

dry matter and soluble solids remained high even after extended cold storage, with TSS values around 19-20 °Brix, indicating that trellis-grown fruits can maintain dense, sweet flesh and nutritional richness over time.

6.3 Effects on marketability and postharvest quality

Trellis systems frequently enhance overall marketability by increasing the proportion of marketable fruit and extending shelf life. For spaghetti squash, the use of trellis and mulch together produced more marketable fruits and heavier fruit weight, which directly improves pack-out and economic return per plant. In cucumber, trellising doubled marketable yield compared with ground culture and reduced the proportion of fruits with defects such as yellow belly, jumbo size, and distortion, indicating fewer downgraded culls and a higher share of Fancy-grade produce.

Shelf life and storability can also benefit from trellis-based systems through effects on firmness, color retention, and disease incidence. In long English cucumber, training systems that increased canopy light penetration produced darker green fruits with longer shelf life, linking trellis-induced light exposure to chlorophyll retention and delayed surface yellowing. For trellised, greenhouse-grown sweet acorn squash, appropriate cold storage (10 °C-15 °C with reduced humidity) allowed up to 3 months of shelf life with minimal quality loss, and trellis cultivation produced uniformly colored, high-quality fruits that responded well to postharvest treatments such as hot water brushing to reduce rots, supporting steady, extended marketing (Adeeko et al., 2020).

7 Case Study: Comparative Performance of Different Trellising Systems on Sponge Gourd Yield and Quality

7.1 Comparison of horizontal pergola and a-frame trellis systems

Horizontal pergola and related overhead systems can greatly increase canopy area and light interception but differ from A-frame or T-type structures in labor needs and yield response. In grape, pergola trellises allow maximum “green mass” and solar energy assimilation, raising yields by 2-3 times compared with vertical systems, though management becomes much more labor-intensive due to overhead work (Kharibegashvili et al., 2021). A mobile pergola design mitigates these drawbacks by shifting between horizontal and vertical positions, maintaining pergola-level yield while simplifying pruning and harvesting, which illustrates the trade-off between productivity and ergonomics inherent in fully horizontal systems.

A-frame or T-type trellises usually provide intermediate canopy height and partial horizontal spread. In organically grown ridge gourd (*Luffa acutangula*), a T-trellis produced the highest marketable yield (24.8 t ha⁻¹) and the best benefit-cost ratio among six trellis types, slightly outperforming the locally used pandal system despite similar vegetative growth (Sen et al., 2023). In passion fruit, a horizontal “T” system achieved intermediate productivity between simple and total trellis structures, reflecting that partially horizontal designs may not always maximize yield but can balance structural cost, fruit quality, and cultural operations (Cleves-Leguizamo, 2021).

7.2 Production efficiency analysis of fence trellis and vertical training systems

Fence-like and simple vertical trellises emphasize linearly arranged canopies, favoring ventilation, pollination and access. In Colombian passion fruit, a simple vertical trellis reached 30.5 t ha⁻¹ with 73% first-quality fruit, outperforming a horizontal T-trellis and a full “barbecue” system in both productivity and quality while also enabling higher planting density and mechanization. Similarly, long-term records from Colombian orchards indicate that simple trellises combine good phytosanitary management, efficient foliar spraying, and ease of structural repair, leading to stable high-quality yields over 18-24 month cycles (Cleves-Leguizamo, 2021).

High-wire and other vertical training systems in greenhouse cucumbers highlight additional efficiency dimensions. A high-wire system produced more consistent weekly yields than a modified-umbrella system, even though the latter doubled fruit number per plant and increased total yield, suggesting that vertically oriented canopies can stabilize harvest rhythm at the expense of some productivity. In another high-wire study, training cucumbers on a single main stem per slab achieved the same yield per area as multi-stem configurations while improving water use, simplifying work, and stabilizing weekly production, underscoring that simple vertical architectures can enhance input efficiency and labor organization without sacrificing output.