Herman Warsaw and his successful search for higher corn yields

Werner L. Nelson and Harold F. Reetz, Jr.1

Farmers are continually searching for higher corn (Zea mays L.) yields and they have been particularly successful the past 30 years. The highest U.S. average corn yield up to 1954 was 42 bushels (2.63 Mg ha⁻¹); up to 1964, 68 bushels (4.27 Mg ha⁻¹); and up to 1985, 117 bushels (7.34 Mg ha⁻¹). Farmers have made this progress by searching for and removing the next limiting factor, employing new research results and adopting technological improvements.

Herman Warsaw, a central Illinois farmer, pioneer, scientist, student of corn, and steward of the soil, has been in the vanguard of this search. He has studied university information and adapted it along with industry ideas, experiences of other farmers, with his own experience to fit his soil and management.

Herman Warsaw was born 31 Jan. 1910 at Foosland, IL. In 1941 he and his wife, Evelyn, purchased a gently rolling farm near Saybrook, IL, about 25 (40 km) miles east of Bloomington. The U.S. Agricultural Stabilization and Conservation Service corn yield rating for the farm at that time was 38 bushels per acre (2.39 Mg ha⁻¹). It had been badly eroded and the fertility was very low.

World-wide attention has been attracted to this modest central Illinois farm in recent years as a result of Herman’s impressive yield record on his on-farm corn management test plots. The yields on his test plot for the last 15 years are shown in Fig. 1—a 274 bushels per acre (17.18 Mg ha⁻¹) average. The 370 bushels per acre (23.21 Mg ha⁻¹) in 1985 is a world’s record for non-irrigated corn as far as is known. A surprising statistic is that 9 of those years had 15 inches (38 cm) or less of growing season rainfall. This appears to be proof that the roots are exploring deep into the soil for the stored water to carry plants through temporary dry periods. Purdue University and University of Illinois researchers have found corn roots at least 60 inches (152 cm) deep in Warsaw’s field.

Along with his high yield record, Herman is known for his interest in improving the soil. He firmly believes that conservation tillage is the answer to both improved crop yields and reduced erosion. Hence, he voices strong support for soil conservation. His proven program demonstrates that increased yields and responsible soil management are compatible goals.

THE BASIS IS THE TILLAGE

After purchasing his farm, Herman started immediately to build fertility to increase grain yield and amount of stover. He first tried chiseling a persistent wet spot which had often delayed completion of his plowing. This worked well and helped incorporate livestock manure and residues in the upper surface. That was the beginning of the end of the moldboard plow, which he has not used since 1962. Herman feels that the residue must be shredded right after harvest so that a chisel can incorporate it into the upper surface of the soil where it can decompose to build soil structure.

At first the chisel would not penetrate 15 inches (38 cm) deep but after a few years he was able to reach that depth with ease. The chisels are 12 inches (30 cm) apart and chiseling is done at an angle to give a rocking motion to clear the chisel. He uses a 4-inch (10 cm) twisted chisel in the fall. If wet weather makes fall chiseling impossible, a 16-inch (41 cm) wide sweep at the same depth is used in the spring. These sweeps cut all the area, control perennial weeds, but do not bring wet soil to the surface.

Herman feels incorporation of residues and fertilizer with deep chiseling increases root depth and the size of the water reservoir. He states, “If you do not wish to irrigate or can’t irrigate, change the soils over the years to deepen the root zone, increase water infiltration and increase the water in the reservoir.” He finds roots as big as soda straws down to 60 inches (152 cm).

The high amounts of residues are increasing the soil organic matter and the soil has less tendency to compact. The soil is loose in the summer. After fall chiseling the mixture of soil and residues is quite complete and there is little chance of snow or water loss on the slopes. Soil loss to wind and water erosion has been virtually eliminated.

Herman feels that yields over 200 bushels per acre (12.54 Mg ha⁻¹) on his soil cannot be obtained with no-till. No-till gives more runoff, the soil is more compact, fertility is shallow, and roots do not grow deep. He says prairie soils were built by decay of residue from the top down and that is the way we must do it.

HIGHER FERTILITY IS ESSENTIAL

Herman finds a high level of fertility is essential to produce high grain yields and the stover necessary to make conservation tillage work. For each pound (454

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Fig. 1. Mr. Warsaw has a 15-year average yield of 274 bushels per acre (17.18 Mg ha\(^{-1}\)) on his high yield area. In 9 of the years the growing season rainfall was 15 inches (38 cm) or below. Reprinted with permission of Better Crops with Plant Food 69:14 (Winter, 1984–1985).

HYBRID AND HIGH PLANT STANDS HELP PRODUCE THE YIELD

Herman uses hybrid FS854 that stays green and undergoes photosynthesis longer than other hybrids. Other farmers cannot make it stand, but with management Herman has reduced the problem.

About 34,000 seeds (84,000/ha) are dropped in 28-inch (70 cm) rows. Herman feels even spacing and even emergence gives an extra 10 + bushels (0.627 Mg ha\(^{-1}\)). While planter manuals say to plant up to 6 MPH (2.86 m s\(^{-1}\)) he points out that when planting over 30,000 seeds per acre (74,100/ha), more even spacing is achieved when you plant at 3 1/2 MPH (1.67 m s\(^{-1}\)).

SHARING INFORMATION IS THE FINAL STEP

Herman is generous with his knowledge in many ways.

A constant stream of farmers, industry, research, extension, and media people visit his farm in the summer and fall to see his program in action. They go away convinced of the importance of a complete management program to grow corn and to conserve soils.

Visitors include dealers, extension and research agronomists, farm news media, and overseas visitors. For example, a group representing some 15 countries visited 6 July 1985. Visitors poke around in the soil, examine stalks, and compare hybrids. Then they come back to Herman’s shade tree and Evelyn’s brownies and lemonade. Questions for Herman start to come. Visitors are impressed with his analytical approach, capacity to consider big and small problems, and his ability to field questions. He outlines the principles for people to consider. Better management, higher yields, and soil conservation are all part of the lesson to be learned.

It seems that he has thought of all the angles. Herman is a student of corn and the total production system for his farm. The visitors go away convinced. Most important, many have been stimulated to improve management on their own farms or research plots.

He has spoken at hundreds of meetings over North America in recent years. They have included farmer and dealer training meetings, numerous soil conservation district meetings, state and national fertilizer association meetings, and university seminars. He spoke at a World Food Conference in India in 1981. In 1985 a videotape movie “Herman Warsaw—a steward of the soil” produced by the University of Illinois, Interna-
The identification phase of the contests. Following a study of the manner of classification of weed species in each state, 10 weeds formerly classified in the Rules identification list as Restricted Noxious Weeds were moved to the Prohibited Noxious Weeds list, while an additional 11 weeds were moved to the Common Weeds list. The 1986 Rules will reflect these changes.

The identification phase of the 1986 Contests will again include 200 items selected from the identification list, and will require the use of common names only.

Copies of the 1986 Rules will be distributed soon. If you should have questions relative to the 1986 Contests, contact Dr. Gerry L. Posler, Secretary, Coaches Committee, Department of Agronomy, Throckmorton Hall, Kansas State University, Manhattan, KS 66506. Telephone: 913/532-6101.

John A. Goodding, Agronomy and Plant Genetics, University of Minnesota-Twin Cities.
Planning—Planting an experiment teaches skills

Many courses in agronomy provide an opportunity for instructor and students to plan and start a management practice, variety evaluation, or fertility trial. If access to field space and equipment is available, field evaluation can be done in plots of 2 to 3 m × 6 to 10 m. Larger plots can be used if equipment is large and sufficient space is available. Students can plan a project, plant, fertilize, and use chemicals as appropriate. Such complete involvement makes an invaluable overall experience.

If grain yield or season-long plant growth is to be evaluated, one problem may be getting the final results to the students who planned and initiated the experiment. An approach that I have used successfully is to list the plot-by-plot outcome, treatment means, and simple statistical interpretation on a fact sheet that can be mailed to course alumni as a followup. Many undergraduate students have little or no opportunity to take a course in statistics. However, these students need to know the principles of random assignment of treatments to the field plots, pots, or containers, and the need to replicate treatments three to four or more times due to variation in the outcome of experiments using crop plants. A few simple evaluation techniques, like t-test or one-way analysis of variance, can be explained both at the planning and the evaluation stage.

This experimental approach can be done outside in plots or, with weather and space limitations, in a greenhouse or growth chamber. This experience combines the benefits of the crops garden hands-on experience (Patterson and Jones, J. Agron. Educ. 7:67–71) with the discovery of research projects. The learning value of such experiments makes them worthwhile.

D. A. Munn,
The Ohio State University,
Wooster.

Course improvement

An excellent way to improve an existing course is to develop and teach a mini-segment of the course for farmers or others purposefully employed in the agriculture industry. Offer a 8 to 10 h course concerning alfalfa production, for example. Extract only the most important, meaningful, and practical information from your regular forages course. If all goes well during the minicourse offering, then revise your regular course, focusing on the minicourse format. I did this 2 years ago and have completely revised my forages course into one that is more practical, better received by students, and more enjoyable to teach. In essence, most of the first eight lectures in the course focus on the materials developed in the minicourse, followed by information concerning forages that might be used in areas undesirable for alfalfa production. I found two additional benefits for teaching the minicourse—better rapport with area farmers, and a great opportunity to pare down course materials (we all need to “clean house” more often).

Bill Anderson,
University of Minnesota Technical College,
Waseca.

Agronomy reference notebooks

One of the objectives of an undergraduate education is to be able to leave the university with some reference material that can be used by students in their careers. While textbooks often supply basic information, they usually do not provide everyday general information that might be useful in applied agronomic careers. I teach a crops and soils management course normally taken by students in their last couple of semesters of academic work. One requirement of the course is to develop an organized notebook appropriately indexed, containing such things as extension publications, semi-technical journal articles, pest identification picture sheets, soil and forage testing forms, and other credibly published applied agronomic information. The student is graded on originality of content and organization. The relative value of the grade is low overall but sufficient to add encouragement to what most students feel is a worthwhile project. The complete reference notebook (three-ring binder) is not only useful to the students in their jobs but the remembering of sources of information, particularly those of the Cooperative Extension Service, are vivid reminders of the university’s lifelong continuing effort at educating their past, present, and future students.

Zane R. Helsel,
University of Missouri,
Columbia.

The purpose of this review is to announce the availability of a glossary of terms used in plant sciences. This glossary serves the purpose outlined in the preface of the book. It helps bridge the communication gap by allowing easy access to a wide variety of plant terminology.

There are two indexes in this book: crops and terms. Both are extensive, with crops listed by either their common name or scientific name and terms listed as single words or phrases. Topics covered include morphology and anatomy, crop ecology, propagation, soils, crop production, plant breeding, post-harvest handling and marketability, as well as horticulturally specific topics such as horticultural crops, physiology, taxonomy and nursery production. These topics are further divided into many sections, for example mineral nutrition, water relations, micropropagation, pests, hormones and growth regulators. Line drawings accompany many of the sections and serve to illustrate the definitions. One can easily see use of the glossary at all levels of teaching and for clarification of terms and techniques encountered during graduate study. If there is any flaw in this glossary, it is in the title. By identifying it as a glossary for horticultural plants, many plant scientists may deem it as too specialized and not applicable to their interests. This is far from the case! All plant scientists should peruse a copy before making a decision.

Ellen T. Paparozzi, University of Nebraska-Lincoln.


This slide-tape program on hay evaluation is another in the RAM (Reinforcement Agri-Media) Series developed at the University of Minnesota Technical College, Waseca. It consists of thirty-one 2X2 slides, an 11-min prerecorded cassette tape, and a copy of the script and study questions. The program illustrates and discusses five factors that are considered when performing a field analysis of hay quality: maturity, leafiness, condition, foreign material, and color. The slides do a good job of illustrating these factors, and considerable attention was obviously paid to detail when taking the pictures.

After briefly discussing these factors, the tape reviews the criteria that affect quality by asking a question and then directing the listener to stop the tape and determine the answer. Copies of the questions are included in the written material that accompanies the slide-tape program. Because each question is answered when the tape continues, most students will probably just leave the tape running to get the answers rather than to determine them on their own. Hay Evaluation would be valuable in a forage course as part of an exercise on forage quality when students have actual samples to evaluate.

Richard Waldren, University of Nebraska-Lincoln.


In the last decade there has been a tremendous amount of research on soil erosion. In this revised edition of his 1971 book, the author has incorporated recent advances and shown how these advances can be applied to control soil erosion while at the same time bringing about more productive farming. Since the first publication of this book, there has been increasing realization that sound soil conservation practices in North America cannot be directly applied worldwide. The author points out the need for translating present knowledge into workable solutions to problems in developing countries. An entirely new chapter dealing with problems of implementing soil conservation practices and policies is included in this edition. The author discusses factors that hinder the process of putting our knowledge of effective soil conservation measures into practice. Because of these factors, practice has not kept up with current scientific knowledge.

This is an extremely useful text for an upper level, undergraduate student studying soil erosion and soil management. Starting with basic principles, the author develops a logical method of understanding the mechanics of soil erosion as a function of erosivity and erodibility. The study presupposes some knowledge of the physical properties of soil and a working knowledge of mathematics. Although it is written from an engineering viewpoint, the author's common sense approach makes it practical for any student desiring to understand the mechanics of soil erosion.

Several chapters are devoted to the factors involved in soil erodibility. Excellent illustrations and data help to relate physical properties, land management, and crop management to soil erodibility. A chapter on designing soil conservation structures is included. This chapter presents the principles of designing structures such as channel terraces, bench terraces, and grass waterways. It is complete but at times tedious and difficult to follow.

In my opinion, one of the strengths of this book is the author's treatment of the Universal Soil-Loss Equation. By using examples, the author explains the equation step by step, making it comprehensible and useful in estimating soil movement.

The author provides an excellent introduction to land management and the USDA-SCS Land Capability Classification. He shows how this USDA system could be applicable in other countries. Soil physical properties, such as effective depth, texture, permeability, slope, and previous erosion are also related to land management. A subsequent chapter is devoted to crop management. A brief discussion relating the advantage of grass in a rotation is presented. The author's thesis is that optimum soil conservation results in maximum production.

The reviewer found two chapters to be incomplete: Chapter 13, "Erosion Control on Non-Arable Land," and Chapter 14, "Wind Erosion and Its Control." The equation for estimating...
Eroding Soils: The Off-Farm Impacts—

The documented study attempts to accomplish two goals concerning sediment and related contaminants that are carried off farms following cropland erosion. The first goal is to identify, document, and estimate the off-farm impacts associated with cropland erosion. The second is to access various policies to efficiently reduce these impacts.

The title of this book is somewhat misleading. The authors do not in most cases distinguish the off-site impacts of sediment and related contaminants resulting from agricultural land from the impacts associated with other non-point sources. Limitations in the current data base made it difficult for the authors to distinguish between these two sources of sediment-related problems. Where the impacts were apportioned between farm sources and other non-point sources, the distinction is made only to cropland and not to other farm-related land uses such as rangeland, pastures, farmsteads, and woodlots. Also the study does not concern itself with the off-site effects of wind erosion, with the exception of any wind erosion losses that end up in water. Essentially this study focused on pollution problems resulting from sediment and related contaminants (nutrients, pesticides, and others) which are released to surface waters.

Following an introductory chapter, the second chapter summarizes several basic processes important in understanding how sediment and related contaminants may cause off-site impacts. Several physical processes are discussed, including determinants of erosion, sediment delivery, and sediment transport. Various chemical and biological factors such as nutrients, pesticides, bacteria, viruses, metals, and salts are also discussed in this chapter.

Chapters 3 and 4 summarizes the specific in-stream and off-stream impacts resulting from sediment and related contaminants. In-stream damages are those damages to aquatic organisms, water-based recreation, water storage facilities, and navigation in lakes and streams. Off-stream damages are those that either occur before the sediment or contaminant reaches a waterway, during floods or when water is taken for municipal use, irrigation, or other purposes. The impacts discussed in these chapters span a wide range of disciplines.

Cost estimates for the damages resulting from various in-stream and off-stream impacts are discussed in Chapter 5. Estimates given are considered order-of-magnitude estimates only and are generally expressed as a single-value best guess within a wide range of values. Some impacts were considered as a cost savings such as the value of nutrients contained in irrigation water while others, such as biological impacts, were not assigned a value. Both the difficulty in assessing an economic value for some impacts and the very wide range of values in others indicated some major limitations in the current data base available to the authors. Difficulties also arose when assigning estimates for impacts which incorporated information from a wide range of disciplines. Estimates were made as to what share of the damages from general non-point sources could be attributed to cropland water erosion losses. In most cases, cropland was assumed to account for approximately one-third of the damages. This assumption was based on an estimate that cropland contributes about one-third of the sediment and nutrients entering streams.

A summary of information on the costs and effectiveness of various management practices in controlling the impacts from sediment and related contaminants is found in Chapter 6. Practices discussed included tillage practices, cropping patterns, and structural practices as well as several other land-management practices. Also discussed is information on the relative efficiency of such control measures and making choices between different practices. The final chapter focuses on public policy issues in developing programs to control off-site damages.

Additional information on many of the topics discussed in the book would be available from the lengthy list of references at the end of each chapter. A portion of the literature cited is from reports not normally found in a personal or office library. The book has numerous figures (mostly tables of information), some of which do not stand alone. Also several times in the economic analyses, the information presented in the figures did not clearly represent an annual or a one-time cost.

An 8-page executive summary precedes the introductory chapter. Much of this information as well as some of the economic analysis contained in Chapter 6 can be found in an article written by Edwin H. Clark II titled, "The Off-Site Costs of Soil Erosion" (J. Soil Water Conserv. 40:23–6, 1985).

I found the final chapter, which discusses the various public policy issues, most useful. Although policies concerning targeting funds for soil conservation at the national level have changed since the writing of this book, I found the author's treatment of the concept of targeting clear and concise. The concept of targeting was emphasized for all levels of decision making, from the on-site treatment of specific fields through national policy. Also discussion of the importance in recognizing and relating off-site impacts as well as on-site impacts to soil conservation programs should present a challenge to many who are working in this area.

The book was not without some problems, however. I found the technical sections of the book, especially those which discussed some of the fundamental principles of soil and water conservation and soil science weak and containing errors. Obvious errors included statements such as "Organic materials... tend to prevent other soil components from sticking together strongly" and "Most of the phosphorus in commercial fertilizers is in the form of phosphoric oxide..." Additional problems in the technical content of the book present some weaknesses in relating off-site damages to on-site recommendations, a concept the authors wish to portray. I would not recommend this book for use in the classroom, especially at the undergraduate level. Various problems and errors in the more technical

The seventh edition of the Western Fertilizer Handbook is oriented to fertilizer usage practices for irrigated agriculture in the western USA. This book is available in Spanish and French as well as in English. It is written in a practical, applied manner with the intended audience to be growers and professional agriculturalists, although many university teachers and students find this applied presentation of fertilizer usage helpful. Accompanying the Western Fertilizer Handbook are slide-tape sets for each of the 14 chapters. Each tape represents the same information that is contained in the corresponding chapter, with the tape often being a verbatim reading of much of the chapter. Each tape has nice background music and is easy to understand. The slides are professionally prepared and help in understanding the material presented. Many of the slides also appear as photographs in the handbook. Each slide-tape set can be completed rapidly since the longest one only takes approximately 30 min. The slide-tape set may be useful to help students with reading deficiencies or to present an alternate learning experience from reading a textbook. Many of the slides from this set could be combined with instructor's personal slides to use in lecture or audio-tutorial presentations for introductory soils and/or crops courses.

This handbook slide set series is divided into 14 units or chapters. The first chapter, “Soil—A Medium for Plant Growth,” briefly discusses the process of soil formation and soil properties that influence plant growth. Chapter 2, “Water and Plant Growth,” emphasizes the factors to consider in determining the amount of irrigation water to apply and the important quality aspects of irrigation water. Although the title of this chapter suggests that the role of water in plant growth is a central part of this chapter, little discussion of this factor is present. Chapter 3, “Principles of Plant Growth,” is an excellent review of the basics of plant growth and development.

The essential elements for plant growth are presented in Chapter 4. This chapter includes nutrient transformations in soils, ionic form taken up by plants, and deficiency symptoms. The handbook contains 24 excellent color photographs of nutrient deficiencies and toxicities. Chapters 5 and 6 contain readable presentations on fertilizer products, formulation, and handling. Other chapters deal with the use of soil amendments, soil organic matter, soil and tissue testing, methods of applying fertilizer, hydroponics, benefits of fertilizer to the environment, western fertilizer laws, and amending the physical properties of soils. Appendices in the handbook contain a glossary, conversion tables, and calibration tables.

I find the Western Fertilizer Handbook Slide Set Series to be a useful resource for teaching of introductory soils and crops courses. The presence of the handbook, tape, and slides allows flexibility in the use of this resource, and adaptation to the instructor's classroom needs.

Stephen C. Mason, University of Nebraska, Lincoln.


The author's stated purpose for this field guide is to supplement his textbook Soils and the Environment (Chapman and Hall, New York, 1981, 178 p.). Most chapters in this guide cite specific pages and/or material from the 1981 textbook.

The Field Guide is divided into three parts:

I. Language of soil surveys and criteria for soil ratings.

II. Applications of soil surveys in systems of wide usage.

III. Principles governing the applications of soil survey interpretations in the future.

Each chapter in the field guide is presented as an exercise. The order of subjects included in each part of the field guide are as follows:

Part I
Soil Profile Descriptions
Soil Maps
Laboratory Analyses
Soil Taxonomy
Computerized Groupings of Soils
Projects
Photographs
First Exam

Part II
Engineering Applications
Waste Disposal
Agricultural Land Classification
Erosion Control
Yield Correlations
Farm Planning
Community Planning

Part III
Soil Potentials
Soil Variability
Sequential Testing
Land Uses and Soils
Tragedy of the Commons
Strategic Implications
Military Campaigns
Research
Predictions
Soils Tours
Slide Sets
Final Exam
Evaluation

Each chapter begins with a purpose statement followed by a procedure or technique or background or sampling suggestion. Most chapters include many illustrations and tables. Some chapters include a summary statement.

Most chapters suggest general guidelines as to how the reader is to proceed. For example, on page 34 the author states: “List all the soil properties that you think are important for crop production (see page 67 of the textbook).” The written material in each chapter is usually no more than 2 to 4 pages in length followed by a series of illustrations and/or tables. Most chapters include a listing of references that are cited within the respective chapter.

The field guide has both weaknesses and strengths. The shortcomings involve the quality of reproduction of material from other sources, organization and consistence of each chapter, and failure to include appropriate references for some subjects.

Several tables are reproduced directly from reference sources, most notably USDA Soil Conservation Service publications. The quality of some reproductions is poor due to small print and/or lack of sharpness and contrast. Tables 6, 9, 16, 17, and 18, Figures 13 and 47, and the legend for Figure 14 are offered as examples.
The author has reproduced soil maps to illustrate how maps can be used for identifying soil limitations and soil potentials. The reproduction of many of the soil maps was accomplished by a photo-reduction process that changed the size and legibility of some of the examples. Tones of gray shading on black-and-white photographs are the standard used in the guide for illustrating soil limitations and soil potentials. Due to the combination of reproduction, reduction, and the lack of tone contrast, many of the soil map illustrations are less than ideal. Figures 2 and 3 and Figures 15 through 21 are examples of these shortcomings.

Organization of material is inconsistent from chapter to chapter. Some chapters are general in guidance and have little detail and few references. Other chapters provide specific guidelines for the reader, describe a comprehensive review of the subject, and include an extensive list of references. A combination of these strengths and weaknesses is often the situation found in the field guide.

The chapter on agricultural land classification is inadequate. The chapter includes a discussion of soil limitations and soil productivity potentials, to include the use of soil maps for agricultural land evaluation and taxation. The classic Storrie index is discussed but none of the more recent state devised systems of soil productivity potentials and use for taxation is discussed or included in an extensive reference listing at the end of the chapter. Most notably missing are references for the productivity systems developed by Illinois, Indiana, Iowa, Minnesota, Missouri, Ohio, Oregon, and South Dakota. Also, no reference is made of the text by David Dent and Anthony Young entitled Soil Survey and Land Evaluation (Allen and Unwin, Boston, 1981, 278 p.). Dent and Young devote three chapters to development of land classification systems and land evaluation procedures.

The strength, and in my opinion, the highlight of the field guide is in three chapters: Tragedy of the Commons, Strategic Implications, and Military Campaigns. Information in these chapters has not previously been incorporated into a textbook on soils and land use, at least to my knowledge. This material made interesting reading and includes an extensive listing of references.

The field guide contains a great amount of information that is readily available in USDA Soil Conservation Service publications. It can serve as a reference for undergraduate teaching faculty for developing laboratory exercises and for additional reading assignments at the undergraduate level. I recommend the field guide be added to a central library collection, but hesitate to purchase it for my personal library, especially the cloth copy at $49.00 per copy.

Gerald A. Miller, Iowa State University, Ames.


This is one of the most complete volumes on the subject of geomorphology I've ever had the opportunity to read. To quote the authors "When one considers even the most subtle of chemical changes to which the near surface bedrock is susceptible, one embarks on a chain of thought which runs unbroken through slope and stream process to the destruction of continents." This is the pattern of presentation in the book. The factors, processes, and outcomes associated with geomorphology are interwoven in such a way that the reader can see and understand the magnitude of complexity of processes governing the form of the surface of the earth, including the oceans and their spreading floors.

The book represents a truly significant effort on the part of the authors to draw together all existing knowledge on the subject and summarize it in one volume. There are 20 chapters, each with a very extensive bibliography, such as chapter 18 with 113 cited references. I found between 600 and 700 drawings, graphs, and charts to illustrate the text. These are clear, and one could get a great deal out of most chapters by study of these figures alone. Combined with a well written text, they present a clear picture of processes described by the authors—from the beer can experiment to depiction of mathematical expressions such as water depth threshold for moving material as a function of wave height. In addition the Appendix contains 33 one-half to full page photographs illustrating landforms and landscapes. The book is organized into four parts, with part 1 as an introduction to the topic (3 chapters). Part 2 considers Geologic Geomorphology (5 chapters), part 3 (9 chapters) discusses geomorphic processes and landforms, and part 4 (3 chapters) looks at climatic geomorphology.

The book begins (part 1) with a consideration of approaches to the study of geomorphology (chapter 1) and a consideration of the evolution of concepts in its understanding. The Davisian model is considered along with those of Penck and King. The equilibrium concept is presented as are the concepts of geomorphic threshold and complex response (chapter 2). Cascading process systems (chapter 3) including the solar energy cascade, the hydrologic cycle, denudation, diastrophism, and diastrophism, and erosion are considered with the interactions between them discussed.

Geologic Geomorphology (part 2) includes a discussion of minerals, rocks and sediments, as well as chapters considering the relationship between landforms and diastrophism, igneous activity, geologic structure, and lithology. Sea floor spreading and plate tectonics are considered with diastrophism (chapter 5) along with other forms of crustal movement.

Geomorphic processes (part 3) includes a discussion of weathering, mass movements, hillslopes, rivers, drainage basins, fluvial depositional landforms, coastal geomorphology, aeolian processes and landforms, and the glacier sedimentary system. These chapters consider the erosional and depositional processes acting on the earth's surface to produce a sequence of landforms. Both historical and functional approaches are considered. Both quantifying as well as descriptive expressions are used in a successful effort to get across to the reader the concepts the authors attempt to convey. I found the chapters on rivers and drainage basins to be especially interesting in their discussion of river metamorphosis, and the relationship of the intricacy of drainage networks on geologic deposits of differing age. I have used the latter relationship many times in class to show the relationship of landscape age to the distribution of soils in the various drainage classes. The chapter on glacier sedimentary systems covers many of the topics often considered in courses concerned with glacial geology. This chapter plus that on Diastrophism (chapter 5) where crustal depression under ice and rebound following glaciations are discussed covers the topics of continuous and valley glaciation very well.

Climatic geomorphology (part 4) considers the cumulative effect of climate and climatic change on landforms. It includes a detailed consideration of the relationship between
climate, vegetation, and landforms. This relationship is approached in much the same way as by one who first attempts to consider the separate effects of climate and vegetation on the genesis of soils. Finding them so confused that they are nearly impossible to separate, it is often common to consider the combined rather than individual effects. This problem is handled well in this section, even though the similarity between study of genesis of landforms and of soil is not mentioned. The chapter on morphogenetic landforms poses the question as to whether or not clastic types can produce assemblages of landforms that transcend differences in lithology, structure, and relief. Landforms and processes associated with climatic regions from arid through the humid tropics are then discussed. But, as the authors suggest, past climates may have a role here. They suggest that “there is no matter of prime significance to the geomorphologist on which he is so profoundly ignorant as that of climatic change.” A discussion of the complexities of trying to understand climatic change and its relationship to landforms completes the text of the book.

The final “chapter” of the book is in the Appendix. This deals with the application of geomorphic principles to the solution of problems arising when the land is used. Geomorphic hazards are discussed in terms of how to recognize them and their effects. Three case studies of rivers and problems arising from their tendency to follow natural laws are presented.

Examples from many parts of the world are drawn upon by the authors to clarify the concepts they present. Views of differing students of geomorphology are discussed thoroughly, and their relative merits (in the opinions of the authors of the book) are weighed. One feels after reading the book that a great deal of varying opinion has been considered and weighed in terms of its relative value, and that there is still room and need for the development and exploration of new hypothesis to clarify points where significant differences of opinion exist.

I discuss the merits of this book as one who uses many geomorphic relationships in teaching and research on the subjects of soil morphology, classification, and survey. I have drawn extensively on the work of Robert Ruhe and have found the books of Peter Birkeland to be useful references in that context. The book reviewed makes few references to soils. Yet, study of soils by the pedologist incorporates a great many geomorphic principles, and an understanding of these principles is essential to a full understanding of soils as they exist on the landscape. Conversely, many geomorphologists have found the principles incorporated in the study of pedology to be useful in development of understanding of geomorphic processes. It seems that it would have been possible to incorporate the relationship described above in the chapter that was used to describe weathering processes, for soil is the result of these processes. I think coverage of this topic would have added to the book.

I find little else to suggest as shortcomings of this book. The systems approach to geomorphology may make the subject more difficult to follow than other approaches. Yet, my own observations while working with soils and landscapes lead me to believe that this approach is more consistent with observed phenomena, and more useful to those trying to apply geomorphic principles to problem solving situations than are the approaches that hypothesize erosion and denudations cycles. This is a large book, and the print in it is small. It may be a bit difficult to read for a beginner in the subject. However, it should serve as an excellent text for the advanced student, and as a valuable reference in the library of the geologist, pedologist, hydrologist, or anyone else concerned with past, present, and future changes in landscape features.

David T. Lewis, University of Nebraska, Lincoln.


This book deals with the processes to follow in development of crop production technology in developing countries by means of on-farm trials. Of the many components that could logically make up the subject matter implied by the title of this book, only three major components are quite thoroughly covered:

1. Experimental design, statistical analysis of plot data and data treatment. About two-thirds of the book is devoted to these items.
2. The authors’ categorization of the types of on-farm research plots that are necessary for farming systems research to develop information that will ultimately be adaptable and acceptable by the limited resource farmer.
3. The socioeconomic-personal and public relations guidelines leading to successful acceptance of the research program, and finally acceptance of research findings by the limited resource farmer into his existing farming system and culture.

Chapter 1 covers “the role of on-farm research in technology development.” It gives a clear and concise analysis of socioeconomic-cultural considerations for developing a research program in new and unresearched regions. It is oriented toward dealing with the small-scale limited resource farmer in developing countries.

Chapter 2: While entitled “General Considerations Relative to On-Farm Trials,” it nevertheless deals with the somewhat more specific factors that must be considered when dealing with the “on-farm” research, such as researcher-farmer relations, experimental procedures, field data management, etc. The factors described and discussed are probably quite familiar to anyone who has been involved in any “outlying testing” program of a Land Grant university.

Nevertheless, this serves as well-organized reference or as a means of gaining a perspective on this type of work. A major emphasis is given to experimental designs, statistical analysis, dealing with missing numbers, etc.

Chapters 3 through 8 deal with the different types of on-farm experimental trials that the author considers necessary for the process of i) developing new and improved knowledge (data) and ii) trials needed to achieve adoption of the improved practices by the farmer into his farming system. The authors list six different types of trials and describe the characteristics and functions of each type. Suggestions are given relative to experimental design, statistical analysis and final data treatment. A major part of all these chapters is devoted to statistical procedures for evaluating field plot data.

While a considerable part of the book deals with experimental design and statistical treatment of field plot data, little or no discussion is devoted to how one determines what treatment or practices should be tried in the first place.

Chapter 8 deals with the aspect of FSR/E (Farming Systems Research/Extension) that is a concern to those who are involved with administration of these programs and/or in dealing with the political administration of these
programs in the host country. The comments made relative to these areas show that the authors are speaking from experience.

A good bibliography of related material on Farming Systems Research/Extension (FSR/E) is included with each chapter. The major thrust of this book is in the area of statistical evaluation of data. Therefore, its title seems a bit misleading. A more appropriate one might have been "Statistical Approaches to Evaluating Data For On-Farm Agronomic Trials in Farming Systems Research and Extension." I evaluate this book from the point of view of one trained in soil science, and have found there to be a great deal more to on-farm agronomic trials than statistical design and data evaluation. Selection of plot sites was given only bare mention in the book, and factors such as the types of treatments most appropriate to evaluate a situation were not mentioned. These considerations are of more importance than the statistical evaluation of data in such trials, and considering the title of the book, deserve a much greater mention than they received.

A. R. Halvorson, Washington State University, Pullman.


This is the first of a projected series of "comprehensive reviews on topics of current interest in the discipline as a whole." As such it is an interesting and valuable beginning, and we hope that future volumes will be of an equal quality.

Volume 1 contains six chapters. Each makes a valuable contribution in summarizing the literature within its own niche. Chapter 1 "The Efficiency of Nitrogen Fertilizers Applied to Cereals Grown in Different Climates," by Eric T. Craswell and Douglas C. Godwin, admirably undertakes the task of examining the ways in which climate affects nitrogen-use efficiency.

Chapter 2 "Nutritional Characteristics in Cereals," by Robin D. Graham, is a thorough discussion of the case for incorporating micronutrient efficiency into modern cereals.

Chapter 3 "The Control of Nutrient Uptake Rates in Relation to the Inorganic Composition of Plants," by Anthony D. M. Glass and M. Yaees Sididi, is an excellent review of the subject that points up the need for more research if we are to understand completely some of the more perplexing problems the subject presents. The authors point out the lack of biochemical information on the putative transporters, a major barrier to a complete understanding.

Chapter 4 "The Functions of Calcium in Plant Nutrition," by J. B. Hanson, is an exhaustive and valuable survey of the roles of calcium as an essential nutrient in plants.

Chapter 5 "Membrane Associated ATPases and Nutrient Absorption by Roots," by Robert T. Leonard, summarizes the current literature on this subject, which is fundamental to understanding plant nutrition.

Chapter 6 "Nuclear Magnetic Resonance and the Study of Plants," by B. C. Loughman and R. G. Ratchiffe, is a thorough review of all the work on NMR relevant to plant nutrition.

This volume will make a valuable addition to the professional library. It is too advanced to have any use as a text in the field since its appeal is mainly to the professional working in this discipline. As such it makes a worthy contribution to this fundamental and complex science.

Warren L. Anderson, and Anthony J. Halterlein, Middle Tennessee State University, Murfreesboro.


The authors intend this book to be a general primer on vegetable crop production. The first third of the book briefly reviews basic agronomic principles associated with vegetable production such as agricultural climatology, site selection, soil properties, and soil fertility. The treatment is cursory, though, and this is not adequate as a reference book. Other more complete texts would be needed by anyone seriously pursuing commercial vegetable production.

The chapters on plant establishment, pest control, irrigation, and harvesting discuss vegetable crop production principles. Examples are provided throughout. Literature citations are included in the text and a list of references concludes each chapter. The actual production information contains more depth and is more useful than the introductory chapters.

The book completes the growing cycle with chapters on marketing, storage, machinery, and vegetable seed production. The chapters on storage, fertility, weed control, and harvesting were too general. Vegetable marketing (chapter 9) gave a fairly complete list of marketing ideas and is probably the best chapter in the book. These chapters cover the basic principles so that the intelligent reader will know what questions need to be asked for any specific crop.

At times the book needs to present more information. In one chapter the authors remark that tillage should only be undertaken when the soil is sufficiently dry, but they neither define "sufficiently dry" nor tell how to determine that state. A section on problem solving with charts or tables would be a useful addition.

Perhaps the main problem with the book is its orientation toward Great Britain, the source of most of the examples and literature citations. The reader probably can adjust to the English spellings and nomenclature, but there is no attempt to help the American reader and distribution in the USA seems to have been an afterthought. For example, the maps of Britain do not have any cities on them. One gets the feeling that the use of Britain as the main example may ignore some of the high technology used in California and other advanced vegetable growing areas.

The book could be used in an introductory Vegetable Production course. It would be more useful in Great Britain than in the USA. With supplemental references to cover specific crops and technical data, this book would provide an overview of vegetable production principles. In addition, the added effort needed to understand the English nomenclature and metric system provide the reader with the tools necessary to read other agricultural publications from Great Britain.

Charles A. Shapiro, University of Nebraska, Concord, and
Terry Gompert, Knox County Extension Service, Center, NE.

A researcher at AT&T Bell Laboratories, the author wrote a seminal article in Science on the emerging field of graphical perception. This book, Cleveland's second, has an introductory chapter plus three others. The author states that many of the methods and principles in the book are new and others are old but not widely known. The material in the book is relevant for those who want to analyze and communicate data. In this review I will concentrate on data communication, leaving evaluation of Cleveland's view of data analysis to those more versed in that field than I am.

The book is easy to understand, exemplifies good graphical communication, but requires knowledge of statistics. The examples in the book present information about fascinating subjects, and Cleveland skillfully uses these examples to drive home the points. In Chapter 2, Principles of Graph Construction, Cleveland uses data from a Science article on “nuclear winter.” And in Chapter 3 he explains the graphical method called “The Dot Chart” by plotting the number of speakers for 21 of the world's languages. Chapter 4 on Graphical Perception contains the famous graph of William Playfair, first shown in 1786, on imports vs. exports. The point here is that a visual system can misjudge vertical distances, and Cleveland illustrates the point by subtracting imports from exports and plotting them below Playfair's graph.

Chapter 4 raises additional issues of graphical perception. Cleveland argues strongly that data should be encoded on graphs so that the visual decoding involves tasks as high in the ordering as possible. In other words, user-friendly graphs are preferred. He illustrates this idea with many examples, and concludes that following this idea would allow us to develop new methods of graphing and to set aside other graphical forms. Among the many graphical methods espoused are use of color to discriminate between different data sets. Cleveland argues this view by printing the same graph in black-and-white and in color. One graph, having eight different lines representing surface land temperature and time after detonation, contains so many dashed lines and a computer-printed caption, that I found it difficult to compare the variables. On the other hand I could easily compare variables on a color version of the same graph. Cleveland gives an even more convincing example by showing a scatter plot of brain weight vs. body weight of various animals. The confusing black-and-white picture has circles, triangles, x's, and “s” as a legend identifying the various animals. The color scatter plot, produced by computer, simply uses blue, magenta, yellow, and green. Although color is better, it remains to be seen whether authors and publishers will be able to afford using it because of its expense. Color does communicate better than complicated black-and-white graphs with many legends and lines. Teachers might find this book useful for demonstrating to students how to plot their data for easy communication with a variety of audiences.

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