

Plasma Agriculture: A New Frontier for Sustainable Food Systems

The world population continuously increasing and there are growing concerns about future global food production and consumption. Feeding a growing global population under increasing environmental constraints is one of the major challenges of our time. Conventional agricultural fertilization has delivered remarkable gains, but often at the cost of soil health, biodiversity, and long-term sustainability issues. Addressing this challenge demands not only fundamentally new but sustainable approaches.

Plasma agriculture represents one such emerging frontier [1]. By applying low-temperature, non-thermal plasma to seeds, water, and agricultural environments, it is possible to stimulate plant growth, enhance stress tolerance, reduce reliance on chemical fertilizers, and degrade pesticides [2-6] that too without genetic modification or harmful residues. At its core, plasma agriculture leverages physical energy to trigger biological responses, creating a powerful interface between plasma physics, food chemistry, and living systems [1].

This plenary talk will highlight recent advances in plasma-based agricultural technologies, from plasma-treated seeds and plasma-activated water to their impacts on plant physiology, soil remediations, and nutrient dynamics. Drawing on laboratory studies and early field-tests, both the opportunities and the challenges of translating non-equilibrium cold plasma technology into real-world food systems will be discussed. Beyond individual applications, plasma agriculture can offer a new way to think about how physical sciences can support sustainable agriculture. Controlled plasma processes can help in developing future farming systems that are more resilient, efficient with resources, and environmentally benign, highlighting the value of plasma science for the future need of food.

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