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Editorial: Advancements in post-harvest physiology and technology of fruits and vegetables for sustainable food production

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Editorial on the Research Topic
Advancements in post-harvest physiology and technology of fruits and vegetables for sustainable food production

The growing global demand for food, combined with the urgent need for more sustainable agricultural systems, highlights the critical role of post-harvest management of fruits and vegetables. Physical losses, nutritional and sensory deterioration are issues that remain key challenges in fresh produce supply chains. Within this context, the Research Topic "*Advancements in Post-Harvest Physiology and Technology of Fruits and Vegetables for Sustainable Food Production*" emphasizes that increasing food production is not enough—what matters is preserving what is harvested through physiological understanding, appropriate technology, and integrated approaches, exploring different yet complementary perspectives on postharvest physiology and technology—ranging from preharvest factors influencing fruit integrity to the valorization of natural compounds and plant residues for food preservation and quality enhancement.

Such perspectives reflect a broader transition toward circular economy models, where plant residues, bioactive compounds, and post-harvest by-products are re-envisioned as inputs for new food preservation strategies. Even as the field moves decisively toward circular-economy principles, postharvest research must go beyond a techno-centric perspective and adopt an economic value-based lens that balances the aspiration for circularity with its real costs, benefits, and distributional impacts on society (Khanna et al., 2024; Meneses-Espinosa et al., 2024). Thus, this transition requires rethinking the very purpose of postharvest science and technology—from merely extending shelf life to

designing systems that minimize environmental impact, optimize resource flows, support long-term agricultural resilience, and remain economically viable and scalable beyond controlled laboratory conditions (Figure 1).

This Research Topic brings together studies that explore different yet complementary perspectives on postharvest physiology and technology—ranging from preharvest factors influencing fruit integrity to the valorization of natural compounds and plant residues for food preservation and quality enhancement. By integrating ecological principles, technological innovation, and a systemic understanding of food chains, the field is increasingly embracing frameworks that prioritize working with natural processes, fostering sustainable production practices, and designing interventions that remain viable over time (Figure 1).

In summary, the four articles that compose this Research Topic exemplify the convergence between postharvest physiology, emerging technologies, and sustainability. Collectively, they emphasize that postharvest research extends far beyond merely prolonging shelf life, seeking instead to understand and manage the complex interactions among physiology, biochemistry, and environment. Together, these contributions illustrate how post-harvest research is evolving toward approaches that balance technological advancement with ecological awareness, emphasizing

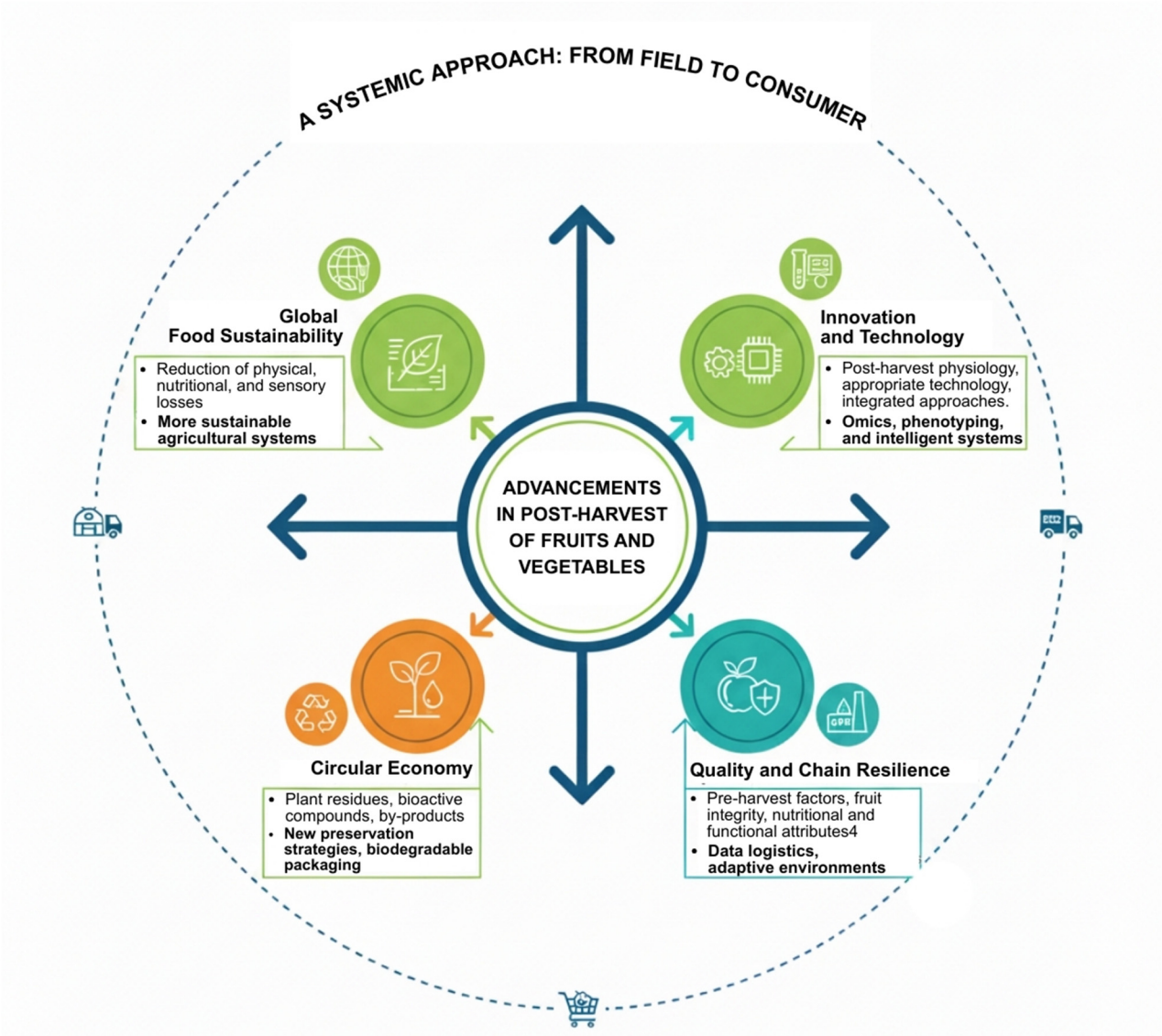

FIGURE 1
A systemic approach to post-harvest science and technology: from field to consumer. Conceptual representation of four interconnected pillars driving advancements in postharvest physiology and technology: Global Food Sustainability, Innovation and Technology, Quality and Chain Resilience, and Circular Economy. The elements shown within each pillar illustrate representative examples of topics that can be explored—such as loss reduction, *omics*-based tools, data-driven logistics, bioactive compounds, and biodegradable packaging—highlighting the multidimensional nature of postharvest research across the food supply chain.

not only product quality but also environmental integrity and resource efficiency.

The study on cracking susceptibility in cherries (*Prunus avium* L.) highlights how preharvest environmental factors critically determine postharvest performance, illustrating the importance of integrated orchard management strategies to maintain fruit quality (Xu et al.). This reinforces a critical message: sustainable postharvest solutions often begin before harvest takes place, requiring holistic management that accounts for plant stress responses, climatic variability, and genotype–environment interactions.

At the same time, investigations on bioactive compounds from *Laurus nobilis* L. (Boussaoudi et al.) and *Silybum marianum* (Iraqi et al.) broaden the concept of postharvest quality by incorporating nutritional and functional attributes, while the work by Rached et al. on *Mentha pulegium* L. essential oil demonstrates the multifunctionality of natural extracts, showcasing their chemical richness, bioactive potential, and safety assessment for sustainable use in food preservation. Together, these studies emphasize the value of natural compounds not only as quality enhancers but also as key elements in circular economy approaches, where agricultural by-products and plant residues are transformed into resources for food systems.

Such advances make it clear that progress in postharvest science depends on integrating physiological knowledge, technological innovation, and interdisciplinary collaboration among physiologists, chemists, food technologists, and sustainability experts.

Looking ahead, the field of postharvest science is moving toward a transformation driven by integrative approaches that combine *omics* tools, phenotyping, and artificial intelligence to predict and manage the behavior of fruits and vegetables after harvest. Future directions should focus on smart monitoring systems, data-driven logistics, and adaptive storage environments capable of reducing both losses and energy consumption. Equally relevant is the incorporation of circular economy principles—developing biodegradable coatings and packaging, exploring natural extracts, and valorizing plant residues—while ensuring that emerging technologies remain accessible and applicable across diverse socioeconomic contexts. The sustainable advancement of the field will rely on adopting a systemic view of the food chain, from farm to consumer, balancing quality preservation, environmental responsibility, and economic feasibility.

We invite researchers from different disciplines to join this journey: to explore new methods, validate innovative technologies, consider diverse production contexts, and connect physiology, technology, economy, and environment in solutions that truly make a difference.

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Conflict of interest

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