Recent Advances in Sustainable and Smart Agriculture: Innovation for Future Farming

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Chapter - 26
AI-Based Forecasting and Decision Support System for Plantation Crops

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Chapter - 26

AI-Based Forecasting and Decision Support System for Plantation Crops

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Several of the most significant vegetable crops in the world are members of the Solanaceae family, including eggplant/brinjal (Solanum melongena), pepper/capsicum (Capsicum spp.), tomato (Solanum lycopersicum), and potato (Solanum tuberosum). These crops are essential to the nutrition and food security of the world. For instance, tomatoes, which are prized for their vitamins and antioxidants, are produced in excess of 180 million tons every year. In 2018, 368 million tons of potatoes were produced, making it a staple crop. While eggplant is high in phenolics (anthocyanins, chlorogenic acid), pepper offers vitamins C and A as well as phytochemicals. However, the need for improved quality, increased production, and climatic resistance has outpaced breeding advancements. The use of genomic tools (genome sequences, molecular markers, high-throughput genotyping, and genome editing) in breeding, known as genomic-assisted breeding (GAB), has become a potent strategy to speed up the development of crops in the Solanaceae family. Compared to traditional approaches, GAB allows breeders to more accurately integrate advantageous alleles and analyze complex attributes (disease resistance, abiotic stress tolerance, yield, and quality) at the molecular level. With the help of important case studies, this chapter examines the most recent genomic resources, techniques (MAS, QTL mapping, GWAS, genomic selection, genome editing), and integrated omics methods in the breeding of solanaceous vegetables.

Solanaceous Vegetables: Diversity and Breeding Objectives

Major Crops and Their Traits

The archetypal solanaceous vegetable, the tomato (S. lycopersicum), is cultivated all over the globe for both fresh consumption and processing. It offers antioxidants (lycopene, vitamins) and minerals (K, Mg, P). Disease resistance (to late blight, bacterial wilt, and tomato yellow leaf curl virus, for example), abiotic tolerance (to heat, drought, and salt), yield components (fruit