Harnessing the plant microbiome: innovation towards sustainable agriculture and ecological resilience

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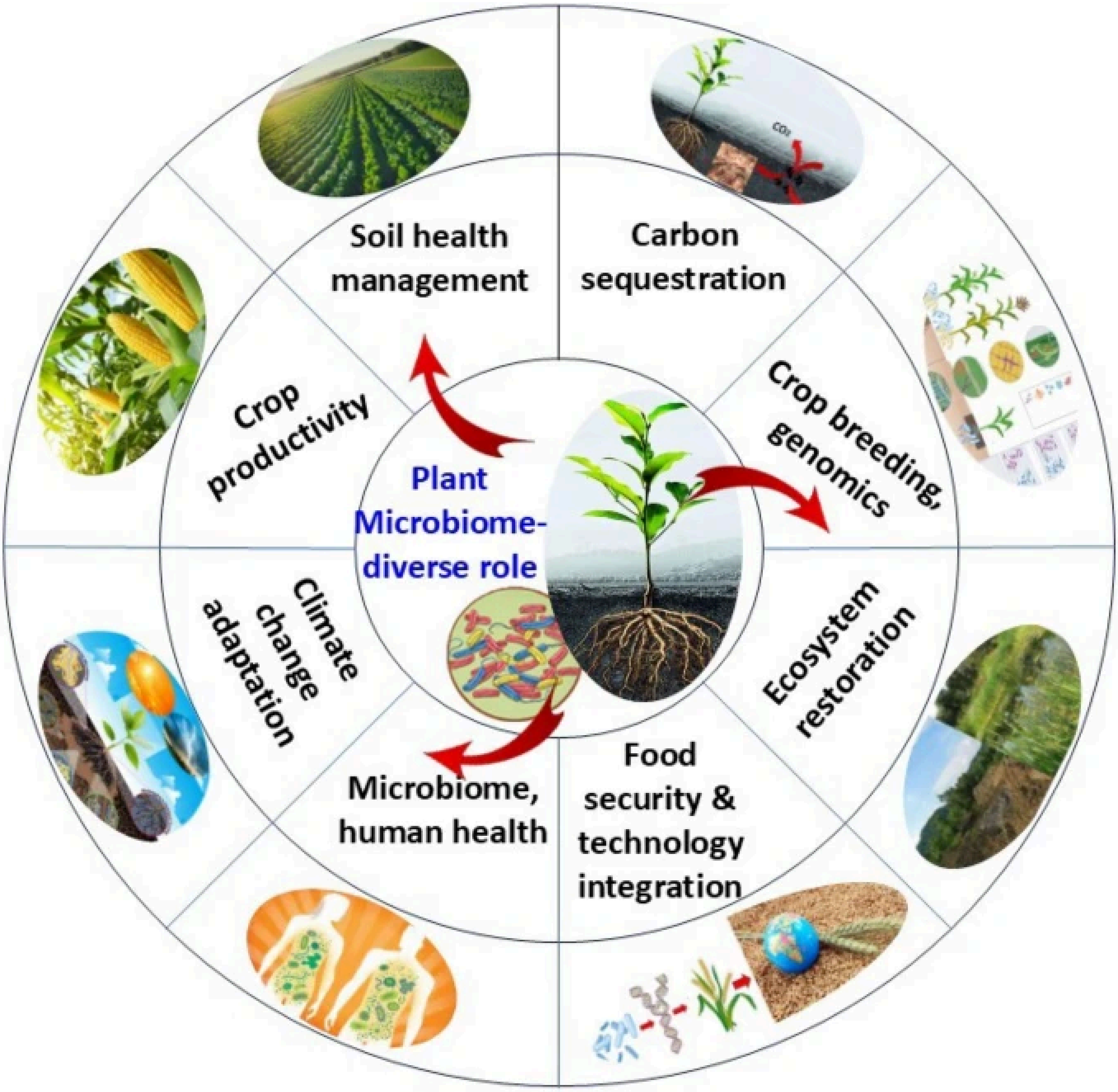
Antonie van Leeuwenhoek

Vivek Kumar & Chandra S. Nautiyal

Abstract

Assimilation of plant-microbiome synergism into contemporary sustainable approaches offers transformational prospective for augmenting crop production, and environment resilience. Efficient microbiome enhances nutrients acquisition, encouraging plant's growth, and mitigate diverse stressors. Synthetic microbial communities could be another strategy to augment crop yield by improving bioinoculants activity, regulating and reinstating microbial diversity. Long-term agricultural output depends on microbiome's intervened activities, such as nutrients acquisition, thereby lowering chemical fertilizers necessity. Microbes also contribute to climate change mitigation by endorsing soil carbon stowage and minimizing release of greenhouse gases via enhanced nutrients use efficacy. Developments in sustainable crop breeding and genomics have facilitated the recognition of plant traits and genetic loci that influence alliances of valuable microbes. Integration of plant-microbiome breeding tactics might lead to optimization of microbiome selection in plant varieties, thus improving yield and stress resilience. Such approaches will conserve biodiversity, restore ecosystem by nurturing functional microbiome population, supporting plant's diversity and soil health. Microbiome are also able to improve degraded soils recovery, plant's establishment, parallelly safeguarding ecosystem restoration. The integration of microbial technology in crops could enhance the nutritional value and safety of food while supporting environmental sustainability and human health. Understanding microbiome–plant–climate change interactions is critical for developing adaptive strategies that enhance resilience to environment and climate variability, ensure sustainable food systems, and promote ecological balance in a changing global environment.

Graphical Abstract



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Data availability

No datasets were generated or analysed during the current study.

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Author information

Authors and Affiliations

School of Biosciences, Swami Rama Himalayan University, Jolly Grant, Dehradun, 248016, Uttrakhand, India

Vivek Kumar & Chandra S. Nautiyal

Contributions

VK conceptualized the article, original draft preparation, and data curation; CSN reviewed, edited, and made final changes to the manuscript. Both the authors checked and certified the final article.

Corresponding author

Correspondence to Vivek Kumar.

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