

Future protected tomato production will not only aim to achieve high and stable yields but must also emphasize efficient resource utilization and environmental sustainability. Consequently, green and efficient protected agriculture systems will become an important development direction. This model emphasizes the integration of technologies such as precision water-fertilizer management, nutrient recycling, renewable energy coupling, and biological pest control to maintain high productivity while reducing carbon emissions and environmental pressure. Compared with open-field production, protected systems often achieve better resource-use efficiency due to higher water-use efficiency and greater yield per unit area. In China's solar greenhouse and plastic tunnel systems, measures such as drip irrigation, integrated water-fertilizer management, and controlled-release fertilizers can significantly reduce carbon emissions, with fertilizer management considered a key factor influencing the environmental footprint of greenhouse production. Furthermore, high-tech soilless cultivation systems in greenhouses demonstrate the potential for circular and low-carbon production through nutrient solution recirculation systems and the use of clean energy. In the future, protected tomato production will also place greater emphasis on integrated pest management (IPM) and biological control technologies, while adapting to different greenhouse structures and regional conditions to develop diversified and sustainable green production systems.

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Conflict of Interest Disclosure

The authors affirm that this research was conducted without any commercial or financial relationships that could be construed as a potential conflict of interest.

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