For eggplant in arid oasis conditions, a two-year drip-irrigation trial identified mild water deficit combined with medium N rate as the optimal strategy, significantly increasing yield, fruit quality, and water productivity compared with both higher and lower N and water levels, illustrating how fertilizer optimization must be co-designed with water management under variable climates.

Climate-smart agriculture (CSA) offers a framework to adapt eggplant systems to temperature and rainfall instability while reducing environmental impacts. A recent review highlights precision nutrient management, integrated soil fertility strategies, and regenerative practices (e.g., organic amendments, biochar, agroforestry) as key CSA options that improve soil health, raise nitrogen use efficiency, and increase carbon sequestration, thereby buffering crops against climate stress. Another synthesis of climate-change impacts on agroecosystems stresses that adaptation must address multiple risks-yield decline, water scarcity, pests, and product quality-through measures such as improved water and soil management, agronomic practices, and smart technologies tailored to local conditions.

At farm level in drought-prone regions, smallholders already employ practical adaptive strategies that are highly relevant for eggplant, including optimal water resource use, soil and water conservation, and nutrient management techniques to stabilize production under rainfall variability (Mpala & Simatele, 2024). A global scoping review of agricultural adaptation strategies further identifies crop and land-use adjustment, water and soil management, farmer training, agro-meteorological services, and early warning systems as central adaptation pillars; it emphasizes that biodiversity-based and climate-smart agriculture can simultaneously enhance resilience and productivity if supported by suitable policies and knowledge transfer.

Intelligent yield prediction systems can support sustainable eggplant production by integrating fertilization regimes, climate variables, and real-time field data to guide adaptive management. A comprehensive review of AI-based crop-yield prediction shows that machine and deep learning models using temperature, rainfall, humidity, soil type, and vegetation indices (e.g., NDVI, EVI, LAI) alongside management variables (such as irrigation and cultivation practices) substantially improve estimation accuracy and offer powerful tools for planning under environmental variability. Building on these insights, a crop yield prediction algorithm (CYPA) that combines climate, weather, yield, and chemical (including fertilizer) data demonstrated very high performance with ensemble models such as Random Forest and Extra Trees, and further enhanced efficiency via active learning to reduce labeled data needs.

For climate-resilient farming, future systems must be lightweight, deployable on edge devices, and tightly coupled with sensing infrastructures. An on-device AI framework using Random Forest on smart agricultural devices showed that integrating environmental sensor data with ML can achieve over 90% accuracy in detecting yield suitability and optimize irrigation scheduling to enhance water-use efficiency and support climate-resilient production without reliance on cloud computing. Reviews of IoT-enabled smart sensors in precision agriculture underscore that networks of soil, plant, and climate sensors, linked with AI/ML on IoT platforms, enable real-time monitoring, predictive analytics, and automated control of irrigation and fertilization, though challenges in cost, data management, and connectivity must be overcome for large-scale application in eggplant systems.

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