

MICROBIOME ENGINEERING FOR SUSTAINABLE FRUIT CROP PRODUCTION IN INDIA: 4F BIOECONOMY MODEL

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ABSTRACT

One of the greatest challenges of Indian fruit production is meeting rising demand while reducing dependence on synthetic fertilizers and pesticides. Plant- and soil-associated microbiomes are now recognized as one of the important agents for improving soil health and fruit quality by enabling nutrient cycling, improving stress tolerance and helping in biological disease control (Nadarajah & Rahman, 2023; Kaul et al., 2021; Suman et al., 2022; Srivastava et al., 2021). A “designer” rhizosphere and phyllosphere communities that enhance productivity under biotic and abiotic stresses is offered by Microbiome Engineering—through targeted use of microbial consortia, host-mediated selection, and in situ manipulation (Nadarajah & Rahman, 2023; Kumar & Dubey, 2020; Mahmud et al., 2021; Kaul et al., 2021; Afridi et al., 2022).

The present paper highlights the latest concepts and tools in the plant microbiome engineering and incorporates them with fruit production systems in Indian context, emphasizing the importance of Integrated Soil Fertility Management (ISFM), organic and biofertilizer-based horticulture, and emerging “microbiome-driven cropping systems (Nadarajah & Rahman, 2023; Srivastava et al., 2021). The chapter synthesizes the mode 4 approach centred on (i) study of native fruit crop microbiomes, (ii) integrating beneficial microbes with in sustainable agricultural systems, (iii) co-optimization of host- microbe using omics and gene editing and (iv) farmer acceptable and accessible technology. Further, the chapter concludes with the research and policy priorities to mainstream microbiome engineering in climate-smart, resource-efficient Indian fruit production

KEYWORDS: *Plant Microbiome; Microbiome Engineering; Rhizosphere; Fruit Crops; India; Biofertilizers; Biocontrol; Integrated Soil Fertility Management (ISFM); Sustainable Horticulture; Omics; CRISPR; Mode 4 Agriculture.*

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