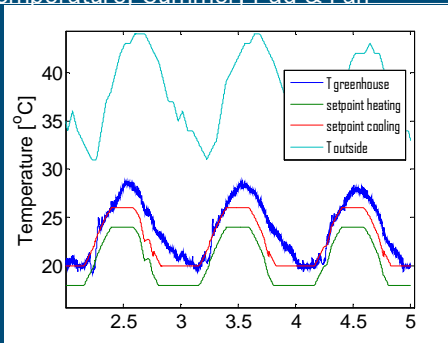


Boundary conditions

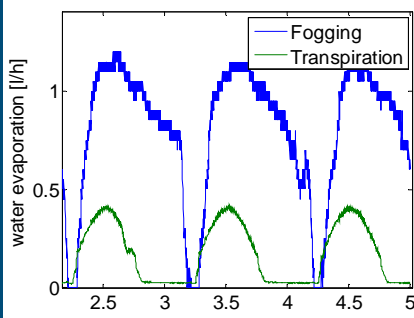
- Weather conditions of Riyadh 2009
- Minimum temperature set at 18°C
- Maximum temperature set at 26°C
- Maximum ventilation of Pad & Fan 100 m³ m⁻² h⁻¹



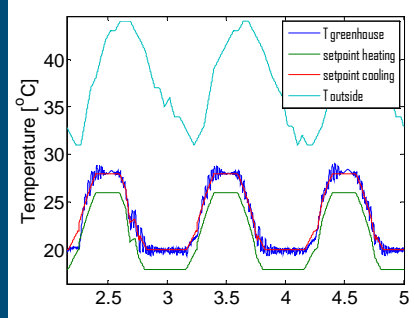
Temperature, Summer, Pad & Fan



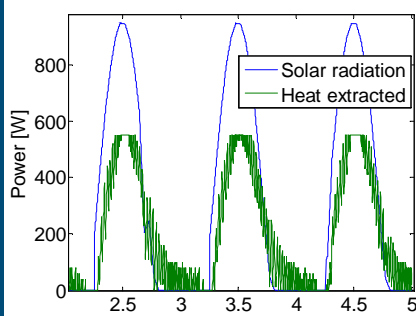
Moisture added by pad and fan, Summer



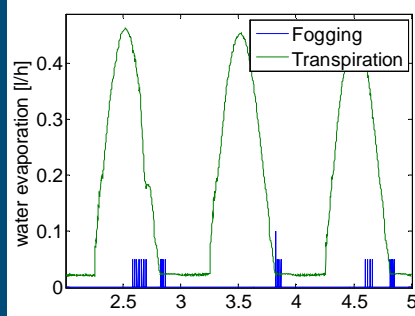
Closed greenhouse, summer



Cooling need, summer



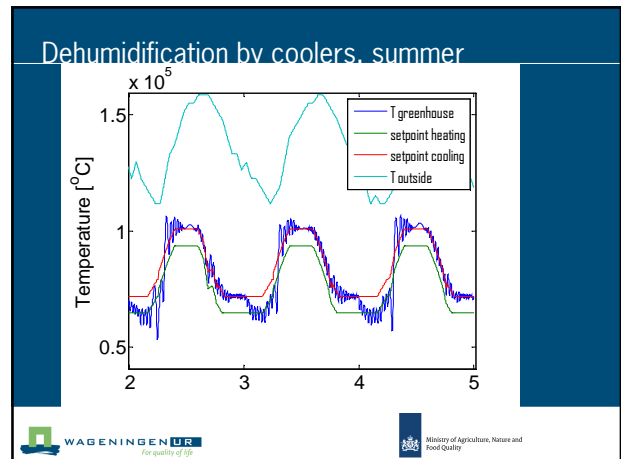


Vapor fluxes, summer





Dehumidification for a closed greenhouse

- Moisture removal by condensation in the coolers
- Moisture removal by ventilation with outside air

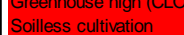
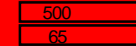
Comparison pad & fan <-> closed greenhouse

| | P&F | Closed greenhouse |
|-------------------------|------|-------------------|
| Transpiration (l) | 1200 | 1063 |
| Evaporative cooling (l) | 3260 | 6 |
| Water loss (l) | 4460 | 180 |
| Max temperature (°C) | 34.8 | 30.5 |
| Biomass production (kg) | 11.4 | 19.9 |
| Carbon dioxide (kg) | - | 34 |
| Cooling need (MJ) | - | 3900 |

Assumptions

| Prices | | | |
|------------------------------|--------------------------|-------------------------|----------------------------------|
| Price of water (desalinated) | 0.25 EURO/m ³ | 1.25 SAR/m ³ | |
| Price of Electricity | 0.02 EURO/kWh | 0.10 SAR/kWh | |
| Price CO ₂ | 0.2 EURO/kg | 1.00 SAR/kg | |
| Price labor | 2 EURO/hour | 10.00 SAR/hour | |
| Investments | | | |
| | EURO/m ² | SAR/m ² | Depreciation and maintenance (%) |
| Pad and Fan | 20 | 100 | 25 |
| Fogging | 10 | 50 | 20 |
| Air distribution | 10 | 50 | 20 |
| Chiller | 150 | 750 | 20 |
| CO ₂ supply | 15 | 75 | 15 |
| Greenhouse low tech (P&F) | 30 | 150 | 25 |
| Greenhouse high (CLOSED) | 100 | 500 | 15 |
| Soilless cultivation | 13 | 65 | 30 |



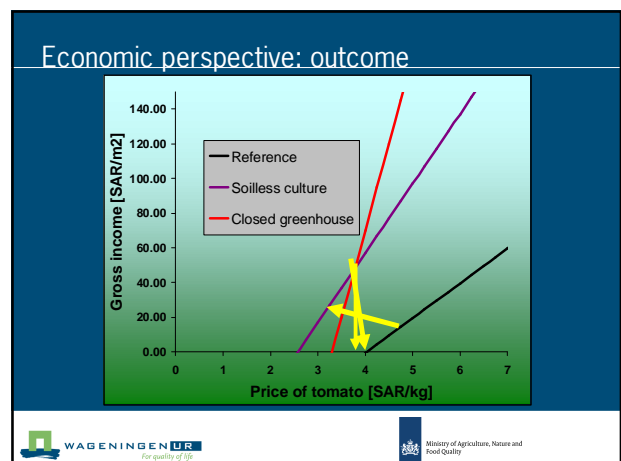



Assumptions

| Production | |
|----------------------|-----------------------|
| Reference | 20 kg/m ² |
| Soilless cultivation | 40 kg/m ² |
| Closed greenhouse | 100 kg/m ² |


| Use | Electricity [kWh] | CO ₂ [kg] | Water [m ³] | Labor (hours) |
|----------------------|-------------------|----------------------|-------------------------|---------------|
| Reference | 30 | 0 | 8 | 0.5 |
| Soilless cultivation | 35 | 0 | 6 | 1 |
| Closed greenhouse | 361 | 30 | 0.5 | 2.5 |

| Conditions | | |
|----------------|--------|-------------|
| Cooling demand | 3.9 GJ | |
| Currency rate | 0.20 | EURO/SAR |
| COP chiller | 3 | incl. pumps |

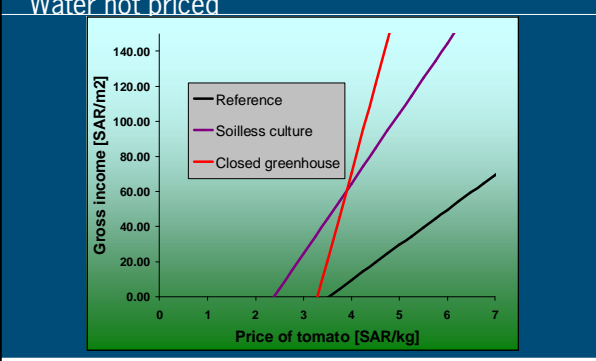





Sensitivity analysis

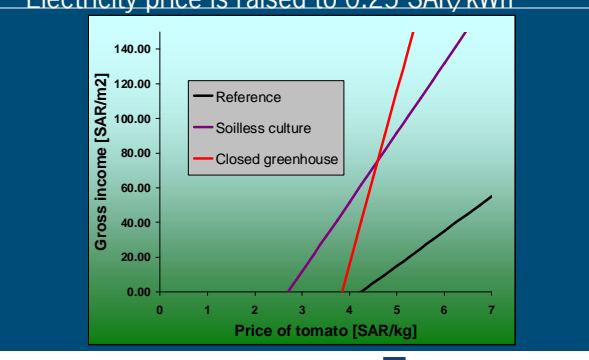

- No pricing of water
- Price of electricity is raised



Water not priced





Electricity price is raised to 0.25 SAR/kWh

Conclusions

- The application of soiless culture should be the first step to save water
- Soiless culture is a good investment due to the increase in production
- A closed greenhouse is feasible when the price of tomato is higher than 4 SAR/kg
- Investments are compensate for



Discussion

- Is quality going to be paid in KSA?
- Will water be priced?
- Are growers willing to invest? Do they think in terms of return on investment?

