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Terms of reference for commercial greenhouse facilities in arid regions

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Background

Commercially available technologies that increase water use efficiency, reduce pesticides application and increase the production per unit area, are being evaluated at ESTIDAMAH center, Riyadh, KSA. Based on the experiments have been done in the last five years, the terms of reference of best practices greenhouse can be described for economical and sustainable application in Saudi Arabia.

Objective

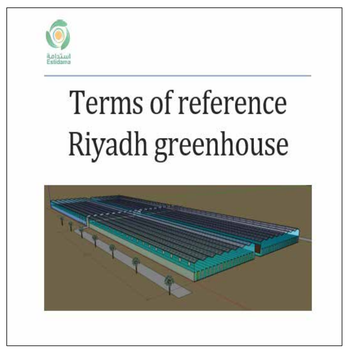
- **Economical design:** This implies the return of investment that should be as low as possible. The return on investment is calculated by taking the profit from the production (assuming a specific price for the product per kg) minus the operational costs (labor, electricity, water, fertilizer, biological control, materials, seeds) divided by the overall investment.
- **Types of greenhouse:** A low-cost medium production and a medium cost high production designs. The low cost will be made from plastics to suit small farmers, while the high cost, mainly for larger companies or investors.
- **Sustainability:** Is considered specifically on the consumption of water but also on durability.
- The greenhouse will be designed for the climate of Riyadh (including Al Kharj, Qassim, Hofuf).
- Local materials are preferred for the construction as well as the resources for operation.
- The greenhouses will be suitable for year-round vegetable production.

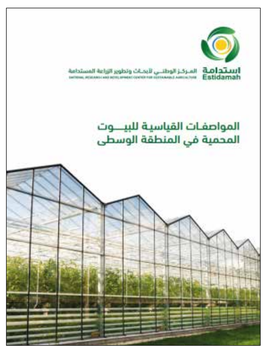
Methods

The design procedure is based on mainly to the following resources:

- The results from Estidamah.
- Simulation results done with the dynamic simulation model KASPRO, which uses the Riyadh climate as input. This model has been validated for many locations in the world including Estidamah.
- Vegetable market analysis.
- Pricing of equipment including the greenhouse.

Cover of the report





Analyze of different levels of technology

Items	Tunnel greenhouse 	Multi span greenhouse 	Closed greenhouse 
Annual production (tomato)	70 kg/m²	80 kg/m²	90 kg/m²
Commercial Investment costs	260 SAR/m²	400-600 SAR/²	1200-1600 SAR/m²
Labour (13 SAR/h)	3.5 h/m2 (45 SAR/m²)	2.5 h/m² (30 SAR/m²)	2.5 h/m2 (30 SAR/m²)
Fertilizer (including CO2)	15 SAR/m²	15 SAR/m²	50 SAR/m²
Pesticides	15 SAR/m²	15 SAR/m²	12 SAR/m²
Planting material	4 SAR/m²	4 SAR/m²	4 SAR/m²
Annual water use (4 SAR/m3)	5.7 m³/m² (1.6 m3 irrigation 4.1 m³ cooling) 23 SAR/m²	3.5 m³/m² (1.2 irrigation, 2.3 m³ cooling) 14 SAR/m²	0.2 m²/m² (1.4 irrigation, -1.2 m3 cooling) 1 SAR/m²
Annual electricity use (0.21 SAR/kWh)	35 kWh (7 SAR/m²)	30 kWh (6 SAR/m²)	600 kWh (126 SAR/m²)
Annual operational costs	109 SAR/m²	84 SAR/m²	223 SAR/m²
Operational costs per kg	1.56 SAR/kg	1.05 SAR/kg	2.48 SAR/kg

Results

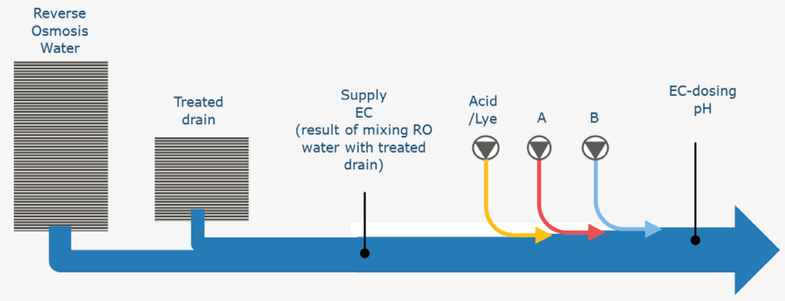


Figure 1. A fertilizer unit, providing scheduled irrigation and the exact composition of nutrients is crucial

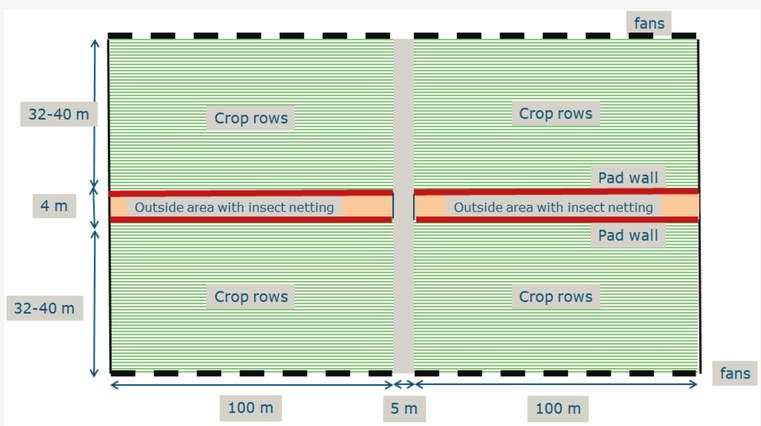


Figure 2. Layout of the greenhouse for efficiency labor management and climate control

Items	Standard tech	Advanced Tech
Return of investment (simple method) years	5.0	5.5
Investment cost [SAR/m2]	400	600
Production [kg/m2/year]	70	80
Total income crop [SAR/m2/year]	210	240
Energy	6	6
labour	30	30
Water & nutrients	29	29
Others (chemicals, substrate, packaging etc.)	19	19
Total variable costs [SAR/m2/year]	84	84
Greenhouse construction & covering maintenance	13	8
Other installation costs (heating, CO2, screening, climate Control, etc.) maintenance	33	38
Total installation costs (depreciation, maintenance) [SAR/m2/year]	46	46
Netto income [SAR/m2]	**80**	**110**

Table 1. Economic analysis for two levels of technology

Discussion

- The document outlines all aspects required for the establishment of a horticultural production facility. It incorporates all the knowledge which has been gathered at Estidamah during its operation. This document can be used by a grower or investors to obtain offers from greenhouse builders.
- The numbers indicate commercial horticultural production unit are economically feasible. Moderate pricing of the products have been considered, though through marketing and branding the profitability can be increased.

Recommendation

- The production levels indicated can only be obtained provided the greenhouse management is optimal. This means crop management is done properly, pest and diseases are controlled using integrated pest management (IPM), and the control of the climate and fertigation is done by trained staff.
- The investment costs also depend on the location where the facility is constructed. The land should be levelled, and resources (water, labor, and energy) should be available. Also, transpiration to the market should be considered, included sorting, packaging and storing.

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