Electrolyzed Water-The Future of Pesticide-Free Farming

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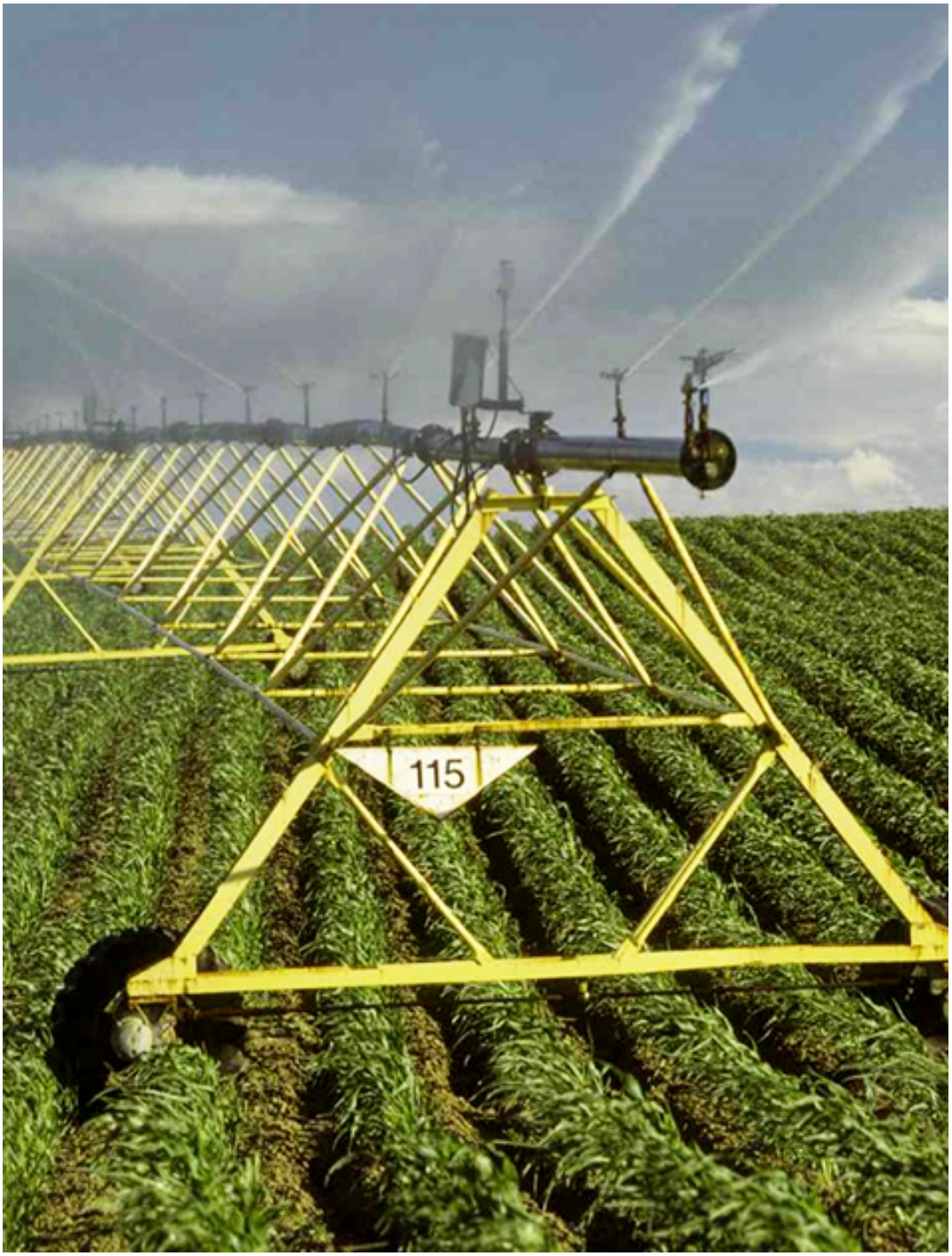

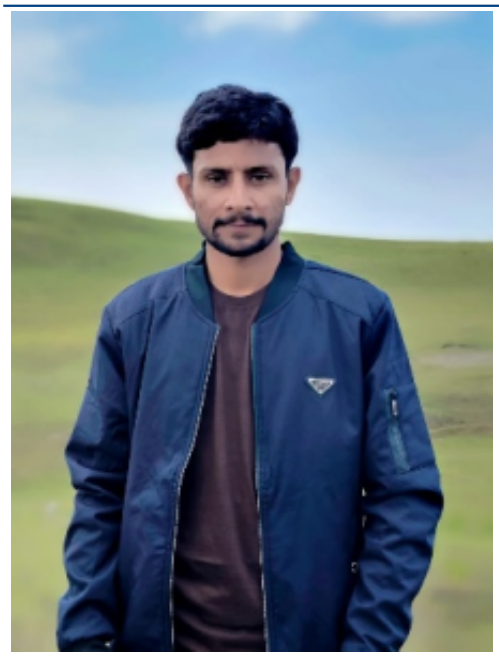

Crop production around the world continues to suffer from pest attacks that reduce yields and damage quality, costing billions of dollars annually. Chemical pesticides have long been used to counter these threats, but their residues raise serious concerns for human health, the environment, and biodiversity. This has pushed scientists to search for sustainable alternatives, with electrolyzed water emerging as one of the most promising solutions.

Electrolyzed water is produced by passing an electric current through a dilute salt solution such as sodium chloride. The process generates two

types of water: electrolyzed oxidizing water (EO) from the anode, with acidic pH (2–3) and high oxidation potential, and electrolyzed reducing water (ER) from the cathode, with alkaline pH (10–12) and strong reducing potential. EO water is rich in disinfectants like hypochlorous acid (HOCl), which penetrate microbial cell membranes, disrupt biofilms, and generate reactive oxygen species (ROS) that damage DNA, proteins, and enzymes, ultimately killing bacteria, fungi, and viruses. ER water, on the other hand, reduces free radicals, alters bacterial metabolism, and strengthens plant defenses, while also promoting growth by enhancing nutrient availability.

Applications of electrolyzed water extend from field to post-harvest management. Spraying EO water on fruits and vegetables reduces fungal spore germination and minimizes post-harvest losses, while ER water delays senescence and boosts natural defense enzymes, extending shelf-life with minimal residues. In soil health management, EO water suppresses pathogens such as Fusarium and Rhizoctonia, while ER water restores beneficial microbes, improves nutrient solubility, enhances seed germination, and mitigates salinity stress. Unlike chemical fumigants, electrolyzed water leaves no toxic residues, making it both safe and sustainable.

Countries like China, the U.S., and Germany have already adopted electrolyzed water for greenhouse farming, with reports showing a 40–50 percent reduction in pesticide use in China alone. Pakistan, however, continues to rely heavily on synthetic pesticides, threatening biodiversity and food safety. To shift toward sustainability, local research institutions must develop affordable generators for electrolyzed water, while government and extension services should raise farmer awareness through training and field programs. With proper implementation, Pakistan can align with international food safety standards and advance toward pesticide-free farming.

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