Soil maps are a basic tool for selecting a system of soil management. The maps show the kinds of soil in a field and farm—essential knowledge for selecting from the various available soil-management practices the combination of practices that is best suited to the soil and to the resources, skills, and desires of the farmer and rancher.

If they know the effect of a given practice on a field, whose kind of soil also is known, they can foresee the effect of that practice on other fields with the same kind of soil. Just as they can predict the behavior of a particular variety of hybrid corn, so can they predict the response to management of a particular soil.

Soils are classified and named, just as plants and animals are. Plants are identified by such characteristics as the structure of the flower and the form of the leaf. Soils are identified by such characteristics as the kinds and numbers of horizons, or layers, that have developed in them. The texture (the relative amounts of stones, gravel, sand, silt, and clay), the kinds of minerals present and their amounts, and the presence of salts and alkali help distinguish the horizons.

Most of the characteristics that identify soils can be determined in the field. A few can be determined only in the laboratory, but even without labora-

tory tests you often can get an accurate knowledge of them from standard works on soils and geology. For example, you can estimate the amount of sand in a soil from its feel when you rub it between your fingers, but for an accurate knowledge you would have to depend on laboratory analyses.

The type is the smallest unit in the natural classification of soils. One or a few types constitute a soil series. These are the common classification units seen on soil maps and survey reports.

A soil series is a group of soils that have horizons that are essentially the same in the properties used to identify soils, with the exception of the texture of the surface soil and the kinds of layers that lie below what is considered the true soil.

The names of soil series are taken from the towns or localities near the place where the soils were first defined.

The soil type, a subdivision of the soil series, is based on the texture of the surface soil. Stones, gravel, sand, silt, and clay have been defined as having the following diameters: Gravel, between 0.08 inch and 3 inches; sand, between 0.08 and 0.002 inch; silt, between 0.002 and 0.00008 inch; and clay, less than 0.00008 inch.

The full name of soil type includes the name of the soil series and the textural class of the surface soil equivalent to the plow layer—that is, the upper 6 or 7 inches. Thus, if the surface of an area of the Fayette series is a silt loam, the name of the soil type is "Fayette silt loam."

The soil phase is not a part of the natural classification. It can be a subdivision of the soil type, series, or one of the higher units in the classification.

Phases shown on soil maps commonly are subdivisions of soil types and are based on characteristics of the soil significant to its use for agriculture.

Phases shown on large-scale soil maps generally have reflected differences in slope, degree of erosion, and stoniness, but other bases for defining phases include drainage and flood protection,
climate, and the presence of contrasting layers below the soil. (A comparable subdivision in the classification of animals might be classes according to their age, such as old animals, old cows, or old Holstein cows.)

The legends that accompany soil maps generally include such names for the units on the map, as "Sharpsburg silty clay loam, eroded rolling phase," or "Fayette silt loam, 8–14 percent slopes, eroded." Those names identify the soil series, the soil type, and the phase. They represent names of the most specific kinds of soil, comparable to the name of a practical subdivision of a variety of a plant, such as old Jonathan apple trees.

The word "Fayette" in the second soil name we mentioned is the name of the soil series. This name, plus the words "silt loam," identify the soil type, and the phase is identified by the words, "8–14 percent slopes, eroded." In this name, the word "phase" is not used but is understood.

Higher units in the classification system include families, great soil groups, suborders, and orders. They are seldom used on any but small-scale soil maps.

Soil series, types, and phases do not occur at random in the landscape. They have an orderly pattern of occurrence that is related to the land form; the parent material from which the soil was formed; and the influence of the plants that grew on the soils, the animals that lived on them, and the way men have used them.

On a given farm, the different kinds of soil commonly have a repeating pattern, which is associated with the slope.

The relationships between the soils and landscapes vary in details in different parts of the country, but the relationships generally exist. Anyone who is familiar with the soils can visualize the landscape from a soil map; or, if he sees the landscape, he can predict where the boundaries are.

A soil survey includes finding out which properties of soils are important, organizing the knowledge about the relations of soil properties and soil use, classifying soils into defined and described units, locating and plotting the boundaries of the units on maps, and preparing and publishing the maps and reports.

The soil survey report consists of a map that shows the distribution of soils in the area, descriptions of the soils, some suggestions as to their use and management, and general information about the area.

Reports usually are prepared on the soils of one county, although a single report may cover several small counties or only parts of counties.

Soil surveys are made cooperatively by the Soil Conservation Service of the Department of Agriculture, the agricultural experiment stations, and other State and Federal agencies. Plans for the work in any area are developed jointly, and the reports are reviewed jointly before publication.

Soil maps have many uses, but generally they are made for one main purpose—to identify the soil as a basis for applying the results of research and experience to individual fields or parts of fields. Results from an experiment on a given soil can be applied directly to other areas of the same kind of soil with confidence. Two areas of the same kind of soil are no more identical than two oak trees, but they are so similar that (with comparable past management) they should respond to the same practices in a similar manner.

But many thousands of kinds of soil exist in the United States. Research can be conducted on only a few of them. The application of the research results must usually be based on the relationships of the properties of the soil on which the experiment was conducted to the properties of the soils shown on the maps. This can be done best by the soil classification system.

The significant properties that can be known from the soil maps include physical properties, such as the amount of moisture that the soil will hold for plants, the rate at which air and water move through the soil, and the kinds
and amounts of clays, all of which are important in drainage, irrigation, erosion control, maintenance of good tilth, and the choice of crops.

Some important chemical properties can be known from the soil maps. The ability of a soil to convert phosphate fertilizer to forms unavailable to plants is an example. Generally speaking, however, the ability of a soil to supply nutrients needed by plants cannot be known with precision from the soil map alone, for the supplies of the nutrients are changed when a farmer applies fertilizers.

Soil tests on individual fields are becoming more and more important. Considered in relation to the kind of soil, they form the most reliable background for recommending the application of fertilizers.

The soil map shows the distribution of specific kinds of soil and identifies them through the map legend. The legend is a list of the symbols used to identify the kinds of soil on the map.

The most common soil units shown on maps are the phases of soil types, but other kinds of units may be shown.

The soil bodies, areas occupied by the individual soil units, generally range from a few acres to a few hundred acres. Often within one soil body are small areas of other soils—series, types, or phases. If the included soils are similar in nature, they are generally not identified unless they represent more than 10 or 15 percent of the soil body in which they are included. If the properties of the included soils differ markedly from those of the rest of the soil body, they usually are indicated by special symbols.

But occasionally the individual parts of a unit are so small and so mixed with other units that they cannot be shown. Then the legend will indicate the area occupied by the intricate mixture as a soil complex if all of the included units are present in nearly every area.

A complex may consist of two or more phases of a soil type, but commonly it consists of two or more series. The names of complexes may carry a hyphen between the names of two soil types or phases, as “Barnes-Buse loams.” If several series or types are included in the complex, the names of one or two of the most important series or types will be followed by the word “complex,” for example, “Clarinda-Lagonda complex.”

Two other kinds of units are common on soil maps—the undifferentiated group and the miscellaneous land type.

Two or more recognized kinds of soil that are not regularly associated in the landscape may be combined if their separation is costly and the differences between them are not significant for the objective of the soil survey. This kind of undifferentiated group is shown in the legend with the names of the individual units connected by a conjunction—for example, “Downs or Fayette silt loams.”

The miscellaneous land types are used for land that has little or no natural soil. The map units then are given descriptive names, such as “steep, stony land,” “gullied land,” and “mixed alluvial land.”

The relationships between the units that appear on the maps and legends and the use and management alternatives are explained in the text that accompanies the soil survey report.

The Department of Agriculture began making soil surveys about 1900. The purposes of the work were the same then as now, but there was no body of knowledge of how soils are formed or how nutrients become available to plants. The early definitions of the soil series therefore failed to take into account some important properties and overemphasized some of the more obvious but less important ones, such as color.

As scientists have learned more about the relationships between soils and plants, ideas have changed about the importance of the properties originally used to distinguish between soil series and types. The first soil series was split into two or more series. They in turn
have often been subdivided. Consequently many of the names shown on the older maps have been changed. Changes will continue to be made as long as we continue to learn new things about soil-plant relationships.

Soil maps are made by experienced soil scientists who are graduates of the State agricultural colleges or other colleges that offer courses in soil science. After graduation, the soil scientists usually receive several months of intensive training. They work in the field. First they observe the techniques of an experienced soil scientist. Then they practice, and their mistakes are pointed out by their supervisor. Finally, when they prove their ability, they begin work.

Ordinarily the soil scientists use aerial photographs as a base for plotting the soil boundaries. The scientist goes over the land and digs with a spade or auger as often as necessary to determine and evaluate the important characteristics of the entire profile. He identifies the kind of soil, locates its boundaries in the field, plots the boundaries, and places the identification symbol of each soil mapping unit on the map.

In making detailed maps, he follows or sees the boundaries between the kinds of soil through their entire length. In making reconnaissance surveys, he may not see the boundaries over their entire length; he merely identifies one when he crosses it and draws the boundary through to his next traverse, or crossing, on the basis of the information he can get from the aerial photograph.

The soil scientist makes simple chemical tests in the field to determine the degree of acidity and the presence of lime, salts, and a few toxic compounds. He measures slopes with a hand level. He usually takes samples of a few representative soils during the survey and sends them to the laboratory for detailed study.

All stages of the work from the mapping to the contents of the report are reviewed by the supervisors and representatives of the cooperating agencies. Soil maps often are used before they are published. Each cooperator of the soil conservation districts is furnished a copy of the soil map of his holding.

County assessors and other users sometimes buy copies of such maps to use in their work before the publication of the completed survey. The local soils handbooks, available for reference at the Soil Conservation Service offices, give information needed to use and interpret the map.

Photographic copies of unpublished maps may be purchased through the Soil Conservation Service offices. These offices are usually located in county seats. Prices for the maps are fixed to cover the cost to the Government.

Soil maps are published by the Soil Conservation Service for all States except Illinois; in Illinois, the University of Illinois Agricultural Experiment Station publishes them.

Copies of available published maps and reports may be obtained through the State Extension Service or Soil Conservation Service offices. Files of unpublished maps are maintained in the Soil Conservation Service offices and may be examined there.

Interpretations of soil maps are physical and economic analyses of the alternative opportunities available to the users of the land. They indicate capabilities of the soils for agricultural use, adapted crops, estimated yields of crops under defined systems of management, presence of specific soil-management problems, opportunities and limitations for various management practices, and problems in nonagricultural use.

The main bases for interpretations are yield estimates, related to specific combinations of practices for soils in their climatic setting. Yield estimates for a soil are predictions of the average production of specific crops that a group of farmers could expect during the following 10 or 15 years if they followed the defined system of soil management. Yield estimates apply less closely to individual farmers, whose skills are variable, than to averages of groups. Sources of information are the results of research, the experiences of farmers, ranchers, and others who
grow plants, and observations of plants growing on different kinds of soils.

The definitions and descriptions of the kinds of soil shown on maps provide information on their characteristics. We use these to infer the qualities of soils such as productivity and erosion hazard. We are able to make predictions about a soil whose behavior is unknown by comparing its characteristics with those of the soils about which we have basic information on behavior. Basic principles of soil management are another tool used to help us extend our predictions of soil behavior and responses to all kinds of soils.

Soil survey reports include a number of interpretations, especially the more permanent ones that concern soil qualities. New and additional research, new weeds or insects, changes in relative prices, new crops, new machines, and other changes in agricultural arts require us to revise interpretations from time to time. The interpretation of the soil units shown on soil maps is a continuing task if we are to make full use of available knowledge on the use and management of soils. Interpretations can be no more static than our civilization. Yet soil maps, with accurately plotted boundaries of carefully defined soils, can be reinterpreted as the situation demands in future years.

To go back to a specific kind of soil we cited earlier, some alternatives for Fayette silt loam, 8 to 14 percent slopes eroded, which will result in sustained production now and in the future are:

(i) Permanent pasture, which permits several choices of legumes and grasses, lime, varying amounts and kinds of fertilizers, and varying systems of grazing;

(ii) Woodland;

(iii) A 4-year rotation of corn-oats-alfalfa-alfalfa with contour cultivation, lime, and fertilizers; and

(iv) A 3-year rotation of corn-oats-red clover with contour strips, lime, and fertilizers.

Estimates of the yields of woodland, pasture, forage, and grain under these alternative uses permit the confident selection of the best management from the viewpoints of the desires of the operator and the conservation of the soil. If new crops, new pests, or new techniques of farming appear, the present "best management" may become undesirable. Yield estimates can be revised at that time, and will again provide the basis for selection of a suitable management.

The Use of Soil Maps

A. M. Hedge and A. A. Klingebiel

Soils may be grouped into land capability classes, subclasses, and units to help us use them properly. Of the eight classes, which normally do not all exist on any single farm or ranch, classes I through IV are suited to cultivated crops, pasture or range, woodland, and wildlife.

Classes V through VIII are suited to pasture or woodland and wildlife and are not generally recommended for cultivation. Some kinds of soil in Classes V, VI, and VII may be cultivated safely, with special management, however.

Because several kinds of soil often occur in the same capability class on the same farm or ranch, the classes are divided into subclasses.

Four kinds of problems are recognized in the subclasses and are indicated by symbols: (e)—erosion and runoff; (w)—wetness and drainage; (s)—root zone and tillage limitations, such as shallowness, stoniness, droughtiness, and salinity; and (c)—climatic limitations. The subclass