Indiana's Soil Survey Adjusts to Changing Needs

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Abstract

While publishing a total of 90 county soil surveys (9 of which are repeats) in a 73 year history, reports and maps have improved dramatically! A greatly expanding audience is served more efficiently due to links forged between soil scientists and others. Disciplines and the applications these links have encouraged include: geologists —surficial geologic maps; hydrologists—ground water recharge; high-way engineers—soil materials surveys; photogrammetrists—locating and displaying physical features; soil conservationists—defining soil depletion and needs for better land husbandry; farm economists—assessing farm production potential; and farm planners—capability of lands for cropping and selection of conservation practices. Rapid post WW-2 land use shifts encouraged surveys and their use by: sanitarians and plan commissions—ordinance development; appraisers and assessors—equitable base for land values; ecologists and foresters—vegetative relations and production potential; and farm managers—drainage and irrigation specifications.

An expanding survey program to complete field work for standard soil surveys by 1984 will challenge soil scientists to new innovations in field procedures, report preparation and educational efforts. Only when the challenge is met will the public achieve maximum use of the finished products to the improvement of land-use decisions in Indiana.

Introduction

Soon after beginning of a national soil survey program in 1899, Indiana completed its first soil surveys. Posey county was published in 1902, Madison in 1903 and the Boonville area, Marshall, Tippecanoe, and Scott counties in 1904. Twenty-nine had been completed before 1925. Soil studies were made in order to extrapolate results of experiment station research to farm fields.

By 1916 reports of early field work on rock and superphosphate at the Scottsburg, N. Vernon, Worthington, Wanatah, Bedford and Littles stations were published in Experiment Station reports. Such work, begun in 1904 and later, was related to the soils used where possible and soils names such as Volusia, Knox, and "slashlands" appeared in the reports. While many of the early soil names used have been replaced in later refinements by other names, this process of extrapolation continues today as we identify and map our soils and relate management experiences to them for the gain of farm managers.

This report will outline how surveys, originally made by the USDA Bureau of Soils, cooperatively with either Purdue University Agricultural Experiment Station (AES) or the State of Indiana Department of Geology (or sometimes both), later became functions of other agencies of USDA. Work moved to the Bureau of Chemistry and Soils and its successors the Bureau of Plant Industry, Soils and Agricultural Engineering (BPIS&AE) and Soil Conservation Service (SCS) all cooperatively working with Purdue's AES.

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This report will trace briefly the use of Indiana's soil surveys progressing from an original central purpose to a number of others which were related to changing demands in the use of Indiana's lands. It should help us understand why, after nearly 160 years of the existence of Indiana as a state and 71 years since making its first survey, the Legislature in 1973 laid plans to help complete all field surveys in the standard soil survey format now in use by 1984. This resulted in the State Soil and Water Conservation Committee, a part of the Indiana Department of Natural Resources, entering into partnership with SCS and the Purdue University AES to cooperatively continue and accelerate the soil survey program. It also reqiured that counties continue to contribute a significant share of the costs of their own surveys, a precedent begun in the mid 1960's.

Soil Survey Develops as a Science

We will not attempt to list here the concepts of classification as they have developed in Indiana since these are described elsewhere (2, 5, 8). The contents of a modern soil survey map and report are evident in the Harrison county survey published in 1975 (18). The emphasis in soil survey has always been to locate on maps well defined soil bodies with reasonably homogenous character of surface soil, subsoil, parent material and geologic origin and to describe properties and uses in reports. Bushnell in 1933 (4) said that the work of the soil survey is "to study the different kinds of soils, to describe and classify them; to learn their needs and adaptations and to show by maps the size, shape and location of areas of different soils. This work is published in the form of reports and county maps."

Soil Science Develops Links with Other Sciences Through the Soil Survey

Mapping units in early soil surveys strongly reflected similar geologic formations such as acid till, limy till, alluvium, outwash and lacustrine sediment, loess, limestone, and sandstone and shale. Earliest maps displayed geologic-physiographic formations and a kind of dominant soil condition assumed to occur on each. This was natural since the origin of field soil science and early soil mapping were greatly influenced by the more mature science of geology and was largely carried on by workers trained in geologic and earth sciences. As understanding increased about soils and their morphology and emphasis shifted from maps of general geologic nature to more complex ones recognizing influence of both geologic and morphologic characteristics, a strong link developed between soil scientists and geologists.

While geologic and topographic maps have greatly helped the soil scientist in his mapping program the soil maps have, in later years, been of prime value to geologists. From the soils maps geologists have prepared maps of surficial geology, so important to locating economic mineral deposits and establishing better prediction of groundwater formations and recharge. Since soil science and surficial geology have so much in common each can and is supplementing the other in important ways.

In the 1920's and 1930's soil maps were beginning to find value among soils engineers whose needs depended partly on nature of the soil mantle and partly on uderlying geology. Early work done in Michigan (7) and other states soon spread to Indiana (1) as engineers applied soil survey findings to booming highway construction occasioned by the automobile age.

Highway materials surveys were greatly aided also by the use of aerial photos and the interpretations made possible by the fledgling science of photogrammetry which was becoming of so much aid to the soil scientist (3). Field work began in 1929 on the Jennings county soil survey where vertical aerial photographs were used as base maps for the first time in the United States for a complete county.

Cooperation between soil scientists and engineers led to useful comparisons between classifications for soil materials including texture by USDA, and, by Unified and AASHO systems developed by engineers. This encouraged better understanding between the two developing professions to mutual benefit of each. It later led to cooperative sample collection by field mappers for testing soils by engineering labs with results available to both groups.

The first chapter in a soil survey publication devoted to engineering soil properties appeared in the report for Scott county in 1962. Purdue's Joint Highway Research Project (16) uses soil surveys as an aid to develop engineering soils materials maps for Indiana counties. This illustrates once again a link between sciences. At the same time appraisers for highway rights of way make great use of crop yield prediction values of soil surveys to help arrive at fair market prices of rural lands. Farmers are using the same predictions to sharpen their appreciation of yield levels to expect through improved management (10).

Depression Spawned Programs Boost Use of Soil Surveys

Farm Planning use of soil surveys increased from the time of the great depression and continues today. At that time national attention was drawn to the plight of farmers and to declining productivity in land resources due to serious erosion and fertility decline. Land depletion plus low crop price structure was threatening the very continuance of a strong agriculture.

Soil surveys were already becoming very useful in defining the broad farm land problem. In 1933 it was a soil scientist, Hugh Hammond Bennett, well grounded in southern agriculture as well as in soils, who dramatized the plight of the land and its people and helped form the Soil Erosion Service. This agency gathered broad data to better define the problem of land depletion. By 1935 the work resulted in formation of the Soil Conservation Service (SCS) which rapidly developed the tenet of farm planning in accord with capability of the land and later made its service available to the locally organized soil and water conservation districts.

Soil surveys were adopted early by SCS as the means to determine the capability of the land for cropping intensity and to indicate practices needed to maximize production but maintain the soil resource.

This called for more attention to delineations of slope, erodibility and drainage conditions in the field mapping program of the soil survey and resulted in important changes to adapt to these new needs. A conservation survey division was established within SCS to handle the mapping requests for the rapidly developing soil conservation demonstration projects of the late 30's and for the expanding soil and water conservation districts which followed.

Demands increased on the cooperating agencies (BPIS&AE and AES after 1939) during the '40s and '50s to modify their programs of county soil survey aimed at publication for general use. Emphasis of soil scientists was placed mainly on mapping for farm planning so they felt less pressure to publish maps and reports as in earlier years. Maps also became more complex and reports more lengthy so that publication time following field work increased greatly both in Indiana (Table 1) and across the U.S.

By 1953 the functions of soil scientists of SCS and BPIS&AE and AES were recognized as being so similar that soil survey programs were consolidated under one agency (SCS) and remain cooperative with the Purdue University AES under the title "National Cooperative Soil Survey." The links between soil scientists and agronomists and conservation engineers have been greatly strengthened by this effort!

Depression times also called for broad agricultural economic studies to allow predictions of productive potentials of states and regions. Productivity indices were first reported for major crops in the 1938 soil survey of Pike County. These and indices for other counties made possible predictions of regional production at varying planting acreages as well as effects of improved practices applied to the land. They helped policy makers define needs for farm programs some of which involved incentive cost-share payments to farmers to adopt improved practices and price support programs to preserve a healthy agriculture.

Soil surveys were also required as background for approval of any cost-share payments made to farmers through supporting government programs whether inside or outside of soil and water conservation districts.

Expanding Post-WW-2 Land Uses Stimulate Use of Surveys!

As individual wealth and leisure time increased after WW-2 and roads and auto transport improved, more and more people left the utility-serviced towns and cities for unserviced rural areas which we now call the rural-urban fringe. Since soil and geologic facts are needed in building and road construction, as well as sanitation and landscaping, the soil survey received a new boost of interest and survey information was greatly needed to meet new demands (9, 17). Public health officers and their colleagues the sanitarians soon became clients of soil scientists. Construction engineers also increased their interest in using soil reports. Soil characteristics influencing uses for engineering first appeared in the survey report for Scott county 1962. Soil limitations for on-site sewage disposal using septic tanks and tile fields first appeared in the soil survey of Owen county in 1964 and have been included in all later surveys.

Individual housing often involves using lots of lesser area than the smallest units commonly shown on soil maps. Standard surveys are not always adequate to predict on-site sewage disposal suitability. On request of health departments and plan commissions soil scientists of SCS have responded by mapping proposed subdivision lands at greater detail. This has bolstered the local community service function of soil and water conservation districts. The standard survey maps and special reports have enabled counties and cities to gain experience in soil knowledge so that they can develop ordinances guiding use of septic disposal fields by soils. In this way soil science has forged a new link with both sanitary engineering and public health professions and future homeowners will be assured of improved sanitary construction and operation while local governments can plan for more orderly growth.

As tax rates continually escalate there has been greater demand for soil scientists to help assessors use soil surveys in the tax assessment process. Indiana's legislature in 1973 mandated that soil surveys should be used as they become available to assist in land assessment and the State Tax Commission is laying plans to do so for the 1976 reassessment. Because county officials see the economic savings possible by using soil maps in place of traditional methods as well as the equalization function maps can perform, they have responded willingly. Perhaps, more than any other factor this need for assessment has resulted in the state's willingness to become a partner and complete soil surveys by 1984.

Soil science and other disciplines have also been linked over the years to application for such divergent purposes as establishing original vegetative patterns (ecology), applying tree site indices to applicable areas and predicting survival and growth of planted forest trees (forestry), establishing infiltration-runoff predictions for watershed planning (hydrology), and to determine specific drainage specifications by soils and probable response of soils to irrigation (agricultural engineering). These are examples of common usage but there are many others.

To forge these links with other disciplines, a great many changes have been needed in the final soil survey maps and reports and this meant great changes in field mapping and data assembly procedures. More detailed soil studies and improved map making and report drafting have helped reports and maps fulfill new functions as needed. Changes in broad emphasis will be considered next.

Changes in Soil Survey Emphasis to Meet New Demands

1902-22—The First Generation of Reports

Prior to 1922 the survey maps and reports aimed at general description of a county's agriculture and particular adaptations of crops and cropping practices to the soils. Though texture of each important soil layer was indicated by mechanical analysis, only enough description was included to differentiate it from others and no chemical or fertility testing was included. General use of the soil according to its slope, drainage and other conditions was noted and the prevalent crops and livestock produced locally were discussed. There was also a general description of county development, including roads, markets, schools and other services as well as average land values. These reports were usually very descriptive of a county's soils and agriculture even though they were not able to extrapolate the results of experimental fields precisely. An attempt was made to do so more in reports of the latter part of that era.

By 1922, 26 surveys were completed, in which the average number of mapping units was 12 but ranged from 4 to 30. Map scales were all one inch per mile (Table 1) and time to publish the map and report after field work was usually only one to two years. Very little time was possible to gather interpretative data in the field on such a schedule!

By 1922 management sections written by Purdue AES workers were added as chapters in reports. Most of the practices formerly described with the landscape and soil descriptions themselves were included in these chapters.

From then on there was more attempt to relate experimental results to applicable soils and a great deal more use was made of chemical analyses. Total elements, elements dissolved in strong HCl, and elements soluble in weak nitric acid were reported for soil layers as a general guide to fertility needs. Three layers down to 30 inches were generally analyzed with approximations of organic matter and total pounds of calcium carbonate needed to raise reactions to neutrality. Adapted fertilizer analyses were stressed. Management discussions were arranged around drainage needs, liming, organic matter and nitrogen supplies, crop rotation needs and fertilization practices.

Reports between 1923 and 1943

During this second period, 23 more county surveys were published in which the average number of mapping units rose from 12 prior to this time to 32 with a range from 7 to 75. This reflected a wide variation in complexity of soil patterns across the State as well as variation in intensity of surveys and an expanding knowledge base about soils and adaptations to use. Map scales continued at 1 inch per mile. In this period an average of 5 years elapsed between field work completion and publication so there was much time for interpretive work both in the field and laboratory. Field work using aerial photographs as a base began in the 20's and added greatly to the accuracy of soil maps.

During this period Bushnell (2, 5) and others developed a system of catenal relations in which soils on similar parent material but on differing relief were seen to have features related to their degree of natural drainage. Catenas were named for their well drained member and were given numbers such as 14 for a group of soils related to Miami.

Drainage classes were numbered as follows: I—Poorly drained level; II—somewhat poorly or imperfectly drained; III—moderately well drained; IV—well drained; V—well to excessively drained, (low water holding capacity); VI—excessively drained (steep and shallow soils); VII—poorly drained, gray, depressional; VIII—poorly drained, very dark gray, depressional; IX—very poorly drained, black, depressional and X—

TABLE 1. *Surveys by 10 year intervals, number of mapping units, publication map scales and years for report completion, 1902-1975, Indiana*

Publication Dates	Number Counties	Avg. No. Mapping Units	Range Mo. Map Units	Map Scale: inches per mile	Avg. Years to Publish	Order of Completion by Counties
1902-1910	10	10	4-17	1.0	1	Posey, Madison, Warrick (Boonville), Marshall, Scott, Tippecanoe, Newton, Greene, Marion, Allen
1911-1920	15	13	6-30	1.0	2	Montgomery, Boone, Hamilton, Tipton, Clinton, Delaware, Hendricks, Elkhart, Warren, Benton, Grant, Starke, Wells, White, Porter
1921-1930	11	27	7-55	1.0	5	Lake, Decatur, Adams, Gibson, Clay, Kosciusko, Lawrence, Monroe, Hancock, Putnam, Wayne.
1931-1940	10	35	15-55	1.0	6	Miami, Blackford, Vermillion, Ohio and Switzerland, Randolph, Dubois, Rush, Pike, Washington
1941-1950	14	74	35-112	1.0 or as listed	10	Jennings, Steuben, Knox, Vanderburgh (2.0), LaPorte, Brown, Fulton (1.32), Martin, Bartholomew, Johnson (1.32), Franklin (1.32), St. Joseph (2.0), Morgan (2.65)
1951-1960	7	114	73-178	2.0 or as listed	13	Noble, Cass, Newton[1], Carroll, Tippecanoe[1], Fayette (4.0) and Union (4.0)
1961-1970	8	112	72-170	4.0 or as listed	5	Scott[1] (3.17), Owen, Fountain, Madison[1], Parke (3.17), Allen[1], Pulaski, Perry
1971-1975	15	64	28-100	4.0 or as listed	6	Sullivan, Howard (3.17), Delaware[1], Lake[1], Spencer, Shelby, Elkhart[1] (3.17), Clark and Floyd, Daviess (3.17), Hendricks[1], Vigo (3.17), Boone, Harrison (3.17), Crawford (3.17)

[1] Second generation survey of this county.

very poorly drained mucks. The numbers 1-0 were used as suffixes following the catena number in developing number legends to use in field mapping. Thus a well drained, brownish Miami was shown as 144 in field mapping while a poorly drained very dark gray Brookston was shown as 148. A textural prefix was used for surface soils other than silt loams. A Miami loam was 5144 and a Brookston silty clay loam was 3148. A Carlisle muck associated with Brookston soils in wet depressions was shown as 140, the zero representing much of drainage class X. All drainage classes were not found in all catenas.

Since this system was used for a quarter century or more all field maps of that period had uniformly numbered legends and persons using maps could obtain a broad concept of soil patterns without extensive reference to descriptive materials.

Improvements in Reports of the 1944-59 Era

During this period even more important changes in soil survey report content and scale of published map occurred! This reflected both changes in soil knowledge and the demands of users when farm planning on a land use capability basis became more common and soil maps were needed to arrive at the capability units. Though farm planning use of surveys began in the '30s the lag in publication time following field work (Table 1) was enough that changes in published reports were not reflected for 10-15 years.

Tables of productive potential expressed as crop productivity indices first appeared in the Pike county survey of 1938. These indices useful to economists were estimated at two levels of input in later surveys such as Vanderburgh. Yields of a county's soils were compared to yields commonly obtained on an extensive soil widely used for the same crop either without amendments (level A) or with combinations of production practices (level B). A soil with potential to produce the crop at standard index levels was assigned a rating of 100. Those more or less productive received proportionately higher or lower indices.

Chapters on morphology and genesis of soils with keys relating soils to formative factors first appeared in Washington county in 1939. These chapters provided a place for soil scientists of these earlier periods to communicate with those who followed as to how they classified the soils and related them to each other. This has been very helpful to later soil scientists.

Outstanding Reports of This Period

One outstanding report of the period is for Knox county (1943) (20) where the first general soil map showing 8 associations appeared with an estimate of how much of each association occurred in the 10 townships of the county. Also included was an estimate of percent cropland devoted to each of 7 crops in these same townships. This recognized the need which many persons have for soil and land use knowledge on a general basis for planning toward broader land use changes.

Perhaps the most innovative report of the period was for Vanderburgh county published in 1944 in which the modern report form began to emerge. Its features included productivity indices at two levels of management as well as estimated acre yields with normal practices and with combinations of improved ones. This helped set yield goals for farmers to achieve. There was also a chapter on genesis and morphology with a key to soils and a section on naturally occurring vegetation detailing trees, shrubs and grasses occurring on broad drainage groups of soils.

The chapter on soil management in the Vanderburgh report included recommended practices such as drainage and erosion control based on drainage class, slope, and degree of erosion. There was also a table grouping soils as to workability, erodibility and management needs. A general soil map of the county at about 4 miles per inch gave users information on the general nature of the soil landscapes and their overall usefulness.

The map for Vanderburgh was published at a scale of 2.0 inches per mile, the first in Indiana larger than 1.0 inch.

All of these innovations probably reflect a strong interaction of soil scientists with farm planners during this survey of the first of Indiana's soil and water conservation districts. It resulted in a report aimed to help users benefit from knowing about their soils in considerable detail. One hundred and eleven units were separated on the maps.

Reports had similar form up to and including Cass county in 1955. Experimental map scales of 1:48,000 (1.32 inches per mile) were tried in Fulton, Johnson and Franklin in the late '40s and at double that scale (1:24,000) in Morgan in 1950. St. Joseph, Cass and Newton counties were all published at 2.0 inches per mile in the early '50s.

During this period rapid technological change was occurring on Indiana farms resulting from use of combinations of practices and products. Improved crop varieties were being produced with regularity and new and more concentrated fertilizers and other farm chemicals were appearing. Survey reports no longer stressed fertilizers by grade. Instead principles of choice of fertilizers were listed.

Carroll and Tippecanoe reports were published in 1958 during a transitional period to a new era of map display. Maps are in color and at 2.0-inch-per-mile scale with sheets bound into the report each covering some 35 square miles. These reports had useful tables suggesting use and management including rotations for soils of similar management groups. They also had block diagrams to connote soil relations to slopes and parent materials and small scale general soil maps interpreted for single purposes. The first tie-in was made in an Indiana report with the land capability classification system of SCS even though all mapping did not coincide completely with those standards used to define the capabilities. They were the last reports to include productivity ratings by indices.

Era of the Standard Soil Survey Report: 1960 to the Present

In 1960 Fayette and Union counties were published together at 4-inch-per-mile scale (1:15,840) having individual map sheets bound into reports and displayed on a photomosaic base. This allowed users more ease in locating themselves on the soil maps since many visible features could be seen on the air photo base map. Each map sheet covers about 6 square miles and is bound into the back of the report. In reports with maps at 1:20,000 (3.17-inch-per-mile) there are 15 square miles displayed per map sheet.

The 9x11-inch report size begun with Carroll and Tippecanoe counties was continued and the first general soil map in color and at scale of about 3 miles per inch was included. One table presents a summary of important soil characteristics while another estimated yields for all 149 mapping units for important crops. A table discussed suggested use and management of soils including adapted rotations and was arranged around capability units as used in farm planning.

Following reports had similar format which has continued until now. They include some fairly standard chapters: A general discussion of a county and its agricultural and forestry practices and industry is enhanced with some selected census and climatological data. Soils are described first by the series (Miami) and next by the soil types (Miami silt loam) and phases (Miami silt loam, 2-6 percent slopes, moderately eroded, etc.) which occur on the maps. General use of each soil and its management problems is discussed. Soil management is discussed by capability units with all soils having the same kind and degree of limitation and about the same needs for fertility, drainage and water management practices being in the same management unit. There may be 10 to 20 of these.

Yield estimates for the major crops are given for customary management levels and for levels achieved by use of improved practices. They help define responsiveness of the soils to adapted practices. In counties like Lake, with a large truck crop industry, a report section deals with adaptation of soils to special crops.

Tables of yield potential by forest site classes and a tree planting guide by soils first appeared in the Scott county report in 1962 which also defined types of forest occurring naturally in each soil association area on the general soil map. The Owen county report included the first discussion of wildlife and its management.

Useful Features Added to Meet User's Needs

A number of additions were made in the reports from 1962 till the present. Chapters defining soil properties important to engineering uses appeared first in the Scott county report in 1962. Engineering test data and group classifications for a number of selected soils tested by the Joint Highway Research Project at Purdue University were first added in the survey report for Owen county in 1964. Estimated engineering properties for all soils also first appeared there along with engineering interpretations tables including limitations for use of septic tile fields. These have become of prime value to sanitarians and plan commissions.

The first section on outdoor recreation potential appeared in the report for Allen county in 1969 which also included listings of trees and shrubs useful by soil groups for wildlife, and shelterbelt plantings and for gully and erosion sabilization. The Howard county report in 1971 included the first table of soil limitations for six common classes of outdoor recreational uses.

The discussion of soil limitations for homesites, septic disposal fields, local roads and streets, sewage lagoons, and landfills were first grouped into a section titled "Town and Country Planning" in the report for Lake County in 1972 which also discussed landscaping plants as adapted to soils. An excellent chapter by that name appeared in the Elkhart report in 1974 (15).

The chapters on formation and classification of soils were strengthened and included small maps of underlying geologic formations, along with a discussion of processes of formation and of the classification system used. Representative profiles of each of the great soil groups was described in detail with data on range of characteristics and relations to other soils.

In 1964 the soil series classified according to Soil Taxonomy (Soil Survey Staff 1973) and the 1938 systems of classification (Order, suborder, subgroup and family of the new Taxonomy vs. Great soil group of 1938) was first included in the Parke county report. These are of primary interest to scientists.

Useful additions to the modern standard reports are tables displayed just ahead of the maps which list mapping units by their capability unit grouping and the pages in the report where descriptive and various management data can be found. These are easily available to the map user. Another helpful addition is a glossary of terms unfamiliar to the layman which appears in the text.

Interpretations Indicate Limitations

In many cases soils have been interpreted by their degree of limitation for use for the intended purpose. A homesite may have a slight, or a moderate or a severe limitation for use for septic tank filter fields which imply the following:

Slight: Relatively free of limitations and any present are easy to overcome. Normal construction costs will apply.

Moderate: Has limitations which may be overcome by careful design and good management. Construction costs will increase, varying according to the kind of limitation to be overcome.

Severe: Has limitations which make use for this purpose questionable and require careful design in construction and superior management during use of the property. Costs may be great enough to suggest that a site with less soil limitations be chosen.

This system of limitations attempts to key the reader to degree of problem. It does not attempt to define a cure for that problem. This is assumed to be the province of other professional people who must use judgments in addition to soil factors in seeking solutions.

Additional Aids to Use of Soil Surveys

In the era of modern standard surveys several other aids have been developed as supplements. Cooperative publications such as the

Key to Indiana Soils (8) furnish a continuously updated list of Indiana soil series mapped in Indiana displayed by parent materials and natural drainage classes.

Special publications on farm planning (6) include management-productivity groups which allow determination of main management needs of Indiana soils grouped according to major limiting factors and productiveness. They also provide updated crop yield goals to supplement those conservative levels reported in earlier surveys. A publication on irrigation for land application of animal wastes (13) uses these same groups and discusses water intake rates and water holding capacities as a guide to potential irrigation rates.

Another booklet (19) lists all Indiana soils interpreted for waste disposal uses not normally included in standard soil survey publications. The Indiana Farm Drainage Guide (14) discusses types of drainage needed and spacing of tile lines, surface water channels and open ditches as adapted by soil groups. It is used by farm planners, contractors and engineers.

Recognizing the value of general soil maps first initiated in Knox county (1943), a set was prepared cooperatively between SCS and Purdue AES in 1971 and was updated in 1975 (12). One association legend was used across the state and maps were finished in one period and at the same scale which allows easy comparison across county lines. Each association was analyzed for a number of factors important to its broad land use pattern, value and management for agricultural and community development (21). These maps and analyses have become powerful tools for planners, appraisers, agribusiness and others having area or state-wide interests. They also help fill gaps where detailed surveys are not yet available.

Modern standard soil surveys are complex and detailed and the reports have to serve many audiences. Experiences in teaching (11) indicate that both individuals and audiences have difficulty in map reading and comprehension of reports. They also find it difficult to locate data from tables and text pertinent to learning the soil problems and the possible solutions for the use in which they are interested.

There is a challenge to develop reports aimed specifically to meet the needs of special user groups but to tie in closely with and supplement the standard survey reports. Such reports could go a step beyond them and offer alternative management suggestions to overcome or decrease the limitations which soils exhibit for various uses. Pioneering such a user-oriented series of reports should logically originate in the universities and be spearheaded by those interested in improving land uses but enlisting support from specialists in many fields.

Systems to put soil data which is read off maps into computer storage are being developed cooperatively with counties (22). This makes possible the recall of information needed by assessors in preparing for updating tax assessment procedures and by others with different reasons to be interested in soils data.

All of these efforts have reinforced the cooperative nature of the soil survey program with Purdue and SCS staff cooperating fully and enlisting support from others as needed to make our surveys useful to ever widening audiences.

Summary and Conclusions

The changing demands since 1902 intensifying land uses for many purposes has resulted in a gradually changing soil survey. This paper traces a number of changes to illustrate the responses made in several periods—1902-22, 1923-43, 1944-59 and 1960 to the present.

There have been great changes in numbers of soils recognized, numbers of units appearing on maps, and, in the gradual accumulation of soil knowledge which was passed along from earlier years to improve later soil mapping and reports. The greater number of small soil units mapped has called for gradually enlarging map scale.

Farm planning uses made a greater number of map delineations seem desirable, and, in the 1951-70, era surveys included over 100 units on an average with the more rolling, eroded counties having the most. In the 70's, 15 surveys have one-third less units per county indicating a trend toward more careful definition of each soil unit before it is accepted for final inclusion on a survey. This trend which started in the early 60's took so long to be noticeable due to publication delays. From the users standpoint this reduction of units is a great improvement. Every unit which must be studied and differentiated from others is an impediment toward understanding unless the unit is clearly different from its neighbors!

Due to pressure to complete Indiana's soil mapping with standard surveys in the present format by 1984 there will be a great push to speed up publication and many innovations will be tried. Also there will be a great need for educational programs to make the public aware of availability, use and value of each report as it is issued. To achieve maximum value this will need a real effort on the part of several agencies and efforts of the past will have to be developed and used much more widely.

The links developed through the years between soil scientists and other disciplines will need to be exploited more fully to bring soil knowledge and management experiences to all potential audiences! Today the main audiences include farmers and farm managers, foresters and wildlife managers, sanitarians and plan commissions, builders, developers, potential homeowners and real estate dealers, rural appraisers and assessors, scientists, architects and engineers.

Other specific user groups will require technical assistance to fully utilize soil surveys. A current need is for using surveys for land evaluation to aid assessors. Other needs will arise in the future though many are completely unforeseeable now. A good soil survey can be used to answer questions that were not even asked when the survey was made.

The challenge is there to increase the usefulness of the soil survey program and its maps and reports. They have served fully and well in the 73 years since the first one appeared in Indiana. They can be even more effective by the time the last ones are completed in the present format sometime after 1984. How well they serve future needs will depend on the innovations made by this and the next generation of soil scientists and the workers with whom they have already established working relations or will do so in the years immediately ahead.

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