

Properties and Management of Soils in the Tropics

The long-awaited second edition of the classic textbook expands on the first edition to include advances made in the last four decades, bringing the topic completely up-to-date. Written from agronomic and ecological standpoints, the book reaches beyond soil science to consequential issues such as food security, poverty and health in tropical countries, climate change, biodiversity, water, and other ecosystem services that soils provide. New chapters in this second edition include coverage of soil organic carbon and soil biology. The wrap-up chapters integrate the various aspects of soils in relation to slash-and-burn agriculture, wetland rice, livestock, forestry and agroforestry. The new edition will again be the go-to textbook for courses on tropical soils, and a reference textbook for soil and agricultural scientists and development professionals working in the tropics.



PEDRO A. SANCHEZ'S name is almost synonymous with the topic of tropical soil science. His work has influenced research in agronomy and ecology, and has changed the way technology and policy are used to increase food production in environmentally sustainable ways. He is Pre-eminent Research Professor of Tropical Soil Science at the University of Florida. Sanchez spent 50 years alternating between US universities and research centers of the Consultative Group for International Agricultural Research (CGIAR). He is the first soil scientist to receive the World Food Prize, a MacArthur Fellowship (genius award), and membership of the US National Academy of Sciences.

“This long-awaited, magnificent new edition of the world’s best-known book on tropical soils could not have arrived at a better time. Beautifully adorned with abundant color figures, and holistic in its thoroughly updated treatment of topics ranging from fundamental soil science to agricultural management, this book is a must for anyone interested in the current and future status of our increasingly fragile tropical environments. *Properties and Management of Soils in the Tropics* offers its readers not only an encyclopedic perspective, but also the insight distilled from a lifetime dedicated to the eradication of global hunger.”

Garrison Sposito,
University of California at Berkeley

“The voluminous data, graphs, and photos synthesized from extensive citations of scientific publications are invaluable resources for any person seeking information on the diverse environmental conditions within the tropics. The identification of where and why specific management practices are applicable to different areas within the tropics serves to guide future research. The reader is also availed of candid observations by an author who has ‘been there and done that.’”

Stanley W. Buol,
North Carolina State University

“This is a fascinating book which surpasses the classic first edition by being so much more than a book about soils. All the necessary expert knowledge is there, but it is embedded in an insightful analysis of the wider environmental and social context. Few people are more convincing than Professor Sanchez about the importance of this truly critical resource – so often taken for granted – our soil.”

Louise Fresco,
Wageningen University

“Professor Sanchez herein contributes a second edition to his already classic text *Properties and Management of Soils of the Tropics*. The update is an even more comprehensive and detailed view of management of soils of the tropics that is unlikely ever to be matched. The book represents a true classic for practitioners and scholars alike. It depicts a journey of nearly 50 years of learning experiences with managing soils of the tropics in a variety of production systems. Some personal experiences are shared in gripping detail. The new edition even improves on the first edition in terms of quality graphics, photographs, and depictions of the diverse systems detailed. Thank you, Pedro!”

Russell Yost,
University of Hawai‘i at Manoa

“I want to congratulate you on what will become a best-seller. You have handled soil science in the most comprehensive way possible, something that only you – with your international experience and writing ability – could do.”

Alfredo Scheid Lopes,
Universidade Federal de Lavras, Brazil

“This long-awaited new edition of the ‘classic’ on tropical soils turned into a very comprehensive document, taking the reader on a long but exciting journey from the pre-Green Revolution era to current multidisciplinary approaches to rural development in the tropics, while keeping the obvious focus on soil issues. Yet this is presented within a context of MDGs and other currently debated topics such as conservation agriculture, soil carbon sequestration and organic agriculture in the tropics. The author does not shy away from taking positions in all of these debates, based on his unique experience and a large dose of common sense which lifts the impact of this book beyond the purely disciplinary. Hence, it is obligatory reading for all those involved in agricultural development and will serve as a solid reference text for students in these or related disciplines.”

Roel Merckx,
Catholic University of Leuven

Properties and Management of Soils in the Tropics

Second Edition

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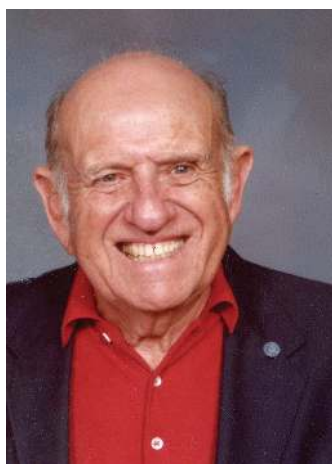
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Dedication

I dedicate this book to the four persons who have been most instrumental in my professional career:



My father Pedro Antonio Sanchez Diaz (1911–2000) who taught me the love of soils and agriculture while growing up in Cuba.



Dr. Nyle C. Brady (1920–2015) my professor at Cornell who mentored me as an undergraduate, graduate student and young scientist, and later provided keen advice to navigate administrative hurdles when I was Director General of the International Centre for Research in Agroforestry (ICRAF), having himself served as Director General of IRRI.

Dr. Stanley W. Buol, professor of soil science at North Carolina State University, who taught me more about soils while travelling with him all over the tropics than I learned during my formal education.



Dr. Cheryl A. Palm, currently professor at the University of Florida and partner for over a quarter of a century, who taught me soil biology and ecology, conducted research together in Africa, Asia and Latin America, and developed multidisciplinary initiatives. She is my fiercest scientific critic and a loving and much loved wife. This book would not exist without her constant support.

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Foreword

The second edition of the book, *Properties and Management of Soils in the Tropics*, by Pedro A. Sanchez, comprehensively addresses soils of the tropics in relation to their properties, eco-region, land use, agronomic practices, ecosystem services and environmental issues. The second edition, published 40 years after the first edition, in 1976, contains updated data which have been vastly improved in all aspects: classification, chemical and nutritional properties, physical and hydrological attributes, biological and elemental transformations, carbon cycling and climate change, etc. Yet, the original focus of the book, an agronomic management for crop and livestock production, is maintained and vastly expanded by including the updated information on ecosystem services and cultural practices such as conservation agriculture, livestock and agroforestry. Description of the subject matter is authentic and credible because of the vast personal experience of Professor Pedro Sanchez in diverse soils and eco-regions of Asia, South America and Africa as a scientist, academician and research manager. In addition to the data presented as graphs and tables, several key issues are vividly explained by color photographs of soils, soil profiles, landscape and management systems.

For a career spanning over 50 years, Professor Sanchez has been an active and a distinguished participant in World Congresses and other activities of the International Union of Soil Sciences. He is widely recognized for his scientific contributions to sustainable management of soils of the tropics. I have personally known his research since the early 1970s and visited several of his long-term experiments including those at Yurimaguas in Peru, and the Llanos of Colombia. Similarly to the first edition, the second edition of the book will also be widely used by students, researchers, land managers, development organizations, non-governmental organizations and the general public. The knowledge presented herein will be useful to soil scientists, policymakers, agriculturalists and land-use planners.

November 20, 2017

Rattan Lal

President, International Union of Soil Sciences

Preface

It is not common when the second edition of a book is published more than four decades after the first one. The need for a tropical soils book became apparent to me while teaching an undergraduate course in soil fertility at the University of the Philippines in the mid 1960s. Students experienced difficulties in relating to maize–soybean agriculture in much younger soils of northern latitudes – so unlike soils that were growing flooded rice and coconuts in their country. The first edition, published in 1976, brought the application of soil science principles to tropical examples. The book was translated into Spanish in 1981 and Bahasa Indonesia in 1992, and a pirated English edition was published in the Philippines. The first edition was rated as one of the top ten core monographs in soil science in 1994.

Since the 1970s, research on tropical soils has mushroomed all over the tropics, conducted by many national and international institutions, with an increasing number of them published in peer-reviewed journals and books. The practical implications of such research formed a major part of the large increases in food production that the tropics have experienced in the last decades, as well as a much better understanding of the ecology of tropical systems.

I was regularly requested to write a second edition by scientists and practicing agronomists from multiple parts of the world, but research in Peru, Brazil, and later in Indonesia and Africa, plus managing the World Agroforestry Center (ICRAF), the United Nations Millennium Hunger Task Force and the Millennium Villages got in the way of writing. Nevertheless, I was able to conduct and oversee research, write review articles, supervise graduate students and post-doctoral students and collect a large amount of publications in hard copy and, nowadays, electronically. I was also able to work and travel in all areas of the tropics – the humid tropics, subhumid, semiarid and arid tropics, the tropical highlands and wetlands, in addition to North America and Europe, and also China.

The first edition was purely agronomic. By joining the Tropical Soil Biology and Fertility Program in the mid 1980s, and subsequently working with my partner Cheryl Palm, I learned tropical ecology as applied to soils. This edition encompasses both agronomy and ecology, addressing the ecosystem services that soils provide, not only food and

nutrition security but also the regulation of climate, water, and nutrients, and the preservation of biodiversity. Now that soils are given more attention by the general public, the book now reaches out to other disciplines, such as economics, climate science, policy and plant genetic improvement. One could call this edition “soils plus.” Like the first one, this edition requires knowledge of an elemental soil science course.

With this broader exposure, soil science has become controversial, with issues like organic farming, use of fertilizers, biochar, etc. I have put these controversial issues through the prism of science, while respecting the values of their advocates.

Sustainability is a term that is often abused. To me, sustainability has to have a temporal dimension and to be trajectory in order to be meaningful. Hence, the emphasis on soil and plants changes with time.

The book follows the structure of the first edition, but with different chapters. Part One is introductory, dealing with the natural and human environment of the tropics in two chapters. Part Two describes the properties and processes of soils in terms of pedology, soil physics, chemistry and biology in nine more chapters. Part Three focuses on soil fertility with four chapters, and Part Four the management of soils in terms of four major systems – slash-and-burn agriculture, wetland rice, livestock-based systems and tree-based systems. I was fortunate to do long-term research on these key systems: slash and burn in Peru, Brazil, Indonesia, and Cameroon; rice in the Philippines and Peru; livestock in Colombia, Peru, Brazil and Africa; and tree-based systems throughout tropical Africa, Latin America and Southeast Asia.

I have taken a more personal – and less stuffy – tone, minimizing jargon and also eliminating the spurious accuracy of many ways of expressing units, to make the book more readable to non-scientists, without compromising science quality. I have listed all co-authors in the list of references, to give credit to all involved in each publication.

Pedro A. Sanchez
Gainesville, Florida
December 2018

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I wish to acknowledge the help of many individuals who have aided in the preparation of this book. To my colleagues around the world, I am grateful for their incisive questions and criticisms of the concepts and examples presented. For reviewing the various chapters, I am indebted to Miguel Ayarza, Stanley Buol, Eduardo Caires, Achim Dobermann, Peter Grace, Peter Groffman, Upmanu Lall, JK Ladha, Johannes Lehman, Alfredo Lopes, Jerry Melillo, Roel Merckx, Meine van Noordwijk, Generose Nziguheba, Keith Paustian, Cheryl Palm, Shelby Riskin, Robert Scholes, Mike Swift, Raymond Weil and Russell Yost. When I had specific questions I reached out to a large number of colleagues by phone or email and have credited their advice as personal communications. I wrote every word in this book and take responsibility for any errors.

I am very grateful to my support staff, which allowed me to focus on the writing. Mary Pasquince, Roseline Remans

and Clare Sullivan helped search the literature and supplied me with pdfs; Philip Fitzgerald made the graphs and photos presentable; Raffaella Kozar copy-edited; Maria Ortiz compiled materials sent to the publisher, all of them in most effective and professional ways.

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