZONAL SOILS

Solonetz: Hoven.....	Alluvium, clayey.....	Nearly level terraces; variable drainage.	Semiarid.....	Grass.....	Drainage, salinity.
Moline.....	Alluvial-colluvial, silty-clayey.	Narrow valley and low slopes; moderately well drained.	Semiarid.....	Grass.....	Drainage, salinity.
Rhoades.....	Shale.....	Undulating to rolling; moderately well drained.	Dry, semiarid...	Grass.....	Saline shales.
Wade.....	Alluvial terraces, silty-clayey shale.	Nearly level terraces; variable drainage, undulating to sloping.	Semiarid to arid.	Grass.....	Drainage, salinity; saline shales.
Saline: Cherry, saline..	Alluvium, silty, saline, from shale.	Fans and low terraces; variable drainage.	Semiarid.....	Grass.....	Drainage, saline shales.
Humic-Gley: McKenzie.....	Clayey alluvium.....	Level flats; poorly drained.	Semiarid.....	Grass, sedge....	Drainage.

AZONAL SOILS

Regosols (Dry sands): Valentine.....	Wind-deposited sands.....	Dunelike; excessively drained.	Semiarid to arid.	Grass.....	Sand and wind.
Lithosols: Bainville.....	Sandstone and shale.....	Undulating, rolling, and steep; excessive drainage.	Same.....	Grass.....	Steep slopes.
Flasher.....	Sandstone.....	Same.....	Same.....	Grass.....	Steep slopes.
Lismas.....	Clay shale.....	Steep slopes; excessive drainage.	Same.....	Grass.....	Clay shale, steepness.
Midway.....	Shale.....	Undulating, rolling, and steep; excessive drainage.	Same.....	Grass.....	Steep slopes.
Wibaux.....	Baked shale.....	Steep slopes; excessive drainage.	Same.....	Grass.....	Baked shale, steepness.
Zahl.....	Glacial drift over shale...	Rolling and steep; well to excessively drained.	Same.....	Grass.....	Steep slopes.
Alluvial soils: Harlem.....	Alluvial silts, sands.....	Nearly level, variable drainage.	Same.....	Grass, brush....	Young, little development.

¹ Miscellaneous land types are not listed.

Principal Factors of Soil Formation

In the preceding sections the soils of the county have been described and suggestions have been made for their use and management. In order to understand the soils better and to use them to the best advantage, it is important to know how they formed. Such information will help explain why soils differ in fertility, physical properties, and productivity.

The factors that are the main causes of soil formation are: (1) the parent material and its geologic origin; (2) topography, or lay of the land; (3) the climate under which the soil has formed; (4) the length of time the soils have weathered or developed; and (5) the plant and animal life in and on the soil.

No one factor can explain all the soil differences. All of the factors act together, and at different rates, to form the different layers, often called horizons, that make up each soil. In some places steep slopes have strongly affected the formation of the soil. In other places the parent material has been the dominating influence. Climate and vegetation have broad and general effects. The length of time a soil has been acted on by natural forces is reflected in the kind and number of horizons that have developed.

Origin of soil-forming materials.—The texture of the soils—their variation from sandy to clayey—is strongly influenced by texture of the parent soil material. Table 3 indicates the parent soil material of each soil series.

Most of the formations in the county are favorable for soil development. Many of the materials are calcareous. The general locations of the geological formations in the county are shown in figure 18. How some of the soils are related to geologic formations in the county is shown in figure 19.

The most common materials in Wibaux County are those of the Fort Union formation of early Tertiary (Eocene) age. They include soft siltstone, sandstone, and clay shale; local bands of impure limestone; and numerous lignitic coal beds. Plant and animal fossils occur, but no dinosaur bones. The bottom of the formation is placed at the lowest succession of the lignitic beds.

Lignitic beds varying in thickness from a few inches to several feet are common throughout the Fort Union formation. Beds of scoria, the baked and burned clinker remnants of lignite beds, are common. They furnish the parent material for Searing and Wibaux soils. The lignite beds themselves have contributed little to soil formation.

Soils associated with the Tongue River member of the Fort Union formation are loams, silt loams, and fine sandy loams of the Morton, Chama, Bainville, Flasher, and Vebar series. The moderately heavy soils, as Regent, Moreau, and Midway, are associated with Lebo shale in the lower part of the Fort Union and in the older Hell Creek formations.

The Hell Creek formation consists mainly of gray sandstone, greenish shaly clay, and mudstone that in places contain dinosaur bones and a few thin lignite and subbituminous coal beds.

Some of the most productive soils have developed in silty and clayey colluvium or in alluvium that washed from shale materials of the Fort Union and Hell Creek formations or from soils developing in those formations.

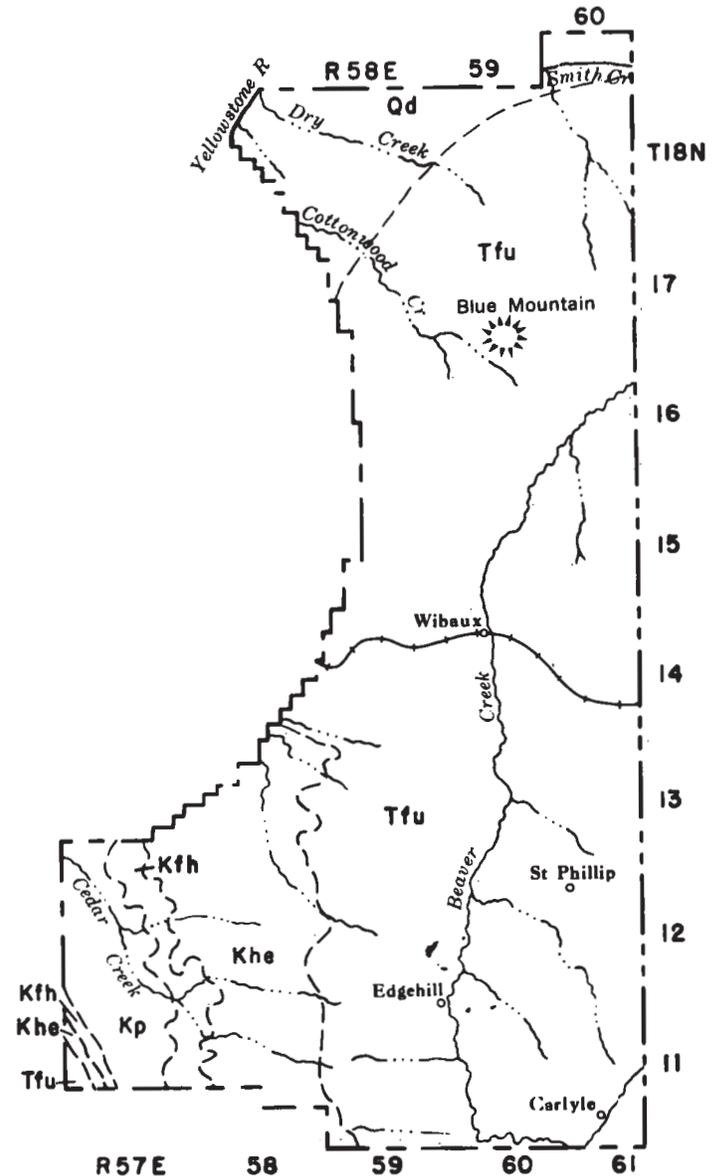


Figure 18.—Geological formation of Wibaux County, Mont.: Qd, Border of continental ice sheet; glacial drift. Tfu, Fort Union formation; includes the Tongue River member, Lebo shale member, and Tullock member. Khe, Hell Creek formation. Kfh, Fox Hills sandstone. Kp, Bearpaw shale.

Among these productive soils are those of the Arnegard, Grail, Savage, Farland, Cherry, and Harlem series. Wade, Rhoades, Moline, and the saline phases of the Cherry series, though derived from the same formation as these productive soils, are less desirable because of claypan, wet spots, or salinity.

Some soil series, as Cheyenne, have developed in ancient gravelly fine earth deposits on stream terraces that are now far above the level of the present valley bottoms and streams.

In the northern part of the county, Williams and Zahl soils have developed from remnants of glacial drift that once covered this area. Geologists classify the age of this deposit as pre-Wisconsin. These soils may mark the southern border of the continental ice sheet.

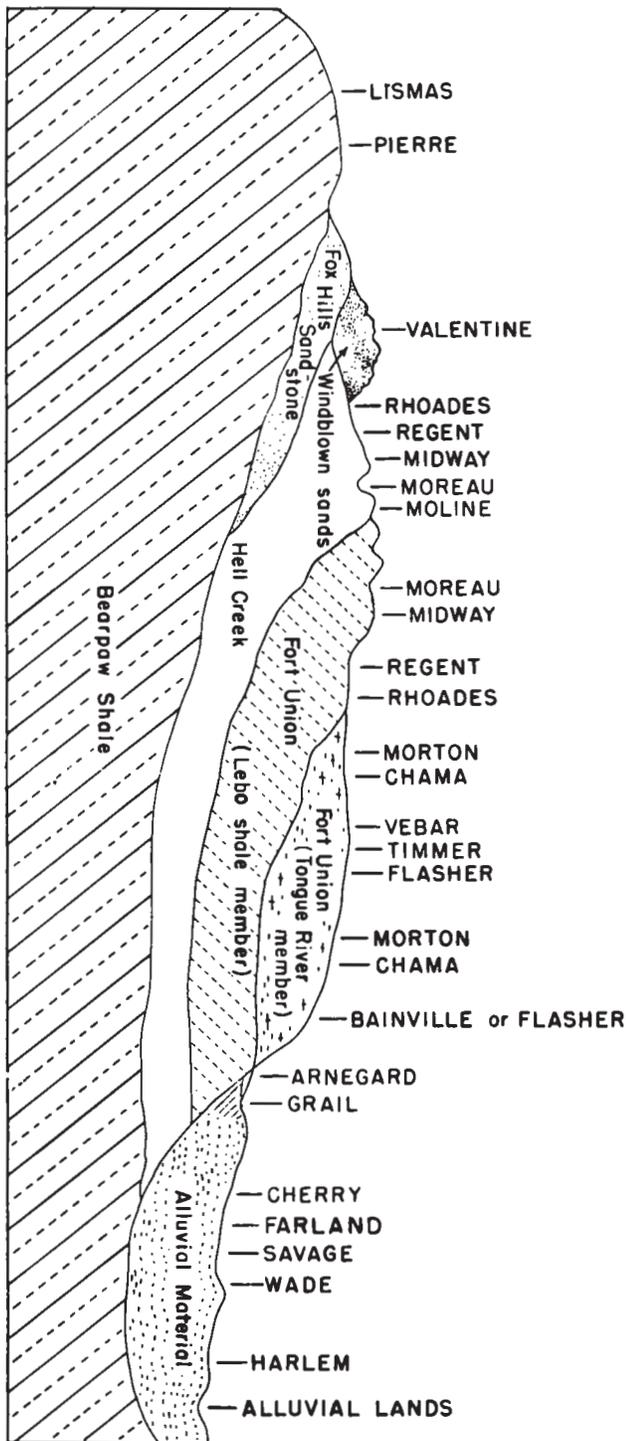


Figure 19.—Relationship of soil series to geologic formations in Wibaux County, Mont.

In the southwestern part of the county, the sandhills—or areas of Valentine soils—have developed from sands sorted and deposited by the wind. The sands were derived in part from the Fox Hills sandstone formation of Cretaceous age. The Fox Hills formation is typically

a shaly sandstone grading upward into massive brownish sandstone; a white sandstone of the Colgate member is locally at the top.

In the southwestern part of the county the variants of the Cushman soils have formed in many kinds of parent materials. Some of these materials were derived from ancient valley alluvium, perhaps of Pliocene age, and from wind-deposited silts.

Lismas and Pierre soils are associated with dense clay shales of the Bearpaw formation of Late Cretaceous age. This formation includes dark-gray and brownish clay shale that has a thick strata of nonfissile bentonitic shale. Calcareous and ferruginous concretions occur throughout, and there are some thick bentonite beds.

Badlands and Rockland are associated with raw exposures of the Fort Union, Hell Creek, and Bearpaw formations in this county.

Topography, slope, and drainage cause differences in the soil.—Total moisture and runoff and run-in water have a major effect on soil development. The steeper soils furnish some runoff to the soils on lower areas. This has the same effect on the lower lying soils as additional rainfall. Vegetation is more plentiful on them, and the surface layers have a greater content of humus. As a result, the more nearly level areas ordinarily are darker and more productive. Thus the normal, or zonal, soils having slopes of 3 to 7 percent often show the average effect of local rainfall and climate. The soils that are forming on the steeper slopes are carried away in part by natural erosion. These soils therefore have less depth and less horizon development.

The land surface in Wibaux County was shaped for the most part by the natural process of erosion, and by water, ice, wind, and gravity. As these natural processes carved the hills and valleys, the valley slopes advanced into the uplands. How soils fit into the present landscape is shown in figure 4, p. 3.

While the main streams and side drainages are being formed, the valley slopes recede from them and are cut back. The process is described by geologists as formation of pediments. Pediments are the land surfaces between the valley slopes and the stream. The slopes of these pediments decrease as they approach the stream.

Climate and soil.—The climate and its influence on soil and plants depends not only on temperature, rainfall, and humidity, but also on the physical characteristics of the soil or soil material and on relief, which, in turn, influences drainage, aeration, runoff, erosion, and exposure to sun and wind.

The climate in Wibaux County fluctuates through dry and wet years from semiarid to subhumid. Its effects are best shown on upland soils with gentle slopes—slopes of 3 to 7 percent. The steeper and the more nearly level soils show dominance of other factors that have affected soil development. The area has a continental climate—that is, the summers are comparatively short, hot, and dry, and the winters are fairly cold and long. Freezing weather may prevail from November through April. Most of the annual precipitation falls in the growing season, a distribution of rainfall that is typical of the Great Plains and that favors crop production.

Ground moisture seldom goes below 3 feet, except in such places as bottom lands or areas that receive run-in water. Layers of accumulated lime indicate the average

depth to which rainfall penetrates in the various soils. Below this layer, the soils are usually dry. Moisture collected on fallow land, however, often goes below this depth.

Time as a factor in soil development.—Soils of the county range from young to old. The number and characteristics of the soil horizons, or layers, is partly a function of time, which is demonstrated in the degree of weathering that has taken place. Some young soils have developed thin A layers in which the parent material is relatively close to the surface. Generally, the greater the number of soil horizons, the deeper or more complex is the soil development. Furthermore, the greater number of soil horizons indicates that the soils have remained in place relatively undisturbed for a longer time than soils with fewer horizons. The more strongly the soil structure is expressed in the layers, the longer it took to develop the layers.

Influence of native vegetation.—Native grasses growing over long periods have contributed largely to the development of the dark-colored surface layers. The favorable crumb or granular structure has been developed in part by the growth of plant roots. The abundance of root growth and the grass density on the surface show the favorable influence of soil structure and development. In some series, such as the Pierre and Lismas, the development is thin and the plant cover is sparse. The spotted condition of the vegetation that is associated with slick spots and claypans demonstrates the difficulty plants encounter because of adverse soil structure. Soils with light-colored surface layers are generally those on which the vegetation is sparse. The accumulation of organic matter is slow in these areas.

Human Influences on Soils

Physical changes in soils may result from cultivation, as when surface and subsurface layers are mixed during tillage. Erosion, especially that brought about by activities of man, can change the nature of a soil by removing the upper layers much faster than they can be replaced by soil-forming processes. Crumbs and granules may be broken down or the structure may be made more dense and packed by grinding and crushing during cultivation. The beating of raindrops on a bare surface can cause puddling and thus break down the natural structure.

Organic matter, under cultivation, slowly decreases, even though there is little surface erosion. Mineral plant nutrients are gradually removed from the soil in grain, straw, and hay.

When the native ranges are overused, the number of plants is reduced and the protection they give to the surface soil is reduced. Overuse can also decrease the amount of mulch provided by natural plant litter and thus cause the soil to be washed or blown away.

How the Soil Profile Develops

After the soil material is deposited, or as it weathers in place, simple forms of life such as bacteria, fungi, and lower plants begin to grow. Higher plants become established, and as they grow and die they add organic matter.

Thus a layer of surface soil is formed. At the early stages of profile development, the subsoil has the same characteristics as the soil-forming material. If the slopes are steep, the subsoil layer may change very little from the original parent material because on such slopes the soil is carried downslope nearly as fast as it forms. If the slopes are gentle, the subsoil may gradually change from the original parent material. Soil horizons then increase in number. They thicken, and the normal soil develops.

The soil-forming factors make the soil profile what it is. They also cause all the differences in the profile. The upper layers can be removed rapidly if accelerated erosion occurs.

The action of ice, wind, water, and gravity occurs along with the development of soil and vegetation. In this area rainfall was adequate to grow mostly the sod-forming grasses. Only in the wettest years was there a surplus that could penetrate below the grass roots. The normal soils that developed on the uplands have thick, very dark brown surface layers high in organic matter. The surface soil was underlain by a layer or horizons in which slowly soluble materials like lime accumulated. Along with the lime, clay particles moved slowly downward in water suspension and were deposited in looser horizons and along root channels. Soil structure was thus formed. The changes were very slow, and the soils were formed at different rates from place to place, depending on the parent materials, the degree of slope, and many other factors.

Wibaux County Soils Related to Other Areas

Some of the soil series described in a soil survey of Morton County, North Dakota,³ are the same as or are related to the soils in Wibaux County. Much of the information on the soils in Morton County can be used for a better understanding of the soils in Wibaux County. However, Morton County has the most eastern distribution of the soils that are common to both counties. Such soils in Wibaux County occur on the western edge of Morton County.

The soil survey of McKenzie County, North Dakota,⁴ also discusses comparable soils having a similar climate and topography. McKenzie County adjoins Wibaux County for a short distance. The soils are mapped in somewhat less detail in Morton and McKenzie Counties than in Wibaux County.

Classification of Soils Into Great Soil Groups

The soil series of Wibaux County are classified by great soil groups in table 3. This classification shows (1) in what broad soil zone and great soil group the soil series occur in the world, and (2) the relative effects of the soil-forming factors, such as climate, vegetation, topography,

³ EDWARDS, M. J., and ABLEITER, J. K. SOIL SURVEY OF MORTON COUNTY, NORTH DAKOTA. U. S. Dept. Agr., Bur. Plant Indus., Soils, and Agr. Engin., Soil Survey Rpt., Ser. 1936, No. 28, 145 pp., illus. 1951.

⁴ EDWARDS, M. J., and ABLEITER, J. K. SOIL SURVEY OF MCKENZIE COUNTY, NORTH DAKOTA. U. S. Dept. Agr., Bur. Plant Indus., Soil Survey Rpt., Ser. 1933, No. 37, 99 pp., illus. 1942.

drainage, and parent material. Such a classification is useful to show how the local soils are related to soils all over the world.

Soil Survey Methods and Definitions

The scientist who makes a soil survey examines soils in the field, classifies them in accordance with facts that he observes, and maps their boundaries on an aerial photograph or other map.⁶

Field study.—The soil surveyor bores or digs many holes to see what the soils are like. The holes are not spaced in a regular pattern but are located according to the lay of the land. Usually they are not more than a quarter of a mile apart, but sometimes they are much closer. In most soils such a boring or hole reveals several distinct layers, called horizons, which collectively are known as the soil profile. Each layer is studied to see how it differs from others in the profile and to learn the things about this soil that influence its capacity to grow 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. Streaks and spots of gray, yellow, and brown in the lower layers generally indicate poor drainage and poor aeration. Colors are given in descriptive terms, such as dark grayish brown. They are noted by a symbol in the Munsell color chart—a national color standard. For example, 10YR 4/2 corresponds to the descriptive term, dark grayish brown. The notation 10YR 4/2 is a standard color reference in the Munsell chart.

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

Structure, which is the way the individual soil particles are arranged in larger grains, and the amount of pore space between grains, gives us clues to the ease or difficulty with which the soil is penetrated by plant roots and by moisture.

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 study and considered in classifying the soil include the following: The depth of the soil over bedrock, over cemented or compact layers, or over loose gravel strata; the presence of gravel or stone in amounts that will interfere with cultivation; the steepness and pattern of slopes and the degree of erosion; the runoff of surface water, drainage through the soil, and occurrence of a high ground water table; the nature of the underlying rocks or other parent material from which the soil has developed; and the acidity or alkalinity of the soil as measured by chemical tests.

Simple chemical tests show how acid the soil may be. The reaction of a soil is its degree of acidity or alkalinity expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality; higher values, alkalinity;

and lower values, acidity. The degree of acidity or alkalinity is expressed in words and pH values as follows:

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

Classification.—On the basis of the characteristics observed by the survey team or determined by laboratory tests, soils are classified into phases, types, and series. The soil type is the basic classification unit. A soil type may consist of several phases. Types that resemble each other in most of their characteristics are grouped into soil series.

Soil type.—Soils similar in kind, thickness, and arrangement of soil layers are classified as one soil type.

Soil phase.—Because of differences other than those of kind, thickness, and arrangement of layers, some soil types are divided into two or more phases. Slope variations, frequency of rock outcrops, degree of erosion, depth of soil over the substratum, type of drainage (natural or artificial), and presence of excess soluble salts are examples of characteristics that suggest dividing a soil type into phases.

The soil phase (or the soil 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 practices therefore can be specified for the soil phase more easily than for soil series or yet broader groups that contain more variation.

Soil series.—Two or more soil types that differ in surface texture, but that are otherwise similar in kind, thickness, and arrangement of soil layers, are normally designated as a soil series. In a given area, however, it frequently happens that a soil series is represented by only one soil type. Each series is named for a place near which the soil was first mapped.

As an example of soil classification, consider the Regent series. This series has only one type in Wibaux County, which is subdivided into three phases:

Series	Type	Phase
Regent.....	Silty clay loam.....	{ 2 to 4 percent slopes. { 5 to 7 percent slopes. { 8 to 14 percent slopes.

Miscellaneous land types.—Fresh stream deposits, or rough, stony, and severely gullied areas that have little true soil are not classified into types and series, but are identified by descriptive names. Alluvial land, Badlands, Gravelly terrace remnants, and Rockland are miscellaneous land types in Wibaux County.

Soil complex.—When two or more soils are so intricately associated in small areas that it is not feasible to show them separately on the soil map, they are mapped together and called a soil complex. Farland-Harlem complex, 0 to 3 percent slopes, is a complex of Farland silt loam and Harlem silt loam.

Great soil group.—A broad group of soils having common internal soil characteristics. Examples are Chestnut, Solonetz, and Lithosols. The great soil groups fall within three orders—the highest category in soil classification. The three orders are zonal, intrazonal, and azonal.

⁶ SOIL SURVEY STAFF. SOIL SURVEY MANUAL. U. S. Dept. Agr. Handbook No. 18, 503 pp., illus. 1951.

General Features of Wibaux County

Climate

The climate in Wibaux County fluctuates between semiarid and dry-subhumid. The data from the record of the United States Weather Bureau Station at Wibaux are fairly representative of the climate throughout the county. These data are given in table 4. Certain years, selected as typical of "very wet," "good," "moderately dry," and "dry," are also included in the table. In very wet years, the crops may be exceptionally good; in good years, they may be above average; in average years, the crops are near or below average; and in dry years, they are produced only on the best sites.

At the present time science is not able to predict the succession of wet and dry years, but the record shows that dry and very dry years can be expected possibly 10 to 20 percent of the time. When dry years occur in succession,

they may cause financial disaster on some farms. On the other hand, when wet years arrive in a row, and particularly when prices are satisfactory, they bring a higher income to the farmer.

The average length of the growing season is 111 days; that is, the frost-free season lasts from May 25 to September 13. The growing season may vary considerably; it has been as long as 120 days.

The average total precipitation is 15.52 inches. Up to 30 percent of the moisture may occur as snow, and the snow cover may last from 80 to 120 days. Fog is rare, and the sun shines 50 to 70 percent of the time. The winds are prevailing from the west and northwest; some are from the northeast and south. They are most severe late in winter and early in spring. At times they may cause some damage to seeded small grains. Hot winds have reduced crop yields in the dry seasons. There may be an occasional tornado and hail. Cold waves are frequent, and warm chinook winds sometimes occur.

TABLE 4.—Temperature and precipitation at Wibaux Station, Wibaux County, Mont.

[Elevation, 2,670 feet]

Month	Temperature ¹			Precipitation ²					
	Average	Absolute maximum	Absolute minimum	Average	Total for very wet year (1916)	Total for good year (1948)	Total for moderately dry year (1951)	Total for dry year (1952)	Average snowfall
	° F.	° F.	° F.	Inches	Inches	Inches	Inches	Inches	Inches
December.....	18.8	66	-39	0.36	1.00	0.16	0.60	(³)	4.4
January.....	16.2	62	-55	.46	.90	.61	.20	.30	5.7
February.....	16.0	70	-47	.30	(³)	.48	.29	1.20	5.9
Winter.....	17.0	70	-55	1.12	1.90	1.25	1.09	1.50	16.0
March.....	27.9	80	-31	.57	.47	.20	.14	.40	5.0
April.....	43.0	88	-1	1.31	1.25	.63	.51	(³)	2.8
May.....	53.8	100	14	2.16	2.00	1.36	1.11	.94	.9
Spring.....	41.6	100	-31	4.04	3.72	2.19	1.76	1.34	8.7
June.....	61.5	102	24	4.10	6.45	3.58	1.81	1.54	.1
July.....	69.0	109	32	2.04	2.19	7.47	2.07	1.77	(³)
August.....	66.6	110	26	1.47	2.90	.42	1.94	1.32	0
Summer.....	65.7	110	24	7.61	11.54	11.47	5.82	4.63	.1
September.....	56.2	106	7	1.37	2.65	(³)	1.64	.70	.1
October.....	44.8	91	-16	.74	1.20	.10	.73	(³)	3.2
November.....	30.0	75	-27	.64	.30	1.05	.36	.33	3.9
Fall.....	43.7	106	-27	2.75	4.15	1.15	2.73	1.03	7.2
Year.....	42.0	110	-55	15.52	21.31	16.06	11.40	8.50	32.0

¹ Average temperature based on a 18-year record, through 1955; highest and lowest temperatures on a 26-year record, through 1952.

² Average precipitation based on a 20-year record, through 1955; wettest and driest years based on a 18-year record, in the period 1894-1955; snowfall, based on a 21-year record, through 1952.

³ Trace.

January, February, and March are cold and dry, with less than an inch of precipitation. April and May warm the country and bring an inch or two of precipitation. Through the last of May and including June, the rains usually come. The weather is warm and humid. July is hot with less moisture. August and September have even less rainfall, and the atmosphere is warm and dry. October is mild and dry. In November, the temperature gradually falls and the precipitation drops to less than an inch. By December it is cold and dry again.

Transportation

United States Highway No. 10 passes through the central part of the county from east to west. It practically parallels the main line of the Northern Pacific Railway. Improved gravel roads run north and south of Wibaux, and several graded county highways provide all-weather roads. Near Carlyle a branch line of the Northern Pacific crosses the southeast corner.

Physiography and Drainage

The main drainage systems in Wibaux County, as well as the geological formations, are indicated in figure 18. Beaver Creek is the main drainage system. Other creeks flow in a northerly direction to the Yellowstone River, which bounds the northwest corner of the county.

Wibaux County covers a part of the northern Great Plains. It is dissected by many down-cutting streams. Blue Mountain, north of Wibaux, has an elevation of more than 3,000 feet. It is capped with sandstone.

During glacial ages one or more sheets moved up the valley of the Yellowstone River and near Smith Creek. The ice sheets deposited a mantle of thin drift on the far northern parts of the county. The occurrence of a high water gap between Cottonwood and Smith Creeks shows that glacial waters moved to the east along the front of the ice sheet. The Cabin Creek anticline is in the southwestern part of the county. Oil and gas wells are located in this area.

The main ground-water supplies are obtained locally from shallow wells in valley alluvium. Deep wells tap coarse strata and sandstone of the Fort Union, Hell Creek, and Fox Hills formations.

Settlement

Wibaux County was established by subdividing Dawson County in 1914. It is bounded by Dawson and Prairie Counties on the west, by Fallon County on the south, by Richland County on the north, and on the east by North Dakota. It was named for Pierre Wibaux, who had large cattle interests in the area in the 1880's and 1890's. Wibaux is the county seat.

The general settlement of the county took place between

1900 and 1914, when homesteaders came into the area seeking farms. Before 1900 almost all of the land was used as cattle range. In 1935 there were 468 farms, and only 290 by 1954. With the adoption of better farming methods and the introduction of mechanized farming, the population has gradually decreased and the size of the farms has increased. The population in the county was 1,907 in 1950, of which 739 persons lived in Wibaux. There were 128 farms that year of 1,000 acres or more in size. Most of the inhabitants are engaged in agriculture.

Agriculture

Agriculture in the county consists principally of growing wheat as a cash crop and producing livestock for sale. Much of the hay and grain grown locally is fed to livestock.

Some of the early settlers planted wheat on shallow and steep soils that should have been left in pasture. Erosion and low productivity have gradually forced the abandonment of these areas. Many such areas have been planted to permanent grass.

At the time of the survey, 28 percent of the county was in cropland, idle land, and seeded grassland; 70 percent was in pasture and rangeland; and 2 percent was in brush, trees, farmsteads, and urban areas. A considerable acreage that is suitable for limited or occasional cultivation was then used for crops. Some areas not suited to tillage were farmed.

Some land in pasture and range that could be used for crop is not cultivated because of isolated position and rough terrain.

The land resources of Wibaux County have been used nearly to their maximum capability. In planning on a long-time range use, the tendency is to decrease the acreage used for cultivation and to increase that seeded to grasses.

Land use and types of farms

The total area of Wibaux County is 568,960 acres. The total area in farms in 1954 was 526,623 acres. The farmland is distributed as follows: Cropland harvested, 104,556 acres; cropland used only for pasture, 3,524 acres; cropland, not harvested and not pastured, 51,839 acres; woodland pastured, 3 acres; other pasture (not cropland and not woodland), 362,078 acres; and other land (house lots, roads, etc.), 4,623 acres. The average size of farms in the county increased from 634 acres in 1920 to about 1,815 in 1954. Land owned by public agencies, including Badlands, occupies approximately 75,000 acres. Some of the acreage is included in farms.

In 1954, the farms in the county were classified according to major sources of income as follows:

Type of farm:	Number
Cash-grain.....	193
Livestock.....	73
General.....	9
Miscellaneous and unclassified.....	6

Livestock

The number of livestock in the county in stated years is given in table 5.

TABLE 5.—*Number of livestock on farms and ranches*

Livestock	1949	1954
	<i>Number</i>	<i>Number</i>
Chickens sold.....	7, 163	5, 249
Cattle and calves sold alive.....	8, 208	8, 382
Sheep and lambs sold alive.....	2, 446	5, 298
Hogs and pigs sold alive.....	5, 255	1, 636
Horses and mules sold alive.....	124	47

Crops

Spring wheat is the principal crop, but corn, barley, oats, and hay are grown extensively. The acreages of the principal crops are given in table 6.

TABLE 6.—*Acreage of the major crops*

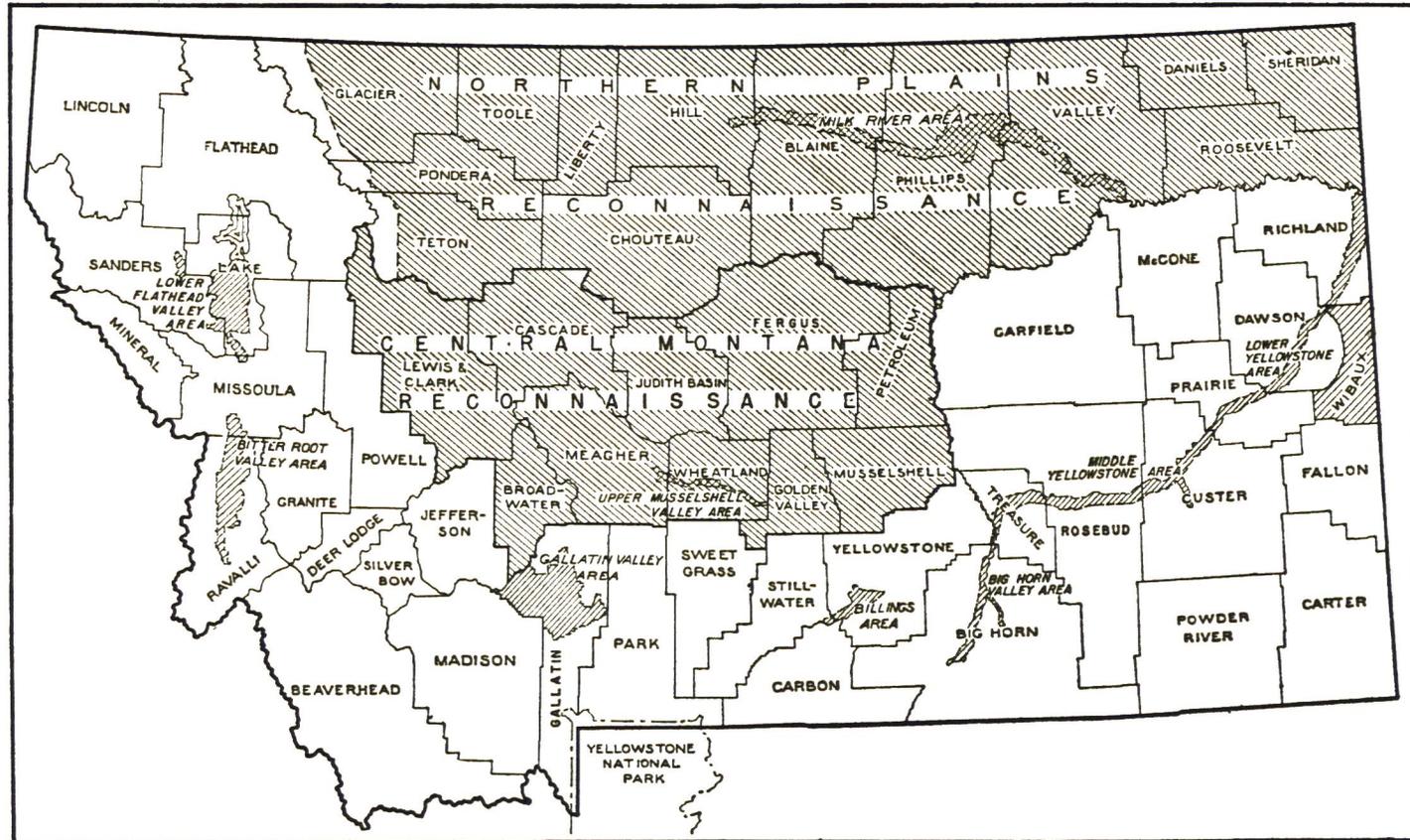
Crop	1929	1939	1949	1954
Corn for all purposes.....	<i>Acres</i> 4, 148	<i>Acres</i> 12, 434	<i>Acres</i> 9, 047	<i>Acres</i> 11, 925
Winter wheat threshed or combined.....	1, 840	4, 114	325	604
Spring wheat threshed or combined.....	65, 930	38, 175	57, 682	55, 720
Oats threshed or combined.....	5, 592	5, 744	2, 512	5, 037
Oats cut for feeding.....	232	268	1, 155	(¹)
Barley threshed or combined.....	7, 715	6, 767	4, 370	7, 011
Flax threshed or combined.....	6, 478	1, 170	1, 728	(¹)
Alfalfa cut for hay.....	989	377	² 911	² 2, 433
Clover or timothy cut for hay.....	96	(¹)	3	³ 544
Small grain cut for hay.....	5, 611	1, 417	6, 754	3, 704
Wild hay cut.....	7, 186	5, 492	10, 871	8, 735
Other hay cut.....	1, 060	4, 155	1, 251	4, 232

¹ Not reported.

² Includes alfalfa mixtures.

³ Includes mixtures of clover and grasses.





Areas surveyed in Montana: Detailed surveys shown by northeast-southwest hatching; reconnaissance surveys shown by northwest-southeast hatching; cross hatching indicates areas covered by both detailed and reconnaissance surveys.

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