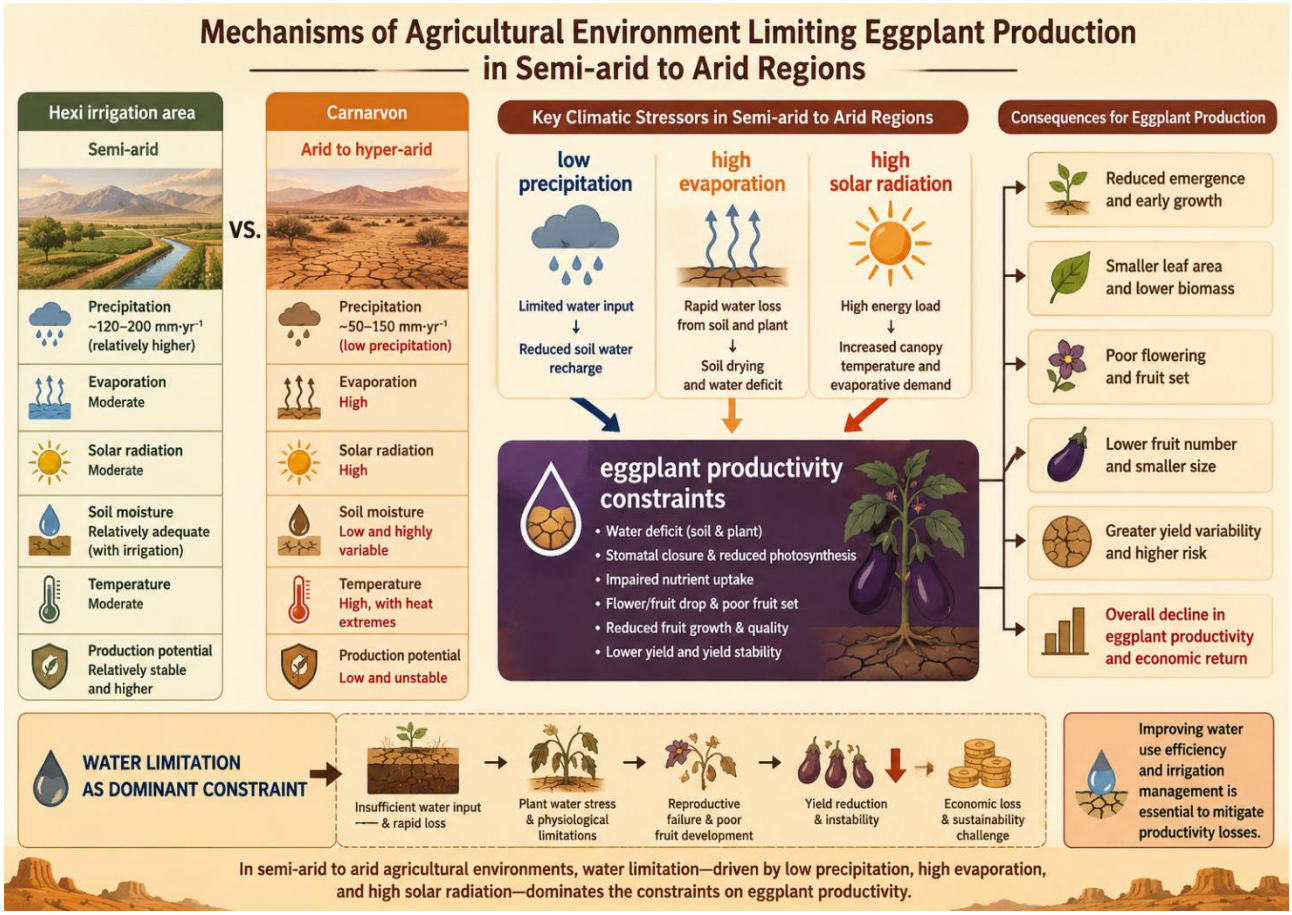

Figure 2 Schematic representation of climatic constraints on eggplant production in semi-arid to arid environments (e.g., Hexi irrigation area and Carnarvon). High evaporative demand, low precipitation, and strong solar radiation jointly limit crop productivity

These findings align with broader advances in precision water-fertilizer management. Reviews of precise water and fertilizer application technologies emphasize that integrating advanced sensors, remote sensing, and machine learning enables variable-rate fertigation and micro-irrigation that improve nutrient uptake, water-use efficiency, and environmental outcomes compared with uniform practices (Xing and Wang, 2024). Decision-support frameworks based on the Internet of Things and optimization models further show that coordinated, long-term irrigation and fertilization planning can simultaneously increase economic returns and environmental benefits compared with empirical management, indicating that regional eggplant yield prediction models can be directly embedded in smart fertigation and farm-planning systems (Lin et al., 2020).

8 Strategies for Sustainable Eggplant Production Under Climate Variability

Sustainable eggplant production under climate variability requires fertilizer strategies that enhance yield while maintaining soil health. A four-year eggplant field study showed that combining the full recommended NPK dose with farmyard manure increased yield by 47% over mineral fertilizer alone and substantially raised soil organic carbon and available N, P, and K, improving agronomic efficiency and nutrient recovery. At the broader vegetable level, a global meta-analysis found that enhanced-efficiency fertilizers (EEFs), such as nitrification inhibitors and polymer-coated urea, increased vegetable yield by about 7.5%-8.1% and improved quality while markedly reducing nitrous oxide emissions and nitrate leaching, especially when matched to soil pH and organic carbon conditions.

Optimizing nitrogen remains central, because excessive N is common in high-value vegetables and is associated with low recovery and high leaching risk. A review of nitrogen management in field vegetables emphasizes that aligning N supply with crop demand, improving synchronization via split applications, sensor-based diagnostics, and better irrigation management can simultaneously maintain yields and reduce nitrate losses below the root zone.