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Moonisa Aslam Dervash · Abrar Yousuf ·
Mohammad Amin Bhat · Munir Ozturk

Soil Organisms

Deciphering the Life Beneath Our Feet

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Moonisa Aslam Dervash • Abrar Yousuf
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Moonisa Aslam Dervash
Punjab Agricultural University
Regional Research Station
Ballowal Saunkhri, Punjab, India

Abrar Yousuf
Punjab Agricultural University
Regional Research Station
Ballowal Saunkhri, Punjab, India

Mohammad Amin Bhat
Punjab Agricultural University
Regional Research Station
Ballowal Saunkhri, Punjab, India

Munir Ozturk
Faculty of Science
Ege University
Bornova, Izmir, Türkiye

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Dedicated to "Our Parents, Teachers, and Alma Maters"

Foreword

This book, "Soil Organisms: *Deciphering the Life Beneath Our Feet*," offers an extensive exploration of soil biology, ecology, and its intricate interactions with human activities. The journey begins with an introduction to soil organisms, emphasizing their resilience and vulnerability to ecological stress. These organisms are crucial in maintaining soil structure, fertility, and ecosystem services, acting as bioindicators of soil health. Amid the challenges of feeding a growing population, the chapter underscores the negative impact of agrochemicals on soil biota and advocates for sustainable practices like biodynamic agriculture to preserve soil health and biodiversity. It also highlights the importance of natural networking systems and ecosystem cybernetics for sustainable ecology, calling for conservation strategies and biological soil remediation to protect and restore fertile soils.

The chapter 1 delves into the diversity of soil biota, from bacteria and fungi to earthworms and small mammals, each playing a vital role in maintaining soil health and ecosystem functioning. Chapter 2 stresses upon the critical ecosystem services provided by soil biodiversity, such as nutrient cycling and carbon sequestration, and the threats posed by pollution and intensive agriculture. Conservation efforts are deemed essential for protecting soil biodiversity and ensuring sustainable agriculture and food security.

The concept of soil stress ecology is then examined in Chapter 3, focusing on how various stressors affect soil ecosystems and their subsequent impact on plant and microbial communities. Understanding these dynamics is vital for enhancing soil health, agricultural productivity, and environmental sustainability, urging the maintenance of soil ecosystem balance amid natural and anthropogenic pressures. On the other hand, the agricultural industry, while crucial for global food production, presents significant challenges to soil biota. Chapter 4 discusses the dual impact of agriculture on soil ecosystems, highlighting the need for integrated approaches that balance productivity with sustainability, conservation, and social equity.

Bioindicators are explored as essential tools for monitoring soil pollution, with plants, soil microorganisms, earthworms, and other indicators providing sensitive responses to changes in soil quality. The importance of these bioindicators in

maintaining soil health is emphasized in Chapter 5, offering valuable insights for detecting and mitigating soil pollution. The book also addresses the role of microbes in organic farming in Chapter 6, highlighting how traditional practices and sustainable strategies can combat the detrimental effects of modern agriculture. The emphasis is on fostering soil health and productivity through microbial activity, paving the way for a more sustainable and regenerative food system.

The concept of the "fungal internet" reveals the intricate networks of mycorrhizal fungi that connect trees and facilitate communication and resource exchange. Chapter 7 underscores the importance of these natural networking systems in maintaining ecosystem health and resilience, with practical insights into their functions and benefits. Biodynamic agriculture is presented as a holistic approach that views the farm as a self-sustaining ecosystem, promoting environmental sustainability and high biodiversity. Chapter 8 discusses the principles, methods, and benefits of biodynamic agriculture, as well as its challenges and future prospects.

The field of ecosystem cybernetics is explored, detailing how soil organisms contribute to nutrient cycling, energy flow, and feedback mechanisms within ecosystems. The interconnectedness and emergent properties of ecosystems are emphasized in Chapter 9, along with the challenges and future directions of this scientific discipline. Finally, the book discusses soil remediation, particularly biological approaches like bioremediation, which utilize living organisms to restore contaminated soil. The role of hyperaccumulator plants, microorganisms, and fungi in mitigating pollution and enhancing soil health is highlighted. Chapter 10 also examines regulatory frameworks and the concept of a circular economy in addressing soil pollution and promoting sustainable land management practices.

In summary, "Soil Organisms: *Deciphering the Life Beneath Our Feet*" provides a profound understanding of soil ecosystems, their critical roles, and challenges and opportunities in soil management. It calls for a shift action toward more sustainable and regenerative practices to ensure the health and productivity of our soil for future generations. The authors have invested significant effort and dedication into crafting this comprehensive and novel volume on soil organisms. By meticulously researching and compiling the latest scientific insights, they have illuminated the fascinating and complex world beneath our feet. Their work not only highlights the critical roles soil organisms play in maintaining ecosystem health but also addresses the pressing challenges and opportunities for sustainable soil management. Through detailed analysis and thoughtful synthesis, this book offers a valuable resource for students, scientists, educators, and policymakers, fostering a deeper understanding and appreciation of the vital life forms that underpin our planet's ecological balance.

Former Professor, Centre of Research for Development G. A. Bhat
University of Kashmir,
Srinagar, Jammu and Kashmir, India

Preface

Soil biota is an important and fundamental part of terrestrial ecology. Soil organisms include all those life forms that pass a significant proportion of their life within a soil profile. The range of organisms may vary from microscopic entities to macro levels. These organisms are the hidden beauties that take up the tasks of food chain regulation, organic matter decomposition, and nutrient enrichment in soil. Soil organisms can be grouped into three classes: chemical engineers (bacteria, fungi, and protozoans), biological regulators (small soil invertebrates like nematodes and mesofauna), and ecosystem engineers (large soil invertebrates and small mammals). These creatures are mainly regulated by certain physical and biological factors. The physicochemical characteristics of soil can determine its biological diversity, which influences the regulatory services in an ecosystem.

There are innumerable economic values of soil biodiversity that can be quantified in terms of maintaining the soil structure and fertility, carbon flux and climate change alleviation, water cycle regulation, decontamination through bioremediation, and pest control. Soil organisms are part and parcel of soil ecosystems with each organism having its own respective niche that weaves the warps and wefts of biological world, pulling out a single creature from the soil environment, will drastically impact the delicate organization of food web.

In the present era of climate change, population explosion, and other environmental problems, there is tremendous pressure on these soil creatures. Soil pollution and environmental upheavals can result in inflation of the services extended by soils and, moreover, can result in the spread of soil-borne diseases to humans. Soil degradation, altered land uses, climate change, anthropogenic soil pollution, impetus given to genetically modified crops, and invasive species can have direct and indirect consequences on soil biology. In order to address the threats with potential solutions, it is mandatory to understand life beneath our feet by comprehending the biological dynamics and services.

The aim of this brief book is to showcase the mechanisms of biological dynamics of soil organisms at micro, meso, and macro scales. The introductory chapters of this book focus on understanding the faunistic diversity and its significance in soil, bioindicators in the assessment of soil quality, and consequences of various

anthropogenic stressors on soil, highlighting the eves and odds associated with agricultural industry vis-à-vis environmental pollution and possible influences on soil biota.

The succeeding chapters focus on the fungal internet, ecosystem cybernetics, and potential remedial technologies in terms of microbial organic farming and biodynamic agriculture for soil conservation, and the last chapter will focus on novel remediation strategies to deal with degraded soils.

This brief book will serve as a logical support for investigators with sufficient references for academicians, research scholars, and students. Researchers and connoisseurs shall find it a comprehensive manuscript regarding soil organisms, fulfilling the diverse needs of readers, staff in ministries, teaching staff, and researchers in this field.

Ballowal Saunkhri, Punjab, India — Moonisa Aslam Dervash
Abrar Yousuf
Mohammad Amin Bhat
Bornova, Izmir, Türkiye — Munir Ozturk

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