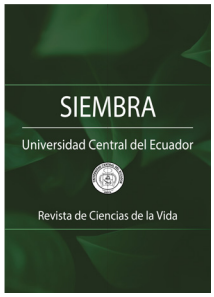
Dossier: Banana production, challenges and opportunities

Towards a regenerative biotechnology: The use of allied microorganisms for sustainable banana crops

Elisa Quiala Mendoza[1], Danilo Isaac Vera Coello[2]



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[1] Instituto Nacional de Investigaciones Agropecuarias, (INIAP), Estación Experimental Litoral Sur. Yaguachi. Km 26 Vía Durán-Tambo. Yaguachi, Ecuador.
✉ elisa.quiala@iniap.gob.ec
https://orcid.org/0000-0002-1593-7715
[2] Instituto Nacional de Investigaciones Agropecuarias, (INIAP), Estación Experimental Tropical Pichilingue. Km. 5 via Quevedo - El Empalme. Mocache, Ecuador.
✉ danilo.vera@iniap.gob.ec
https://orcid.org/0000-0002-2140-1554

The crop of bananas (*Musa spp*.) faces increasingly complex phytosanitary challenges, which arise from both aggressive pathogens (*Fusarium oxysporum fsp. cubense Mycosphaerella fijiensis and Ralstonia solanacearum*), and adverse environmental conditions exacerbated by climate change. Within this context, it is urgent to consolidate integrated strategies to strengthen banana resilience to these phytosanitary problems and, therefore, reduce their socioeconomic impact, especially in Latin America and, in Ecuador, in particular.

1. *Trichoderma spp*. as a biocontrol and biostimulation tool

The study of Terrero Yépez et al. (2025) showed that specific strains of *Trichoderma spp*. such as *T. lentiforme* F19 and *T. harzianum* F73, significantly reduce the severity of bacterial moko in plantain crops. While, simultaneously, they promote the growth in height, diameter and vigor of the plants. This dual role, both as a biocontroller and a biostimulant, positions *Trichoderma* as a pillar of integrated disease management.

2. Endophytic and mycorrhizal fungi: inoculants with transformative potential

Acaro Reyes and Cevallos (2025) conducted a comprehensive review of banana crop-associated fungi with biotechnological potential. Their approach highlights endophytic and arbuscular mycorrhizal species with proven positive effects on nutrient uptake and stress tolerance, which reinforces the value of technologies increasing both yield and sustainability, thus reducing dependence on agrochemicals.

3. Biological synergies for resilient agriculture

Both studies share a common vision: the banana microbiome represents a reservoir of natural solutions. The combination of *Trichoderma spp*. strains with endophytic mycorrhizal fungi can generate synergies strengthening banana resistance to diseases, improve nutritional efficiency, and favor adaptation to adverse conditions. Nevertheless, it is necessary to validate these interac-

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tions in the field, as well as to develop compatible and standardized protocols for their formulation.

4. Challenges for the adoption of sustainable technologies

The dominant production model in the banana agroindustry remains intensive and dependent on agrochemicals, implying negative impacts on health, the environment and access to differentiated markets. The biological alternatives described herebelow offer paths aligned with objectives of sustainability, food security and openness to organic markets. However, their implementation requires regulatory clarity, technical training, as well as dissemination strategies adapted to the socio-productive conditions of farmers.

5. Strategic priorities for research and public policy

To ensure sustainable, resilient and competitive production of crops such as bananas, it is necessary to focus on the development and adoption of biotechnological solutions, institutional strengthening and coordination among key stakeholders in this sector. Within this framework, the following strategic priorities are proposed:

- Establish collaborative research networks in order to measure the effectiveness of these microorganisms under field conditions.
- Develop standardized and replicable protocols for their production, mixing, and application.
- Promote public-private partnerships between universities, research centers, and agricultural institutions for the transfer of the technology generated.
- Invest in training programs aimed at farmers, associations, extension technicians, and academia, among others, integrating biological technologies within existing agroecological systems.

Conclusion

The articles included in this dossier highlight that biotechnology based on the use of microorganisms, and in particular the use of *Trichoderma* spp. and *mycorrhizal fungi,* can constitute a key alternative for strengthening banana production that is more sustainable, efficient and resilient to phytosanitary threats. The articulation between applied research and strategic analysis is key to translate these advances into public policies and production models which can be replicated on a larger scale.
The health of banana crops depends both on the invisible microorganism at the root, and on the institutional will to promote its use. This dossier, supported by the Banana Exporters Agency of Ecuador and its Scientific Committee made up of specialists from research centers, universities, and public-private companies, seeks to consolidate the BANANA TIME Forum as a forward-looking commercial, technical, and scientific event.

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Guest Editors