

Preface to the First Edition

This textbook is developed from lectures for a graduate class in soil-plant-water relations taught at Kansas State University. Students in the class are from various departments, including agronomy, biology, horticulture, forestry and recreational resources, biochemistry, and biological and agricultural engineering. The book can be used as a text for graduate- or upper-level undergraduate courses or as a self-study guide for interested scientists. The book follows water as it moves through the soil-plant-atmosphere continuum. The text deals with principles and is not a review of recent literature. The principles covered in the book, such as Ohm's law and Poiseuille's law, are ageless. The book has equations, but no knowledge of calculus is required. Because plant anatomy is often no longer taught at universities, chapters review root, stem, leaf, and stomatal anatomy. Instrumentation to measure status of water in the soil and plant is also covered. Many instruments could have been described, but the ones chosen focus on traditional methods such as tensiometry and psychrometry and newer methods that are being widely applied such as tension infiltrometry and time domain reflectometry. Because the humanistic side of science is usually overlooked in textbooks, each chapter ends with biographies that tell about the people who developed the concepts discussed in that chapter.

Although a textbook on water relations might logically include developments in molecular biology, this topic is not covered. Rather, the text focuses on water in the soil and whole plant and combines knowledge of soil physics, plant physiology, and microclimatology. Chapter 1 reviews population and growth curves and provides a rationale for studying water in the soil-plant-atmosphere continuum. Chapter 2, which defines physical units, at first may appear elementary, but many students have not had a class in physics. The definitions in this chapter lay the foundation for understanding future chapters. Chapter 3 goes over the unique structure and properties of water, which makes life possible. Chapter 4, on tensiometry, is the first instrumentation lecture. Other instrumentation lectures include: Chapter 9 on penetrometer measurements; Chapter 10 on measurement of the oxygen diffusion rate in the soil; part of Chapter 11 on applications of tension infiltrometry to determine soil hydraulic conductivity, sorptivity, repellency, and solute mobility; Chapter 13 on time domain reflectometry; Chapter 16 on psychrometry; Chapter 17 on pressure chambers; Chapter 22, which includes

ways to measure stomatal opening and resistance; and Chapter 24 on infrared thermometers. Chapters 4 through 13 focus on water in the soil; Chapters 14 through 22, on water in the plant; and Chapters 23 through 27, on water as it leaves the plant and moves into the atmosphere.

Within any one chapter, the notation is consistent and abbreviations are defined when first introduced. When the same letter stands for different parameters, such as *A* for "ampere" or "area" and *g* for "acceleration due to gravity" or "grams", these differences are pointed out.

I express my appreciation to the following people who have helped make this book possible: my sister, Victoria E. Kirkham, professor of romance languages at the University of Pennsylvania, who first suggested on March 12, 1999, that I write this book; Dr Kimberly A. Williams, Associate Professor of Horticulture, who audited my class in 2000 and then nominated me for the College of Agriculture Graduate Faculty Teaching Award, of which I was the inaugural recipient in 2001; Mr Martin Volkmann in the laboratory of Prof. Dr Rienk van der Ploeg of the University of Hannover in Germany, for converting the first drafts of the electronic files of the chapters, which I had typed in MS-DOS using WordPerfect 5.1 (my favorite word-processing software), to Microsoft Word documents, to ensure useable backup copies in case my 1995 Compaq computer broke (it did not); my students, who have enthusiastically supported the development of this book; anonymous reviewers who had helpful suggestions for revisions and supported publication of the book; publishers and authors who allowed me to use material for the figures; and Mr Eldon J. Hardy, my longtime professional draftsman at Oklahoma State University, now retired. His drafting ability is unparalleled. He has redrawn the figures from the original and ensured that they are uniform, clear, and precisely done.

I am grateful to the publishers, Elsevier, including Michael J. Sugarman, Director, for accepting my book for publication, and Kelly D. Sonnack, Editorial Coordinator, for her help during the production of this book. Through my late father, Don Kirkham, former professor of soils and physics at Iowa State University, I have known of the venerable scientific publications of Elsevier since I was a child, and truly am "non solus" with a book.

M.B. Kirkham
Manhattan, Kansas.
April 6, 2004.

Preface to the Second Edition

The second edition results from an invitation that I received on April 22, 2013, from Elsevier/Academic Press to revise the first edition. The major changes in the new edition include the addition of three chapters: one on dual thermal probes to monitor soil–water content (Chapter 9); one on sapflow (Chapter 21); and one on interception of direct-beam solar radiation by leaves of plants (Chapter 30). The comments made in the Preface to the first edition hold for the second edition. These new chapters result from lectures that I give in my graduate class on soil–plant–water relations. They deal with principles and are not a review of the literature. As for the original chapters, I have ended the new chapters with biographies about the people who developed the concepts in the chapters.

In revising the book, I have interviewed experts on the topics—i.e., Loyd R. Stone about tensiometers (Chapter 5); Gerard J. Kluitenberg about the dual thermal probe technique (Chapter 9); and Kevin P. Price about drones (Chapter 27). I thank each of them for sharing their knowledge with me.

Based on a suggestion of one of the reviewers, I have kept all of the original chapters (27 of them). Changes made in the original chapters, based on comments from the reviewers, are the following: a reorganization of the order of the chapters; a shortening of some of the titles; and an addition of the history of the concept of the soil–plant–atmosphere continuum (added to Chapter 22). Other additions include the following: a problem showing how to convert grams to slugs (Chapter 2); Helmholtz's equation for calculation of the acceleration due to gravity (Chapter 4); a problem showing how to determine soil water content with time domain reflectometry probes (Chapter 8); a discussion of the least limiting water range (Chapter 10); a biography of Katherine Esau (Chapter 15); notation of the continuing controversy about the cohesion theory (Chapter 20); a discussion of the normalized difference vegetation index (Chapter 27); and an analysis of the effect of elevated carbon dioxide on water-use efficiency (Chapter 29).

I express my appreciation to the following people who have helped make this new edition possible: Candice Janco, Senior Acquiring Editor of Elsevier/Academic Press, for inviting me to revise the first edition; Sean R. Coombs, Editorial Project Manager, Elsevier, Inc. Science and Technology Books, for his prompt and kind help throughout the revision; Brent E. Clothier and Steven R. Green, both of the Systems Modelling

Group, The New Zealand Institute for Plant and Food Research, Ltd., Palmerston North, New Zealand, for figures provided in the chapter on sapflow (Chapter 21); Soil Measurement Systems, Tucson, AZ, for providing figures of tensiometers (Chapter 5); Eldon J. Hardy, my longtime professional draftsman, for redoing the population figure (Chapter 1); and Marsha K. Landis, Graphic Designer and Web Manager, Kansas State University, for taking pictures of equipment shown in the new edition. I also want to give special thanks to the three reviewers of the draft proposal, who supported publication of the revised edition: Bingru Huang, Professor II, Department of Plant Biology and Pathology, Rutgers University, New Brunswick, NJ; William L. Kingery, Professor and Graduate Coordinator, Department of Plant and Soil Sciences, Mississippi State University; Mississippi State, MS; and Anvar R. Kacimov, Professor and Dean, College of Agriculture and Marine Sciences and Head of the Department of Soils, Water and Agricultural Engineering, Sultan Qaboos University, Al-Khob, Sultanate of Oman.

As for the first edition, I dedicate the second edition to my family whose support made the book possible.

M.B. Kirkham
Manhattan, Kansas.
January 1, 2014.