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*Editorial*

# Metagenomic Analysis for Unveiling Agricultural Microbiome

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Microbial communities play crucial roles in sustaining agricultural ecosystems, influencing both crop health and productivity [1] (Figure 1). To foster sustainable agricultural practices and food production, it is vital to grasp and utilize the capabilities of the agricultural microbiome. Microorganisms, particularly bacteria and fungi in the soil, are pivotal in the cycling of essential nutrients like nitrogen, phosphorus, and potassium. They convert these elements into forms that plants can readily absorb, thereby directly impacting soil fertility and plant nutrition [2,3]. Soil microorganisms are also known to produce hormones and other biochemicals that promote plant growth. For example, specific taxa of rhizobacteria have been found to enhance root growth, thereby increasing a plant's ability to absorb nutrients and water [4,5]. Beyond growth, the microbiome serves as a protective agent against pathogens through various mechanisms including the production of antimicrobial compounds, competing for resources, and triggering plant immune response [6,7]. This biological control is instrumental in managing crop diseases and reducing dependency on chemical pesticides [8,9]. Moreover, microorganisms play a critical role in helping plants cope with abiotic stresses, such as drought, salinity, and extreme temperatures [10]. Diversity within microbial communities also contributes to the resilience of agricultural ecosystems, enabling them to maintain function under changing environmental conditions [11]. Such biodiversity is essential for robust agricultural systems that need to adapt to and mitigate the impacts of climate change.

Grasping the complex interactions and functionalities of microbial communities in agricultural environments is pivotal for advancing sustainable farming practices. Metagenomics, a cutting-edge technology that delves into the structure and composition of these communities, is radically enhancing our comprehension of the agricultural microbiome [12]. This approach facilitates a detailed characterization of microbial diversity and functionality, setting the stage for precise interventions aimed at maximizing the benefits of microbes in agriculture. This Special Issue, titled "Metagenomic Analysis for Unveiling Agricultural Microbiome", encompasses a series of 17 papers that explore the profound impact of microorganisms on various agricultural ecosystems. The research presented here highlights the essential role of the agricultural microbiome in several key areas:

Crop Management Innovations: The study by Wen et al. [13] showcases how paddy–*Lilium* crop rotation enhances beneficial fungal communities and alleviates soil acidification, demonstrating a sustainable practice to mitigate the adverse effects of continuous cropping on soil health. Li and colleagues [14] illustrate how co-ensiling cassava with corn stalk optimizes silage quality by modifying microbial community functions, which could significantly impact livestock feed efficiency.

Disease Dynamics and Plant Health: In the research by Muñoz-Ramírez et al. [15], the dynamics of microbial communities in the rhizosphere of both symptomatic and asymptomatic apple trees are explored, highlighting how shifts in microbial populations can influence plant health and disease outcomes. The interplay between fungal communities



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and pathogen suppression is presented in the study on soybean and maize intercropping by Cheng et al. [16], where increased nitrogen-fixing bacterial diversity correlates with improved plant health. Luo et al. [17] demonstrate that dodder parasitism leads to the enrichment of pathogen Alternaria and flavonoid metabolites in soybean root.

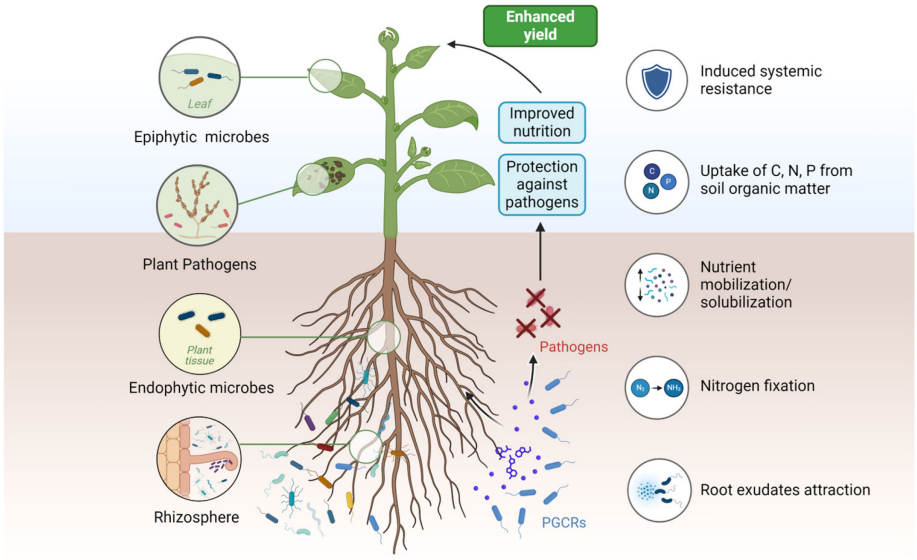


**Figure 1.** Relationships between plants and their surrounding microbial communities are pivotal in sustaining agricultural ecosystems. Microorganisms occupy various niches in relation to the plant, such as epiphytic microbes on leaf surfaces, endophytic microbes within plant tissues, and microbes in the rhizosphere, contributing to plant health and growth. These microbes facilitate nutrient absorption and utilization, and disease and pest resistance, thereby enhancing crop yield. The diversity of these microbial communities is crucial for supporting the overall health and productivity of crops. Created with BioRender.com.

Nutrient Cycling and Soil Health: Microorganisms are instrumental in transforming essential nutrients such as nitrogen, phosphorus, and potassium into bioavailable forms. This process is crucial for enhancing soil fertility and plant nutrition. A study by Ji et al. [18] on different fertilizer sources in maize cultivation shows how organic and inorganic fertilizers distinctly influence soil microbial communities, affecting nutrient cycling and availability. Zhou et al. [19] provide insights into how microbial community diversity under different manure treatments influences methane emissions in paddy fields, suggesting strategies to manage greenhouse gas emissions while maintaining soil fertility.

In conclusion, the contributions in this Special Issue underscore the transformative potential of metagenomic technologies in understanding and leveraging the agricultural microbiome for sustainable practices. These insights not only advance our scientific knowledge but also pave the way for practical applications that enhance crop production, protect plant health, and promote ecological sustainability. It is our hope that this issue inspires continued research and innovation, driving forward the integration of metagenomic insights into effective, sustainable agricultural practices. This Special Issue (https://www.mdpi.com/journal/agronomy/special_issues/S70BHD8E5H) (accessed on 1 December 2022) was closed on 31 December 2023, having been viewed 24,413 times. Due to the sustained interest from numerous authors in this topic and the continuous evolution of research, we have since launched "Metagenomic Analysis for Unveiling Agricultural Microbiome—2nd Edition" (https://www.mdpi.com/journal/agronomy/special_issues/YOQL5J6Y9F) on 1 April 2024. Contributions that advance the development of the field are warmly welcomed. We invite not only the submission of research on agricultural animals and plants [20] but also relevant systematic reviews [21] and analytical methods [22].

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