

# THE PLANT MICROBIOME IN SUSTAINABLE AGRICULTURE

EDITED BY

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# Table of Contents

[Cover](#)

[Title Page](#)

[Copyright Page](#)

[Preface](#)

[List of Contributors](#)

[About the Editors](#)

[1 Plant Microbiome](#)

[1.1 Introduction](#)

[1.2 Plant Microbiome](#)

[1.3 Approaches to Studying the Plant Microbiome](#)

[1.4 Microbiome and Agriculture in Past and Current Scenarios](#)

[1.5 Conclusion](#)

[Acknowledgments](#)

[References](#)

[2 The Plant Microbiome in Agricultural Sustainability](#)

[2.1 Introduction](#)

[2.2 Beneficial Microbes](#)

[2.3 Rhizosphere Microbiome](#)

[2.4 Effect of Host Genotype on Microbiome](#)

[2.5 Microbial Biotechnology in Agricultural Sustainability: The Role of Microbiomes in Plant Defense](#)

[2.6 Future Prospects of Microbiome-based Plant Breeding](#)

[2.7 Conclusion](#)

## References

### 3 Seed Microbiome and Its Implication in Plant Growth Promotion and Health

#### 3.1 Introduction

#### 3.2 Seed Structure

#### 3.3 Endophytes of the Seed

#### 3.4 Seed Microbiome

#### 3.5 Spermosphere

#### 3.6 Interactions of the Spermosphere with Microorganisms

#### 3.7 Treatment of Seed with Microorganisms

#### 3.8 Experimental Manipulation

#### 3.9 Synthetic Microbiomes

#### 3.10 Microbiome Engineering by Artificial Selection on Host

#### 3.11 Applications

#### 3.12 Conclusions

## References

### 4 Microbiome

#### 4.1 Introduction

#### 4.2 Effect of the Microbiome on the Plant System

#### 4.3 Factors that Affect the Holobiont

#### 4.4 The Functional Aspect of Microbiome on Its Host Plant

#### 4.5 Core Microbiome and Ecological Niche

#### 4.6 Developing the Immunity in Plants

#### 4.7 Current Application of Microbiome and Their Future Aspects

#### 4.8 Plant Fitness and Health Mechanism

[4.9 Plant-Microbe Communication](#)

[4.10 Plant and Soil Microbiome Engineering](#)

[4.11 Conclusion](#)

[References](#)

## [5 Ecology of the Diazotrophic Microbiome](#)

[5.1 Introduction](#)

[5.2 Different Modes of Nitrogen Fixation](#)

[5.3 Physiology and Biochemistry of Nitrogen Fixation](#)

[5.4 Genes Involved in Nitrogen Fixation and Its Regulation](#)

[5.5 Nitrogen Fixation in Termites](#)

[5.6 Nitrogen Fixation in the Aquatic Ecosystem](#)

[5.7 Nitrogen Fixation in the Terrestrial Ecosystem](#)

[5.8 Nitrogen Fixation in the Tropical Forest](#)

[5.9 Nitrogen Fixation in the Temperate Forest](#)

[5.10 Nitrogen Fixation in Crop Land](#)

[5.11 Genetic Modification of Crops for Nitrogen Fixation](#)

[5.12 Conclusions and Future Prospective](#)

[References](#)

## [6 Functional Microbiome for Crop Improvement Under a Changing Environment](#)

[6.1 Introduction](#)

[6.2 Current Climate Change and Its Impact on Agriculture](#)

[6.3 Crop Production Under Stressful Environment](#)

[6.4 Challenges in Microbiome Engineering](#)

[6.5 Conclusion](#)

## References

### 7 Agricultural Importance of Phyllosphere Microbiome: Recent Trends and Future Perspectives

#### 7.1 Introduction

#### 7.2 The World of the Phyllosphere

#### 7.3 Importance of the Phyllosphere

#### 7.4 Microbial Life in the Phyllosphere

#### 7.5 Phyllosphere Microbiome and Its Importance

#### 7.6 Structure and Function of the Phyllospheric Microbiome

#### 7.7 Factors Affecting Dynamics of the Phyllosphere Microbiome

#### 7.8 Application of the Phyllosphere Microbiome in Agriculture

#### 7.9 Current Trends and Future Perspectives

#### 7.10 Conclusion

## References

### 8 Microbial Consortia

#### 8.1 Introduction

#### 8.2 Microbial Consortia: Significant Explication for This Dilemma

#### 8.3 Microbial Consortia in Plant Health

#### 8.4 Microbial Consortia in Disease Suppression

#### 8.5 Engineering of Microbial Consortia

#### 8.6 Research Based Initiatives to Explore Microbial Consortia

#### 8.7 Conclusions

## References

### 9 Rhizomicrobiome for Sustainable Crop Growth and Health Management

[9.1 Introduction](#)

[9.2 Characteristics of the Rhizomicrobiome](#)

[9.3 Challenges and Future Research](#)

[9.4 Conclusion](#)

[Acknowledgments](#)

[References](#)

[10 Mycorrhizal Microbiome](#)

[10.1 Introduction](#)

[10.2 Mycorrhizal Networks](#)

[10.3 Biodiversity of Mycorrhizal Associations](#)

[10.4 Mycorrhizae As a Member of the Rhizosphere  
Microbiome](#)

[10.5 Mycorrhizae in the Plant-Soil System](#)

[10.6 Plant Productivity, Ecosystem Functioning,  
and Multifunctionality](#)

[10.7 Mineral Nutrients and Mycorrhiza](#)

[10.8 Factors Affecting AM Fungal Community  
Assembly](#)

[10.9 Carbon and Nutrient Cycling and Ecosystem  
Multifunctionality](#)

[10.10 Evolutionary Stability and Maintenance of  
Mutualism in Mycorrhizal Symbiosis](#)

[10.11 Mycorrhizal Competition with Disease  
Organisms](#)

[10.12 Role of Mycorrhiza in Plant Disease  
Management](#)

[10.13 Conclusion](#)

[References](#)

[11 Microbiome-Driven Nutrient Fortification in Plants](#)

[11.1 Introduction](#)

[11.2 The Microbiome Contribution to Plant Nutrient Fortification](#)

[11.3 Microbiome-Driven Rearrangement of Soil Structure and Enhancing Soil Exploitation for Plant Nutrient Supply](#)

[11.4 Microbiome-Driven Chemical Transformation and Nutrient Mobilization](#)

[11.5 Plant Microbiome Prospects and Limitations in Sustainable Agriculture](#)

[11.6 Conclusion and Perspectives](#)

[Acknowledgments](#)

[References](#)

[12 Engineering Microbes to Improve Crop Health](#)

[12.1 Introduction](#)

[12.2 Complexity of Soil and Its Ecosystem Functions](#)

[12.3 Plant Microbiome Interactions](#)

[12.4 Engineering Microbiomes for Plant-Beneficial Phenotypes](#)

[12.5 Engineering of Plant Microbiome for Crop Productivity](#)

[12.6 CRISPR/Cas9 Technology](#)

[12.7 Glimpses of Successful Microbiome Based Products](#)

[12.8 Implications for Agriculture: A Negative Note](#)

[12.9 Future Perspectives and Outlook](#)

[Acknowledgment](#)

[Conflict of Interest](#)

[References](#)

[13 Biotechnology of Plant-Associated Microbiomes](#)

[13.1 What Are Plant-Associated Microbiomes](#)

[13.2 Factors Influencing the Diversity and Structure of Plant Microbiomes](#)

[13.3 Roles of Plant-Associated Microbiome in Plant](#)

[13.4 Bioengineering Microbial Communities](#)

[13.5 Implication of Plant-Associated Microbiomes in Sustainable Agriculture](#)

[13.6 Conclusion and Future Perspectives](#)

[References](#)

[14 Microbiome Genomics and Functional Traits for Agricultural Sustainability](#)

[14.1 Introduction](#)

[14.2 Production/Improved Availability of Plant Nutrients](#)

[14.3 Disease Suppression Leading to Improved Plant Growth](#)

[14.4 Future Prospects](#)

[14.5 Conclusion](#)

[References](#)

[Index](#)

[End User License Agreement](#)

## **List of Tables**

Chapter 1

[Table 1.1 Some endophytic fungi isolated from different parts of the plants.](#)

[Table 1.2 Bioactive signaling for beneficial plant-microbe interactions.](#)



[Table 1.3 Microbial mitigation of abiotic stress tolerance in plants.](#)

## Chapter 2

[Table 2.1 Effect of the rhizosphere microbiome in crops.](#)

## Chapter 5

[Table 5.1 Rate of nitrogen fixation in different ecosystems.](#)

[Table 5.2 Major constituents of diazotrophic microbiomes in different ecosyst...](#)

## Chapter 8

[Table 8.1 Microbial consortia against plant pathogens.](#)

## Chapter 9

[Table 9.1 Typical numbers of soil organisms in different ecosystems and total...](#)

[Table 9.2 Similarities of the microbiomes of the human gut and plant roots \(B...](#)

[Table 9.3 Major community of organisms and functions in the rhizomicrobiome.](#)

[Table 9.4 The possible microbials between A organism and B organism interacti...](#)

[Table 9.5 Number of bacterial and archaeal taxa identified in the rhizosphere...](#)

[Table 9.6 Root exudates detected in higher plants \(Neumann and Romheld 2000\).](#)

[Table 9.7 Component and function of roots exudate \(Jones et al. 2004\).](#)

[Table 9.8 The contribution of beneficial microbes used as a biofertilizers \(S...](#)

[Table 9.9 Important plant growth promoting rhizobacteria \(PGPR\) \(Parmar and Du...](#)

## Chapter 13

[Table 13.1 Diversity of plant-associated microorganism communities.](#)

# List of Illustrations

## Chapter 1

[Figure 1.1 Plant microbiome structure, function, application, and their stud...](#)

[Figure 1.2 Components of the plant microbiome and its interrelations. SAR: s...](#)

[Figure 1.3 Graphical representation of the publications on different microbi...](#)

## Chapter 2

[Figure 2.1 Schematic diagram showing host plant root secretions that influen...](#)

## Chapter 3

[Figure 3.1 Basic tissue morphology of a plant seed.](#)

[Figure 3.2 Seed cotyledon and its different parts.](#)

[Figure 3.3 Endophytic region of the seed.](#)

[Figure 3.4 Different phases of growth and development of seed.](#)

[Figure 3.5 Assortment of microbial species inhabiting the tissues of the see...](#)

[Figure 3.6 Spermosphere of a seeds.](#)

[Figure 3.7 Microbes linked the developing spermosphere of a seed.](#)

[Figure 3.8 Diversity of endophytes in Marama bean seed.](#)

## Chapter 4

[Figure 4.1 The interaction of host plant with its inhabitant microbes at dif...](#)

[Figure 4.2 Pictorial representation of a holobiont.](#)

[Figure 4.3 The functional aspect of microbiome on its host plant; DAPG: 2,4-...](#)

[Figure 4.4 Factors that affect the holobiont.](#)

[Figure 4.5 Approaches for plant and soil microbiome engineering.](#)

## Chapter 5

[Figure 5.1 Types of nitrogen fixation.](#)

[Figure 5.2 Biochemistry of nitrogen fixation.](#)

## Chapter 6

[Figure 6.1 Microbiome for crop and soil management.](#)

## Chapter 7

[Figure 7.1 A schematic representation of different plant-microbe inter...](#)

[Figure 7.2 Different abiotic and biotic factors responsible for determining p...](#)

## Chapter 8

[Figure 8.1 Effect of microbial consortia on plant growth. \(a\) Control: No ad...](#)

[Figure 8.2 Effect of microbial consortia on disease resistance. \(a\) Control:...](#)

## Chapter 9

[Figure 9.1 The rhizosphere area consists of endorhizosphere, rhizoplane and ...](#)

[Figure 9.2 The diversity of the microbial community in the rhizomicrobiome....](#)

[Figure 9.3 The food web and energy flow \(arrows represent energy flow\) of th...](#)

[Figure 9.4 Schematic overview of microbial community interaction \(the good i...](#)

[Figure 9.5 A declining yield trend over a period of time under a consistent ...](#)

## Chapter 12

[Figure 12.1 Applications of microbiome engineering to improve crop health an...](#)

# **The Plant Microbiome in Sustainable Agriculture**

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## **Preface**

Global agriculture is facing a major challenge of ensuring sustainable and healthy food production for an ever exploding human population, while seeking to reduce adverse effects on the ecosystem. Recent reports indicate that factors like soil health (nutrients, water, and pH), vulnerability to diseases and pests, agronomic practices and climate change affect crop growth and yield. These factors are the prime cause of crop failure and decline in average yields.

The quest to harness the potential of useful microbes from different ecological niches have shown interesting outcomes in that microbiome plays an important role in growth and development of other living communities. Plants depend on their microbiome for multifarious life supporting activities including nutrient acquisition and augmentation of the defense system towards biotic and abiotic stresses. However, the process of crop domestication may have negative associations with the composition and function of the host associated microbiota, thereby limiting their advantageous effects on crop health and development. With major emphasis on agriculture, characterizing the plant microbiome and its function could be applied for better crop designing and management to grow crops in resource limited environments, and protect them from intruding pathogens. Unfortunately, at present, most of the breeding programs across the globe have not taken microbial action into account. Therefore, a deeper understanding of the interrelationships of the soil-plant-microorganism system is essential for improving the efficacy and potential applications of plant growth



promoting inocula for achieving sustainable food security and development.

Many of the laboratories working on plant growth-promoting rhizobacteria (PGPR) have reported that cocktails of useful bacteria in the form of synthetic communities are better than the single inoculants which face competition from other microorganisms and which could be killed or suppressed under suboptimal conditions. These findings clearly establish the importance of the microbial community in the well-being of crop plants. Now the researchers are focusing towards deciphering the microbial communities using next generation molecular approaches, and they are dominating the conventional methods. Modern molecular tools are utilized to recover the microbial information's links with different ecological niches. This information can be used to establish and maintain plant and human health, and finally to achieve comprehensive information of the plant microbiome that can be helped to improve agricultural production. In the past two decades, the plant microbiome has gained interest and crop performance is increasingly being recognized as the result of multipartite interactions. The huge gene pool of the microorganisms living in close association as endosymbionts and surface colonizers extends to the host genome and contributes to its phenotype. The studies clearly indicate that the totality of this genetic information in the form of the hologenome may allow adaptation of crops to diverse environmental conditions and interactions.

The present book provides a comprehensive review and compiled information on different aspects of plant microbe research with reference to its scope in the agriculture system which can be transformed by a complete understanding and application of the specific microbiota in a holistic manner. In the book, the chapters are contributed by active researchers having expertise in the domain.

Following an introduction to the specificities of microbiome research, modern tools and techniques to understand the plant microbiome are described. The updated information on the microbiome of different crops and cropping systems, followed by functional ecology and its potential for abiotic and biotic stress management, crop health and nutrient fortification, has been presented in different chapters. As they are of particular relevance for the future of agriculture in a sustainable manner, the biotechnological and molecular aspects of the translational microbiome are thoroughly covered across the book. Lastly, the relevance of the microbial community as the reservoir of novel genes and metabolites and as the key to green and clean agriculture have been discussed. This book will stimulate the readers to understand this complex subject in a lucid manner. It provides a path to researchers to address some of the contemporary issues before the scientific community, towards development of environmentally friendly and sustainable agriculture to meet the needs of our universe. With great pleasure, the editors acknowledge the efforts and contributions of expert authors, which were crucial for the quality of information provided.

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Dr. Alok Kumar Srivastava is a dedicated scientist in the area of molecular microbiology, presently working as Principal Scientist, ICAR-National Bureau of Agriculturally Important Microorganisms, India. He has made an outstanding and pioneering contribution in the area of Molecular Plant Pathology, contributed to structural,

functional and comparative genomics of agriculturally important microorganisms, pathogens, development of molecular diagnostic tools and biological control of important diseases. He successfully sequenced the whole genome of 15 AIMS, deciphered microbial communities of Leh, mangrove soil of Andaman, landfill sites, and saline soils through metagenomics. Dr. Srivastava is Ph.D. from Banaras Hindu University, India, and completed his post doc at Otto Warburg Centre of Biotechnology with Prof Ilan Chet, at The Hebrew University of Jerusalem, Israel. He has also visited several countries including Hungary, France, The Netherlands, and Norway. He worked as a visiting research scientist in the Department of Plant Sciences, McGill University, Canada in the year 2010. He has 31 years of research experience in the area of biological control of fungal pathogens and plant growth-promoting rhizobacteria (PGPRs) and has supervised eight PhD students. He has successfully completed several externally funded research projects from DST, DBT and other agencies of the Indian Government. He has published about than 130 research papers in journals of international repute, several review articles, edited three books, and has more than 2473 citations to his credit (H index-25, I<sub>10</sub> index 55). He is also associated with the capacity building program in the area of microbiology and has organized/participated in many training programs as a resource expert. Currently, he is associated with one of the mega network projects, "Application of Microorganisms in Agriculture and Allied Sectors (AMAAS)" of ICAR, India and is performing whole genome sequencing of important microorganisms. He is also providing molecular identification services for the microorganisms to be registered with the Central Insecticide Board and Registration Committee (CIB&RC) Govt. of India. His group is focusing on the management of abiotic stresses and soil

health through *Bacillus* and other predominant genera as PGPR, its capabilities related to soil fertility and plant nutrition mobilization, the production of bacterial phytohormones and solubilization of mineral phosphates, allowing them to inhabit diverse niches in agro-ecosystems. For further details of this work visit <https://scholar.google.co.in/citations?user=De5ciSsAAAAJ&hl=en>