7.3 Comprehensive evaluation of representative regional cultivation cases

Regional Luffa and cucurbit case studies show that trellis choice interacts strongly with local climate, infrastructure and market conditions. In Sri Lanka, sponge gourd grown under horizontal trellising achieved average yields of 8.4 t ha^{-1} with improved fruit number compared with prostrate vines, indicating clear agronomic benefits of overhead support under tropical field conditions. In subtropical Mexico, direct-sown sponge gourd on live-stake trellis systems produced 5-20 fruits per plant and fruit weights up to 660 g at the best site, with production costs per fruit about one-third lower than at less favorable sites, demonstrating that simple wire-and-stake frameworks can support profitable small-scale production in diversified landscapes (Fernández-Lambert et al., 2025).

Beyond Luffa, other cucurbits underline how trellising adapts to regional constraints. In North Florida, A-frame and wire-trellis cucumbers showed no significant yield advantage over conventional ground culture, suggesting that in humid subtropical climates with certain cultivars and management, trellising may primarily improve handling and fruit cleanliness rather than yield. In Israel, winter-grown acorn squash under protected cultivation yielded 56% more when trellised, with fruits that were firmer, better colored and richer in dry matter, soluble solids, carotenoids and antioxidants, illustrating that in high-value, protected systems, vertical trellising can simultaneously raise productivity and quality to meet premium markets (Adeeko et al., 2024).

8 Trellising Systems, Production Efficiency, and Sustainable Development

8.1 Effects on labor requirements and production costs

Trellis design strongly influences both variable and fixed production costs in cucurbit systems. In organically grown ridge gourd, the T-trellis produced the highest marketable yield while using simpler materials than the locally common pandal, resulting in the highest benefit-to-cost (B:C) ratio across varieties and demonstrating that trellis choice can improve profitability even when yield differences are modest. Off-season trellis-based bottle gourd cultivation likewise showed only small differences in cultivation cost between seasons, yet off-season crops achieved substantially higher net returns and B:C ratio due to better prices, underlining how trellis systems can support profitable timing strategies (Singh et al., 2024).

Labor requirements are also shaped by trellis structure and associated training operations. In highbush blueberry, adding a V-trellis increased pruning time in some years without compensating yield gains, raising total pruning and harvest costs per kilogram relative to a standard T-trellis and highlighting the risk that more complex trellises can raise labor costs (Strik and Davis, 2022). Conversely, improved training concepts in cucumber, such as lowering-type systems, have simplified repetitive tasks like old leaf removal and harvesting, pointing to the potential for trellis designs that facilitate partial or full automation of key operations.

8.2 Effects on disease and pest management as well as field operations

Raising cucurbit canopies on trellises can indirectly aid disease and pest management through improved aeration and reduced soil contact. In sponge gourd, horizontal trellising increased yield and fruit quality compared with prostrate vines, and pest and disease observations showed only mild leaf miner and low fruit fly damage, supporting the view that Luffa can be grown with minimal external inputs and low production costs when properly supported (Silva et al., 2012). Field studies with trellised cucumbers in open ground report that air exchange between plants improves, soil moisture is better managed, fruit quality improves, and soil-borne diseases decrease, illustrating multiple sanitary and operational benefits of the trellis method over conventional culture.

Interactions between trellising and targeted pest-management tools are also important. In slicing cucumber, trellising reduced downy mildew necrosis slightly and increased total fruit yield by about 15%, but trellising alone did not raise marketable yield; fungicide applications remained the main driver of disease suppression and marketable production, indicating that support structures must be integrated with chemical or biological controls (Keinath, 2019). More generally, trellis-based vegetable systems are recognized as a component of sustainable production that can lower overall production costs, improve food quality, and support organic methods by enhancing sunlight interception, aeration, and reducing pest and disease contact, thereby easing field operations like harvesting and crop inspections (Singh et al., 2024).