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Securing the future of root and tuber crops: Genetic and agronomic strategies for stress resilience

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Abstract

Cassava, sweet potato, yam, taro, cocoyam, elephant foot yam and arrowroot are essential staples and income sources for smallholder farmers across sub-Saharan Africa, Asia and Latin America. Accelerating biotic and abiotic pressures now threaten productivity across all major production systems, demanding coordinated genetic and agronomic responses.

Virus diseases — notably cassava mosaic disease, cassava brown streak, and yam mosaic — alongside root-knot nematodes, sweet potato weevil and taro leaf blight constitute the most damaging biotic constraints. The threat landscape is dynamic: new incursions such as witches' broom of cassava and climate-driven range expansion of root rots, scales and mites are compounding established pest complexes. Natural resistance sources identified within the genepool of cassava, taro and other species provide a foundation for genetic control, while biological control agents and elicitor-based immune priming expand integrated management options. Advances in QTL mapping, resistance gene cloning and CRISPR/Cas-mediated editing are opening credible accelerated breeding pathways for crops historically constrained by polyploidy, long breeding cycles and vegetative propagation.

Abiotic stress presents an equally critical challenge. Cassava yields decline significantly above 35–36°C; yam, sweet potato and taro are more heat-sensitive, with sharp productivity losses above 30°C. Erratic rainfall, waterlogging and terminal drought disrupt crop cycles and drive fungal root rot epidemics. Whole-genome sequencing and pan-genome approaches are enabling the translation of germplasm diversity into functionally characterised climate-adaptive traits, while cross-species comparative genomics offers pathways to novel resilience alleles. Complementing genetic strategies, improved water and soil management and stress-adapted agronomic practices are essential components of a integrated resilience framework.

Underpinning all of these advances is access to diverse, healthy, well-characterised germplasm. Sustained investment in genebank conservation, phytosanitary certification and open international distribution of genetic resources and associated genomic data remains the indispensable foundation for securing the long-term productivity and adaptability of root and tuber crops.

Keywords: Climate variability, cross-population sequencing, disease resistance, germplasm diversity, resilience alleles

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