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Editorial for special issue "Microorganisms and food security under climate change scenarios: From taxonomy to host–microbe interactions"

Global food security represents one of the most pressing challenges of the twenty-first century. Rapid population growth, environmental degradation, and climate change are collectively exerting unprecedented pressure on agricultural systems and food production worldwide. According to recent global assessments, climate variability and environmental stressors are already affecting crop productivity, soil fertility, and the stability of food supply chains (FAO, 2024). In this context, microorganisms have emerged as fundamental yet often underappreciated players in the resilience and sustainability of agroecosystems. Microbial communities influence plant productivity, nutrient cycling, soil fertility, and disease dynamics, positioning them at the center of strategies to ensure food security in a changing climate.

Climate change is expected to alter temperature regimes, precipitation patterns, and the frequency of extreme climatic events, all of which have direct and indirect effects on microbial communities and their ecological functions. These environmental shifts can modify microbial diversity, community composition, and metabolic activity across terrestrial and aquatic ecosystems. Because microorganisms regulate essential biogeochemical cycles including, carbon, nitrogen, and phosphorus cycling, changes in microbial dynamics can significantly affect the ecosystem stability and agricultural productivity. Indeed, microbial processes contribute substantially to greenhouse gas fluxes and therefore play a central role in climate feedback mechanisms (Singh et al., 2010). Furthermore, microorganisms both influence and respond to climate change, creating complex ecological feedback loops that shape the resilience of natural and managed ecosystems (Cavicchioli et al., 2019).

Recent studies have further highlighted the sensitivity of microbial communities to environmental change. Alterations in soil temperature and moisture regimes can shift the functional groups of microbes involved in nutrient cycling and plant health. Such shifts may alter the balance between beneficial microorganisms and plant pathogens, thereby influencing crop productivity and ecosystem resilience (Ibáñez et al., 2023). Moreover, changes in microbial biodiversity under climate stress may affect ecosystem services that sustain agricultural productivity, including soil carbon storage, nutrient mineralization, and plant stress tolerance.

At the same time, climate change presents new challenges for crop production and food safety. Rising temperatures and shifting environmental conditions facilitate the spread of plant pathogens and increase the incidence of plant diseases, potentially reducing crop yields and threatening global food supplies. Pathogen distribution patterns are expected to expand toward new geographical regions as environmental conditions become favorable for their proliferation (Bebber et al., 2014). Extreme climatic events such as droughts, floods, and heat waves can disrupt soil microbial communities and weaken plant–microbe interactions that are essential for stress tolerance. Consequently, climate change may intensify plant disease outbreaks and compromise the sustainability of agricultural systems.

Despite these challenges, microorganisms also offer promising solutions for developing climate-resilient agricultural systems. Beneficial microbes, including plant growth-promoting bacteria (PGPB), mycorrhizal fungi, and endophytic microorganisms, can enhance plant tolerance to abiotic stresses such as drought, salinity, and temperature. These microorganisms also enhance nutrient availability, hormone production, and pathogen suppression, thereby promoting plant growth and productivity under adverse environmental conditions. Increasing evidence indicates that the plant microbiome plays a key role in plant adaptation to environmental stress, mediating complex interactions that influence plant physiology and ecosystem stability (Vimal et al., 2022; Trivedi et al., 2023).

The rhizosphere microbiome, in particular, represents a highly dynamic interface where plants and microorganisms interact to regulate nutrient cycling, plant health, and soil fertility. Through mechanisms such as nitrogen fixation, phosphorus solubilization, siderophore production, and phytohormone synthesis, rhizosphere microorganisms can enhance plant growth and resilience in challenging environmental conditions. Advances in microbiome research have revealed that manipulating microbial communities through biofertilizers, microbial inoculants, or microbiome engineering may provide sustainable alternatives to chemical fertilizers and pesticides (Compant et al., 2023; Giri et al., 2025).

Recent advances in microbial ecology and genomics have greatly expanded our ability to explore and harness microbial diversity. High-throughput sequencing technologies, together with metagenomics and comparative genomics, have enabled researchers to uncover the vast diversity of uncultured microorganisms and characterize their functional potential in agricultural ecosystems. Taxonomic and phylogenomic approaches provide a foundation for understanding microbial diversity, while functional studies illuminate the mechanisms through which microbes influence plant health, soil processes, and food production systems. Integrating taxonomy with functional ecology and

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host–microbe interactions is therefore essential for developing microbial-based strategies that support sustainable agriculture.

In addition to promoting plant growth, microorganisms play an important role in the biological control of plant diseases. Biological control agents, including bacteria, fungi, and bacteriophages, offer environmentally friendly alternatives to chemical pesticides. These biological approaches reduce environmental impacts while maintaining agricultural productivity and food safety. For instance, phage-based strategies have attracted increasing attention as targeted tools for controlling bacterial phytopathogens without disrupting beneficial microbial communities (Haq et al., 2024). Similarly, beneficial bacteria from genera such as *Bacillus, Pseudomonas*, and *Streptomyces* have demonstrated strong potential as biocontrol agents against a variety of plant pathogens.

Beyond crop production, microorganisms are also critical for maintaining ecosystem services that underpin food systems. Soil microorganisms regulate nutrient cycling, organic matter decomposition, and carbon sequestration, processes essential to soil fertility and climate mitigation. In many ecosystems, microbial communities determine the stability and resilience of ecological networks that support agricultural productivity. Consequently, understanding how microbial communities respond to environmental change is a prerequisite for predicting and managing the impacts of climate change on food systems.

This Special Issue, **"Microorganisms and food security under climate change scenarios: from taxonomy to host–microbe interactions,"** aims to highlight the multifaceted roles of microorganisms in shaping sustainable food systems under rapidly changing environmental conditions. The contributions assembled in this issue explore microbial diversity, ecological functions, and host–microbe interactions across a range of agricultural and environmental contexts. By integrating approaches from microbial taxonomy, genomics, ecology, and biotechnology, these studies collectively provide insights into how microbial communities can be leveraged to enhance crop resilience, improve soil health, and mitigate the effects of climate change on food production.

Importantly, this Special Issue underscores the need for interdisciplinary research that bridges microbiology, agriculture, environmental science, and biotechnology. Addressing global food security challenges requires not only understanding microbial diversity but also translating this knowledge into practical applications such as biofertilizers, biocontrol agents, and microbial consortia designed for climate-resilient agriculture. Microbial technologies represent an important component of future sustainable agricultural systems and have the potential to contribute significantly to global efforts aimed at achieving sustainable food production while minimizing environmental impacts.

The articles included in this Special Issue illustrate the expanding role of microorganisms in promoting sustainable agricultural systems and advancing microbial biodiversity research. Several contributions focus on microbial-based strategies for plant disease management. For instance, the study on *Trichoderma yunnanense* TM10 provides new insights into the biocontrol mechanisms this fungus employs against *Fusarium oxysporum* f. sp. *cepae*, the causal agent of shallot wilt (*Allium cepa* var. *aggregatum*), highlighting the potential of beneficial fungi as environmentally friendly alternatives to chemical fungicides. Similarly, another contribution demonstrates the effectiveness of a native *Bacillus* strain (HC-9) in controlling honeysuckle leaf spot caused by *Alternaria alternata*, emphasizing the importance of exploiting locally adapted microbial resources for plant protection. In addition to applied research, this Special Issue also includes studies that expand our understanding of microbial diversity and taxonomy. Notably, the discovery of a novel *Nocardiopsis* species and a new subspecies of endophytic *Micrococcus* from the extreme ecological niche of the Indian Sundarbans mangrove forests highlights the vast and still underexplored microbial diversity present in unique environments. Collectively, these studies underscore the dual importance of microbial discovery and functional characterization for advancing sustainable agriculture, plant health, and microbial biotechnology. We hope that the research presented in this Special Issue will stimulate further interdisciplinary efforts to harness microbial diversity and ecological functions to address emerging challenges in agriculture and environmental sustainability.

Declaration of competing interest

The authors B. Román-Ponce and F. U. Rojas-Rojas declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

No data was used for the research described in the article.

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