



Modern technology for sustainable greenhouse production in Turkey

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Trends world-wide – greenhouse production

- ◆ New production areas are coming up
- ◆ From open field production to more protected systems
- ◆ Low tech and mid tech growing systems have biggest areas, but move to high tech
- ◆ Modern greenhouse industry in Western Europe and US develops more and more to year round production with high quality



Goal innovation greenhouse

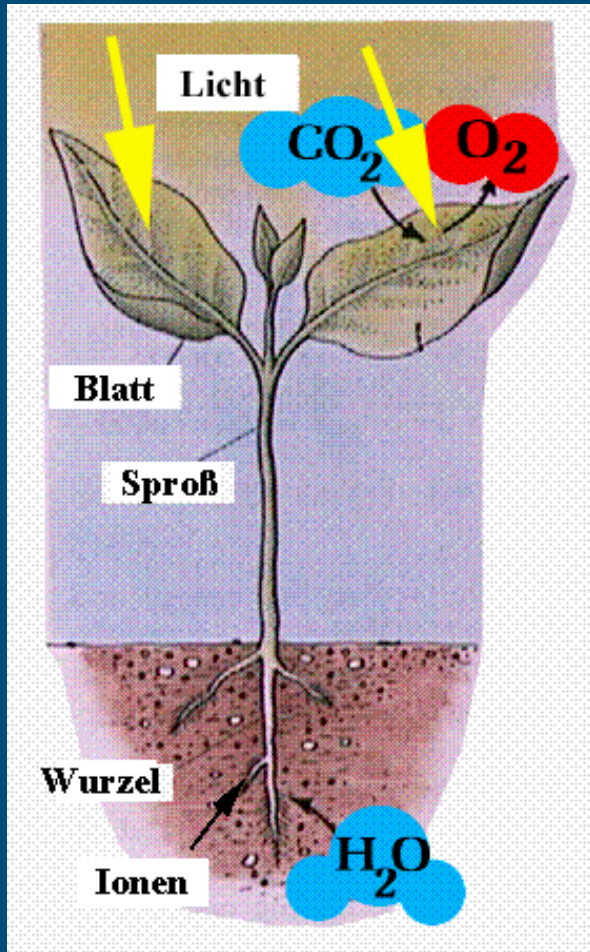
- Build a sustainable Innovation Greenhouse in the scope of SeraCulture in Turkey together with Turkish investors
- Economic feasible horticultural production with Dutch technology (high production, excellent quality)
- Sustainable production (geothermal, CO₂)
- Collaboration of Dutch science & industry and Turkish investors and growers

Sustainable greenhouse production in Turkey

- ◆ Design greenhouse systems which combine (economic) production efficiency with minimal input of energy, water and nutrients
- ◆ Low energy input, use of sustainable energy (geothermal)
- ◆ High production, product quality, predictability
- ◆ Low pesticide use, high food safety
- ◆ High water use efficiency, low nutrient losses
- ◆ High ratio benefit – costs of the production system



Sustainable greenhouse crop production



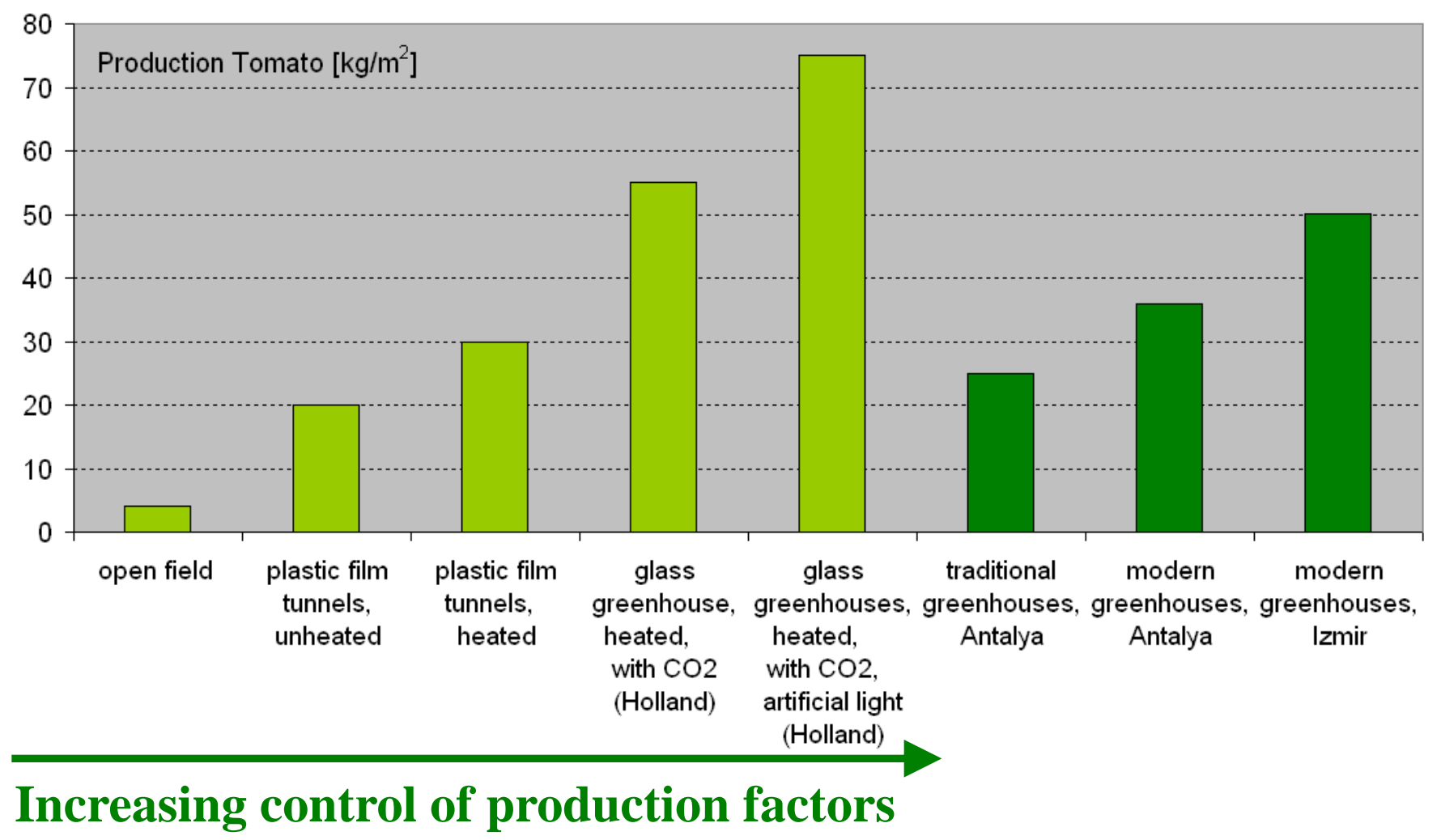
- ♦ $\text{CO}_2 + \text{water} + \text{light} \rightarrow \text{sugar} + \text{O}_2$
- ♦ Sugars and **nutrients** are used for growth
- ♦ Growth \Rightarrow yield
- ♦ Reactions are **temperature** dependent
- ♦ control all growth factors
- ♦ technology needed

Technology for sustainable crop production

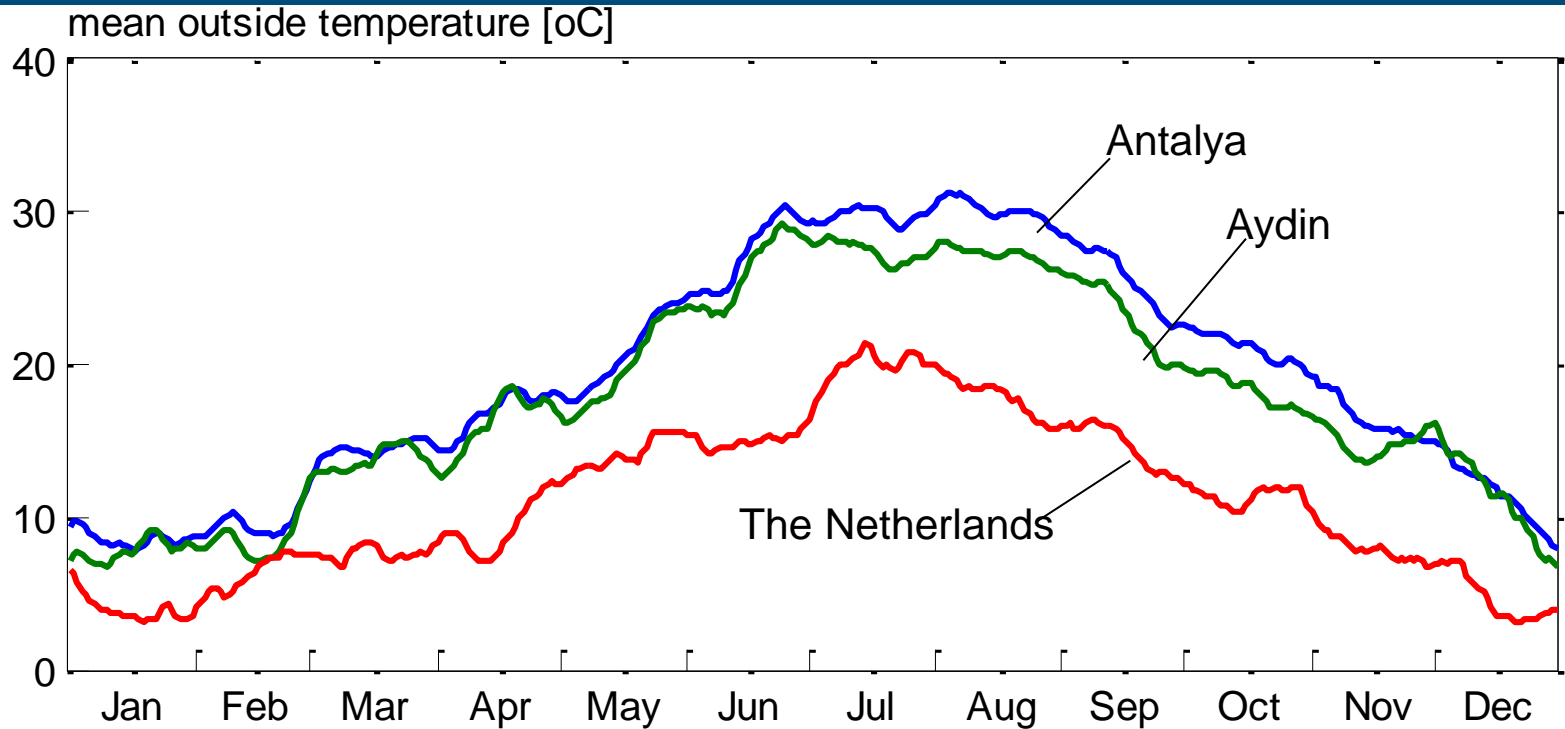
- ◆ Increasing degree of technology
- ◆ Heating
- ◆ CO₂
- ◆ Cooling
- ◆ Light control
- ◆ Soil / Soilless culture
- ◆ Open / closed water cycle
- ◆ Computer control



Technology for sustainable crop production



Outside climate in Antalya and Aydin



**Low
temperature**

Low temp.

High irradiation, less wind, ventilation necessary

Heating in winter

Heating - temperature

- ♦ Why heating?
 - ♦ **Less diseases**,
condensation – botrytis
 - ♦ **Better fruit quality**: low temperature bad colouring of the fruits
 - ♦ **Higher production**: low temperature less development of number of bunches

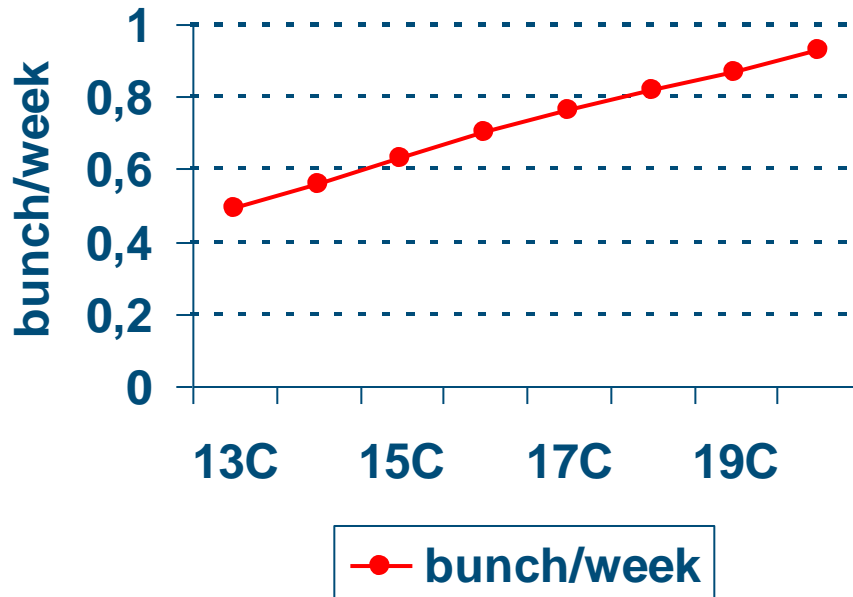


↓↑ **botrytis**



Effect of to low temperature

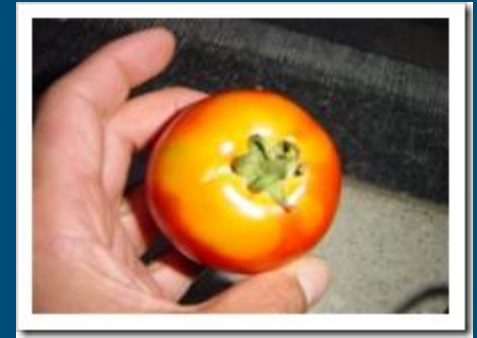
Influence of the temperature on the development of the bunches by tomato



To low temperature at night

Cooling

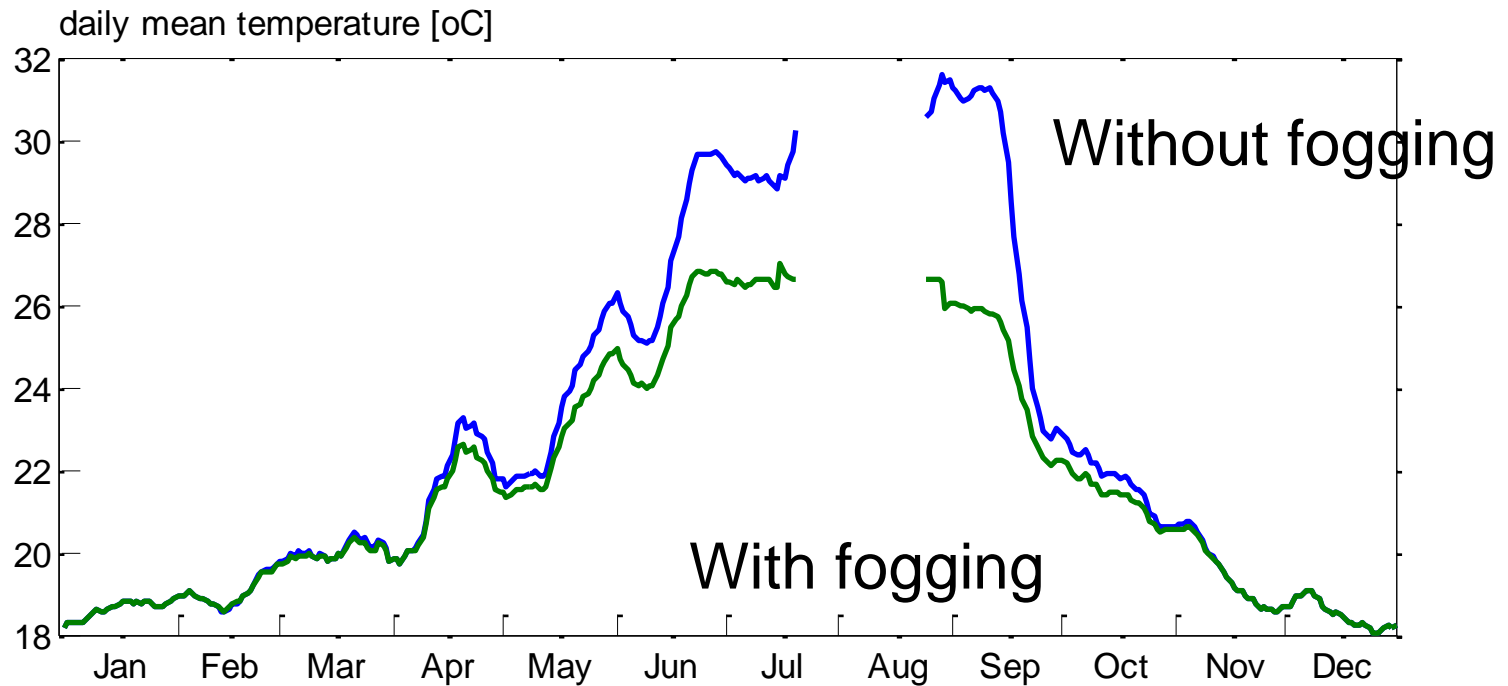
⇒ Too high temperature ($>29\text{ }^{\circ}\text{C}$) may lead to injuries (blossoms, discolouring of fruits, softening, etc)



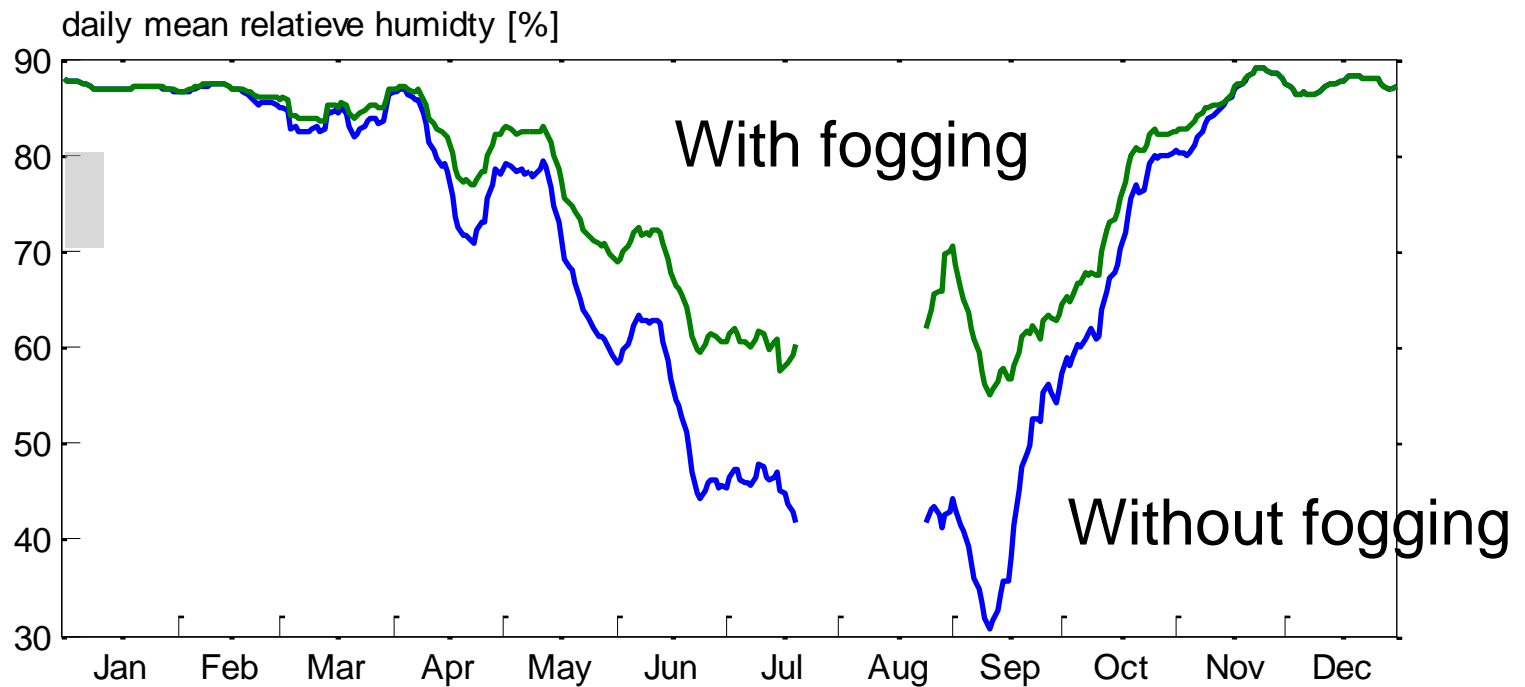
discolouring

- ◆ Effect of fogging
- ◆ Effect of active cooling
 - " (investment € 45,-/m² not beneficial)

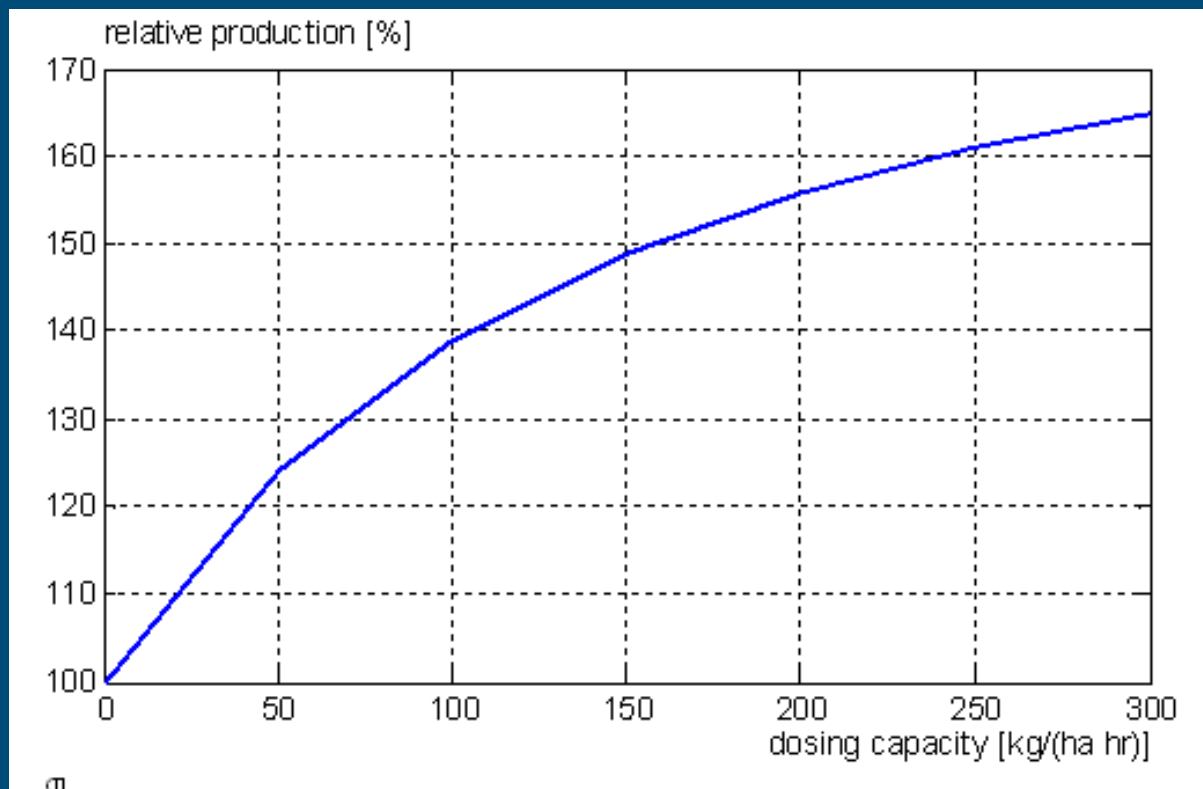
Cooling: Effect of fogging



Cooling: Effect of fogging



Effect of CO₂ on production



Investments of ca. € 2 per m²

- ♦ running costs € 17.5 ct per kg
- ♦ production increase of 30-60%

Effect of **light** transmission

Light transmission 70-75%

Investments plastic:
€ 1-1.5 every 2-4 years

Investment glass:
€ 4 once



The Netherlands



Spain

Effect of light control - screens

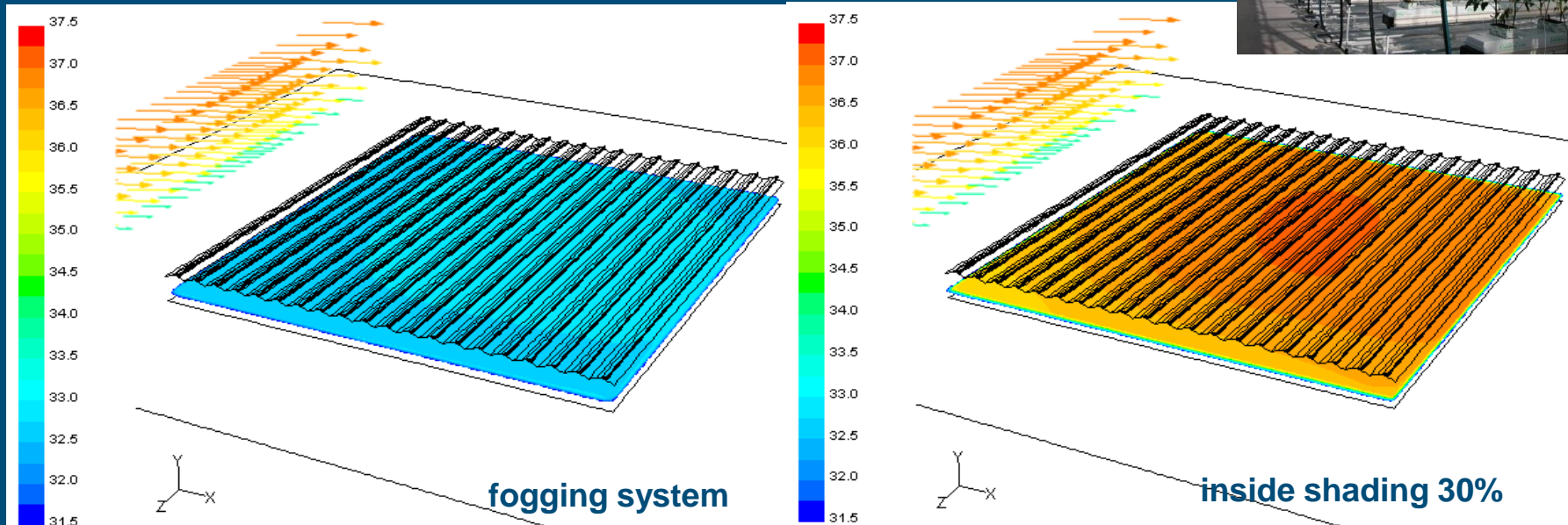


shading fraction	water consumption [$\text{m}^3/[\text{m}^2 \text{ yr}]$]	production
No shading	1.217	100%
30% shading	1.090	94%
40% shading	1.067	93%
50% shading	1.034	90%

Investment costs moving screens ca. € 5-8 per m^2

- ♦ Energy saving, better winter climate, better quality
- ♦ + additional controlling summer light / - decrease production

Effect of shading vs. fogging



Min air temp: 31.20 °C

Max air temp: 32.98 °C

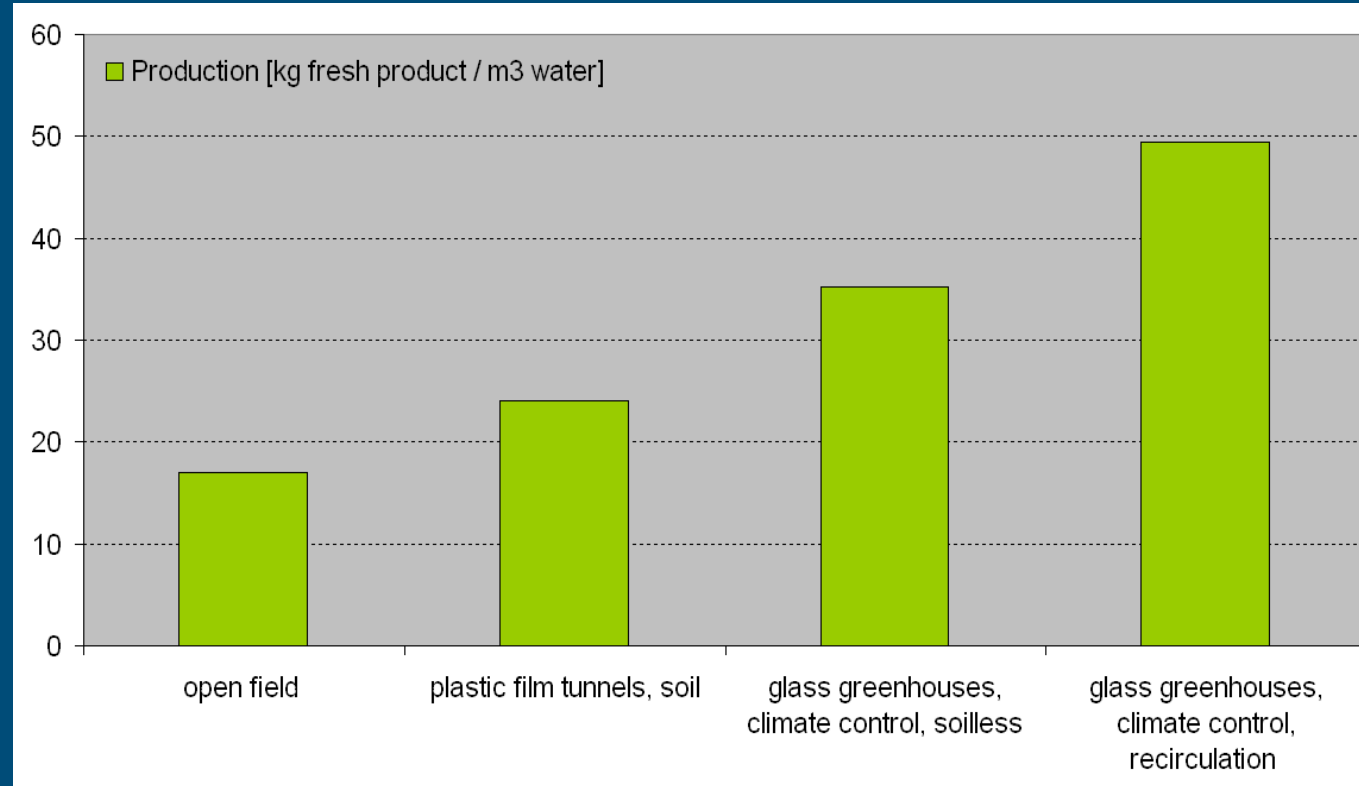
Min air temp: 35.90 °C

Max air temp: 37.05 °C

Hydroponics



- ◆ Independent from soil quality
- ◆ Less nematodes
- ◆ High water use efficiency
- ◆ Saving nutrients, saving costs
- ◆ Local and/or organic material?



Integrated pest control

- ♦ Control of pest and diseases
 - ♦ Integrated pest and disease control
 - ♦ Biological pest control – beneficials
 - ♦ Hygiene
 - ♦ Insect netting



Sustainability factors

	Glass standard	Glass with CO ₂	Glass with fogging	Glass with CO ₂ & fogging	Glass with CO ₂ & fogging & closed water system	Glass CO ₂ & fogging & closed water system & lighting	Glass with CO ₂ & fogging & closed water system & insect nets & screens
Use of resources:							
Water consumption [kg produce/m ³]	28.3	41.8	27.1	38.4	49.4	62.3	51.9
Energy (heat) consumption [MJ/kg]	14.7	9.9	14.5	9.7	9.7	4.5	9.2
Produce less environmental loads:							
CO ₂ application per unit produce	zero	high	zero	medium	medium	high	medium
Nutrient emissions	high	high	high	high	low	low	low
Pesticides applied per unit produce	high	high	high	medium	medium	medium	low
Efficiency of production process:							
Yield per area [kg/m ²]	36.0	53.3	36.4	54.7	54.7	68.9	57.5
Profit per area and year [€/m ² /year]	€6.90	€14.87	€6.74	€15.56	€15.62	€(2.40)	€16.58
Payback period [years]	4.3	3.0	4.4	3.0	3.1	7.9	3.0

What is the optimum greenhouse design for Turkey?

⇒ Highest yields and shortest return of investment by heating and CO₂

⇒ However.....

- ⇒ More technology (fogging, shading, insect nets) increasing certainty of production, return of investment comparable
- ⇒ Economic results are strongly dependent on product prices and interest rates for capital costs

Wageningen UR Glastuinbouw

Innovations for the greenhouse sector

Questions?

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