

Harnessing the power of the plant microbiome for environmental sustainability and protection

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While the human microbiome has proven to be important to our health, the plant microbiome may be essential for all plants. Though symbiosis with nitrogen-fixing *Rhizobium* species has long been known to provide required nutrients for plant growth, this plant-microbe partnership is limited to legume species such as beans and peas. However, a variety of other plant species in natural environments have similar beneficial microorganisms within them, termed endophytes (1). Tapping into this microbial resource has the potential for improving the environmental sustainability of agriculture, forestry, and bioenergy production. Endophytes were isolated from *Populus* plants growing in challenging environments. Some of the endophyte strains were able to fix atmospheric dinitrogen gas, thus providing the plant host with nitrogen fertilizer (2, 3). Some could solubilize phosphate, making this macronutrient that is normally locked up in soils now more bioavailable (4). Under drought conditions, the endophytes promoted host plant survival, reduced the stress response, and increased water use efficiency (5-7). Some endophyte strains have strong antimicrobial activities, inhibiting the growth of several major agricultural pathogens (8). Specific strains are able to degrade environmental pollutants (9-11). With the need to substantially improve production to meet the needs of a growing human population, and the increased stress of climate change, the implications of natural plant-microbe symbioses for agriculture, forestry, and bioenergy production are profound.

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