Soils

An introduction to soils and plant growth

Fourth Edition

Donahue Miller Shickluna

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An introduction to soils and plant growth

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Roy L. Donahue

Professor Emeritus, Michigan State University
Consultant on Soils, Agriculture, and Environmental Sciences,
Midwest Research Institute

Raymond W. Miller

Department of Soil Science and Biometeorology,
Utah State University

John C. Shickluna

Department of Crop and Soil Sciences,
Michigan State University

Editorial assistance
Joyce U. Miller

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Preface

This fourth edition of *Soils: An Introduction to Soils and Plant Growth* has been completely rewritten to engender a greater awareness of the soil—an essential and largely nonrenewable world resource.

The book is written as an introduction to soil science for the student at all levels, emphasizing an easily understandable text and including details for further study, an extensive Glossary, and a list of conversion tables. General principles and concepts are illustrated by specific examples and visual aids.

Rapidly changing technology and human needs have had a great impact on use of the land. Farms have become larger, equipment larger and more sophisticated, more land is needed for waste disposal, and federal regulations are more restrictive in the use of land as it affects water and air pollution.

The serious problem of maximizing production on a variety of soils has prompted the inclusion of three new chapters and extensive rewriting of most others. New chapters are *Saline and Sodic Soils and Their Reclamation*, *Soils Requiring Unusual Management*, and *Soils, Food Production, and World Population*. The increasing need for wise water management is recognized by extensive and enlarged coverage of the chapters on *Soil Water* and *Water Quality and Irrigation*. *Soils and Plant Nutrition* and *Fertilizers and Their Use* have been rewritten to make them more descriptive and current. Overall, there is a new emphasis on soil ecology, environmental quality, and soil surveys as a basis for wise land use. New also are metric units in parenthesis following all U.S. units of weights and measures.

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Dr. Juhani Päivänen, Dept. of Peatland Forestry, University of Helsinki, Unioninkatu 40 B, 00170 Helsinki 17, Finland.

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Dr. Roy L. Donahue, Route 1, Box 169, Forsyth, Missouri 65653.

Dr. Raymond W. Miller, Professor of Soil Chemistry, Department of Soil Science and Biometeorology, Utah State University, Logan, Utah 84322.

Dr. John C. Shickluna, Professor of Soil Science, Department of Crop and Soil Sciences, Michigan State University, East Lansing, Michigan 48824.

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Soils: an essential world resource

1:1 Historical soils and plant science

> *Soil, in its traditional meaning, is the natural medium for the growth of land plants, whether or not it has developed discernible soil horizons . . . in this sense soil has a thickness that is determined by the depth of rooting of plants.*[1]

All sciences, including soil science, are changing as people explore the oceans, new lands, and the planets. Yet the best soil scientists are in agreement that soil comprises the few feet of the earth's surface that influence and have been influenced by plant roots. The careful preservation of this soil mantle can be the difference between a prosperous society and poverty.

Early scientists were curious about what items growing plants needed. The search was to identify the plant nutrients and how to improve the soil's ability to supply them. Not until 1860 (Hilgard in Mississippi) and 1870 (V. Dokuchaiev in Russia) was soil considered worthy of detailed study in its own right. Finally, soil rather than plants began to receive the major interest of many scientists who were geologists, not agriculturalists or chemists.

1:1.1 The earliest records

Even before humans began to record history, the value of water to plants was recognized. Extensive evidences of ancient canals and aqueducts (canals for water) occur in the "Old World." Sumerian (Mesopotamian) irrigation works existed in about 3500 B.C. Minoans on the island of Crete in approximately 2000 B.C. had paved highways, sewer systems, drainage systems, and aqueducts

[1]Soil Survey Staff, *Soil Taxonomy: A Basic System of Soil Classification for Making and Interpreting Soil Surveys*, USDA—Soil Conservation Service Agriculture Handbook No. 436 (December 1975), p. 1.

to rival those of the Romans 1,800 years later (Fig. 1–1).[2] At about 1000 B.C., the Phoenicians of Lebanon were cutting the famous Lebanon cedar forests to send to King Solomon, leaving a present-day heritage of denuded and eroded rocky barrens. Remnants of their rock-wall terraces built to hold the soil 3000 years ago still exist and are in use today.

Hammurabi of Babylon in the 18th century B.C. left descriptions of brick-lined canals having asphalt mortar and of an irrigation system encompassing 10,000 square miles (25,900 sq km)(the size of Vermont), which supported about 15 to 20 million people.[3] The same area, now known as Iraq, supports only one-fourth as many people as in the days of its "hanging gardens." Through the centuries of changes and conquests, the canal system was abandoned. The silt that clogged the canals during periods of disuse was no longer removed. Walter Lowdermilk, a U.S. scientist touring the world for concepts on soil conservation in 1939, reported crossing 98 abandoned canals in a distance of 106 miles (171 km). Their banks were piled with mounds of soil 30 to 50 feet (9 to 15 m) tall, piled there by canal cleaning.[4]

[2]Vernon Gill Carter and Tom Dale, *Topsoil and Civilization* (Norman: University of Oklahoma Press, 1974).

[3]Ibid.

[4]Ibid.

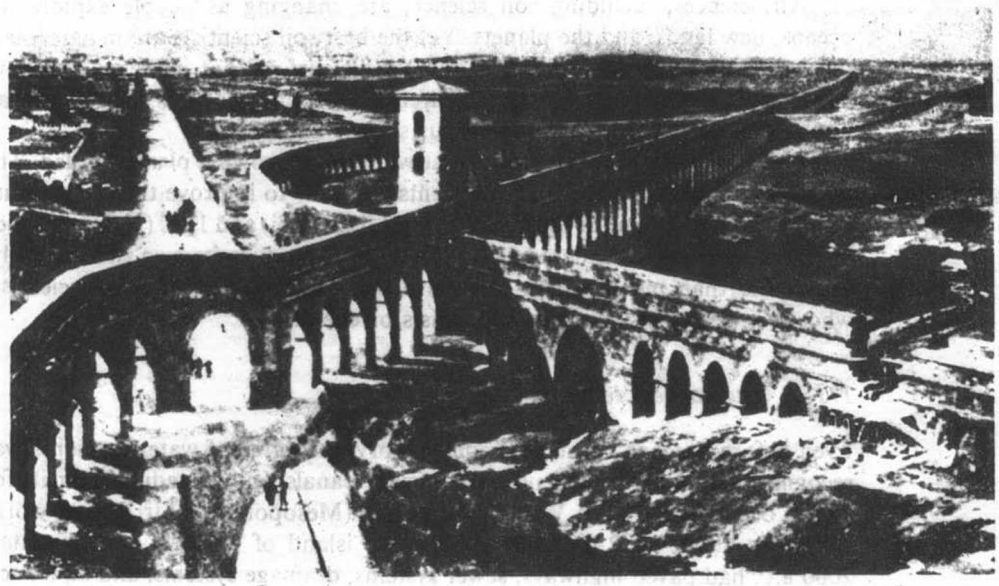


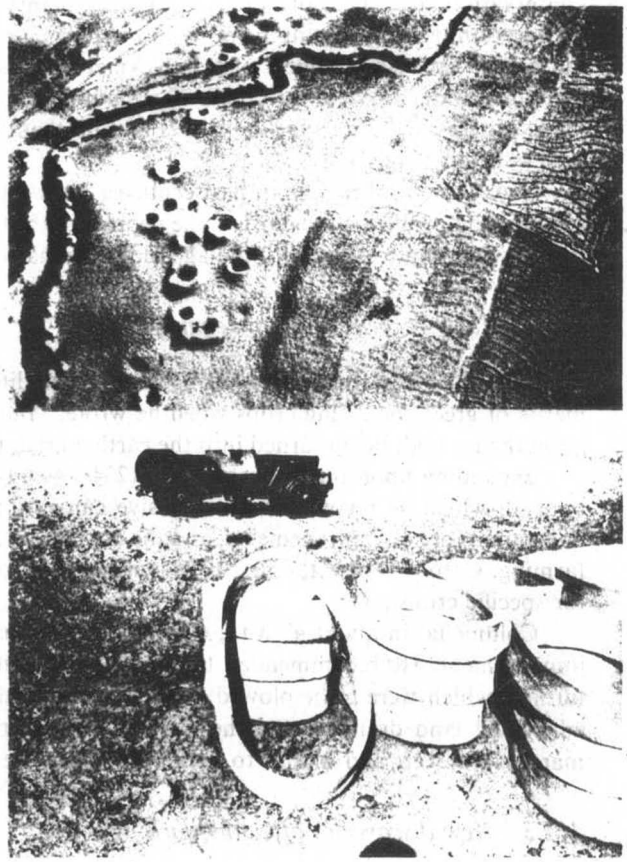
Fig. 1–1 A Roman aqueduct (by the painter Zemo Diemer, the original now in the German Museum in Munich). Many remnants of the aqueducts remain to furnish information on the shape, size, and extent of the Roman systems. (*Source:* By permission from *Arid Lands in Perspective*, William G. McGinnies and Bram J. Goldman, eds., Tucson: University of Arizona Press, copyright 1969.)

The unusual horizontal wells of Iran, which are underground tunnels, are constructed to intercept aquifers (water-bearing substrates). These ***qanats***, built also in Spain, Syria, Iraq, and Pakistan, have many access holes to the surface along their length.[5,6] *Qanats*, invented by the Persians in 3000 B.C., are still in use in present-day Iran (Fig. 1–2). Over 22,000 *qanats* with 167,770 miles (270,000 km) of underground conduits supply about 75 percent of Iran's presently used irrigation water.[7] The underground tunnels conserve the water from the evaporation losses that surface aqueducts would suffer in the hot arid climate.

[5]H. D. Wulff, "The Qanats of Iran," *Scientific American*, 218 (1968), 94–101.

[6]William Graves, "Iran—Desert Miracle," *National Geographic Magazine*, 147 (1975), 2–47.

[7]Carter and Dale, *Topsoil*.



(a)

(b)

Fig. 1–2 Ancient civilizations developed unique ways to get water from below the ground. Underground tunnels (*qanats*) tapped the water-carrying strata. Access holes to the soil surface needed to be frequent (a), and sometimes the tunnels needed reinforcement (b). Near Shiraz, Iran. (Photos courtesy Bruce Anderson, Utah State University.)