

# Intelligent water use in horticulture – trends in Dutch research

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# International dimension



## ■ Challenges:

- World population is now three times higher than 100 years ago (actual 6,8 billion)
- 2,4 to 3,3 billion people will suffer water shortage in 2025
- Poor water quality (salinity, pollution, pathogens)
- Competition between agriculture and industry / tourism
- 70% of water use world wide by agriculture
- → more intensive production necessary  
= more production with less resources (water, energy, soil...)
- → greenhouses?



# Water quality and quantity

- Salinity → crop stress, yield losses
- Pathogens → yield losses
- Scarcity of water → yield losses, quality losses, decreased income
- Increasing water prices
- → resistant varieties, water purification, out of the soil, closed cycles....
- → greenhouses?

100

Relative yield

$$Y = 100 - B \cdot (EC - A)$$

EC (mS/cm)

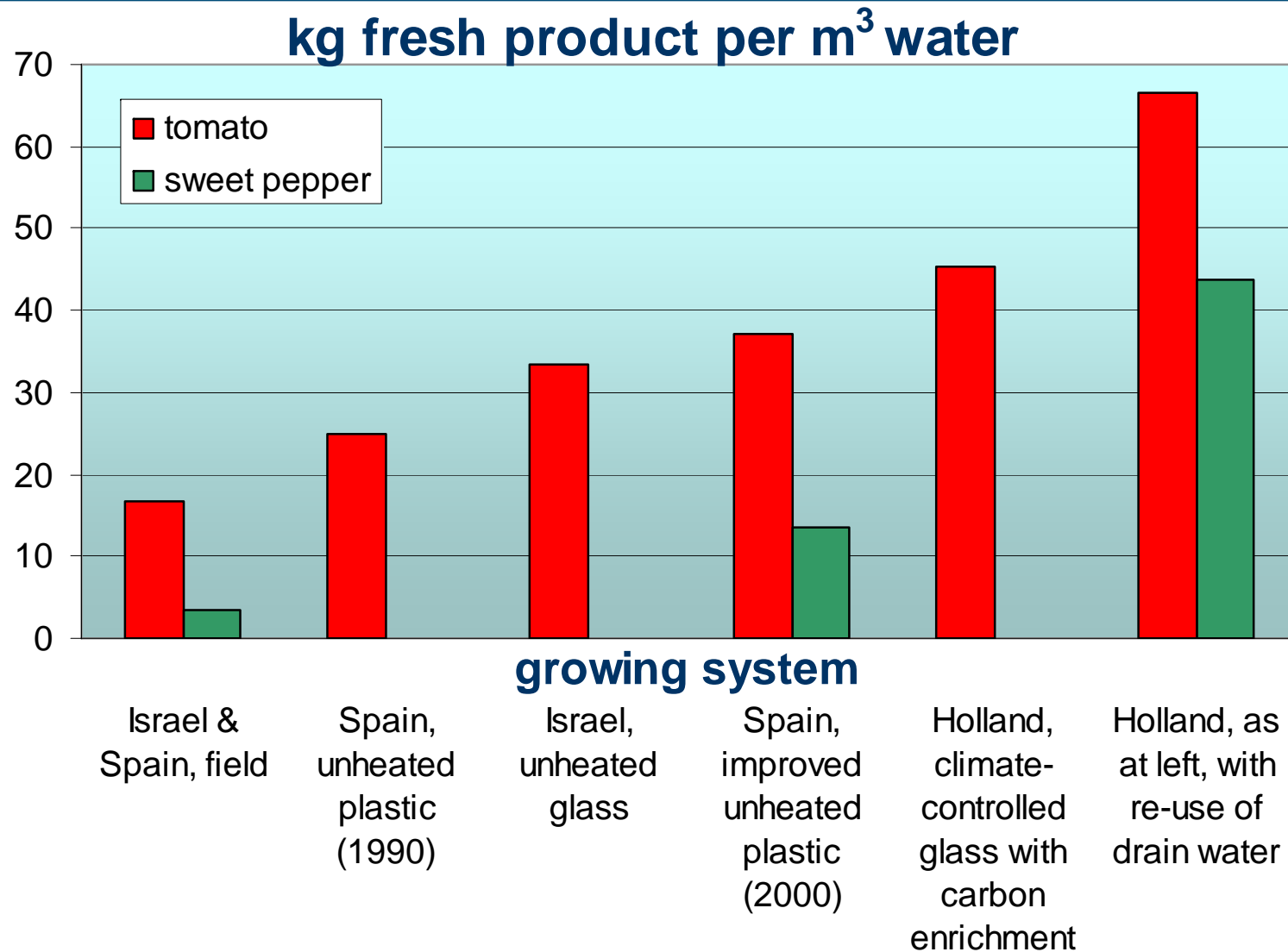


Desalinization plant  
of Carboneras,  
covers 1/3 of water  
needs of **Almeria**,  
costs 0.5 €/m<sup>3</sup>





# Water use efficiency **increases with ...**



**...increased controlled environment**

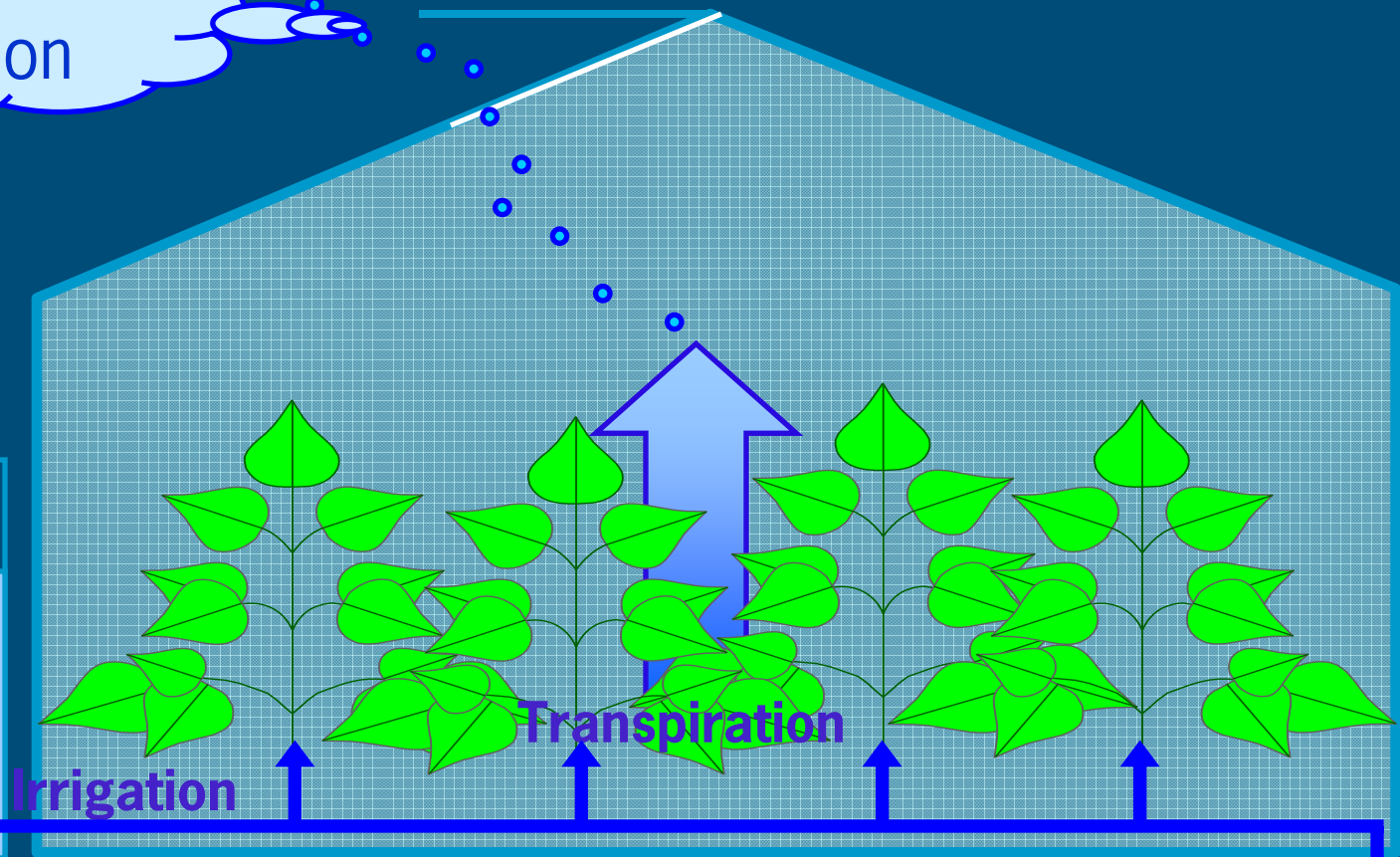
Stanghellini



# Water losses to air – “closed” water cycle

some 70% of  
irrigation

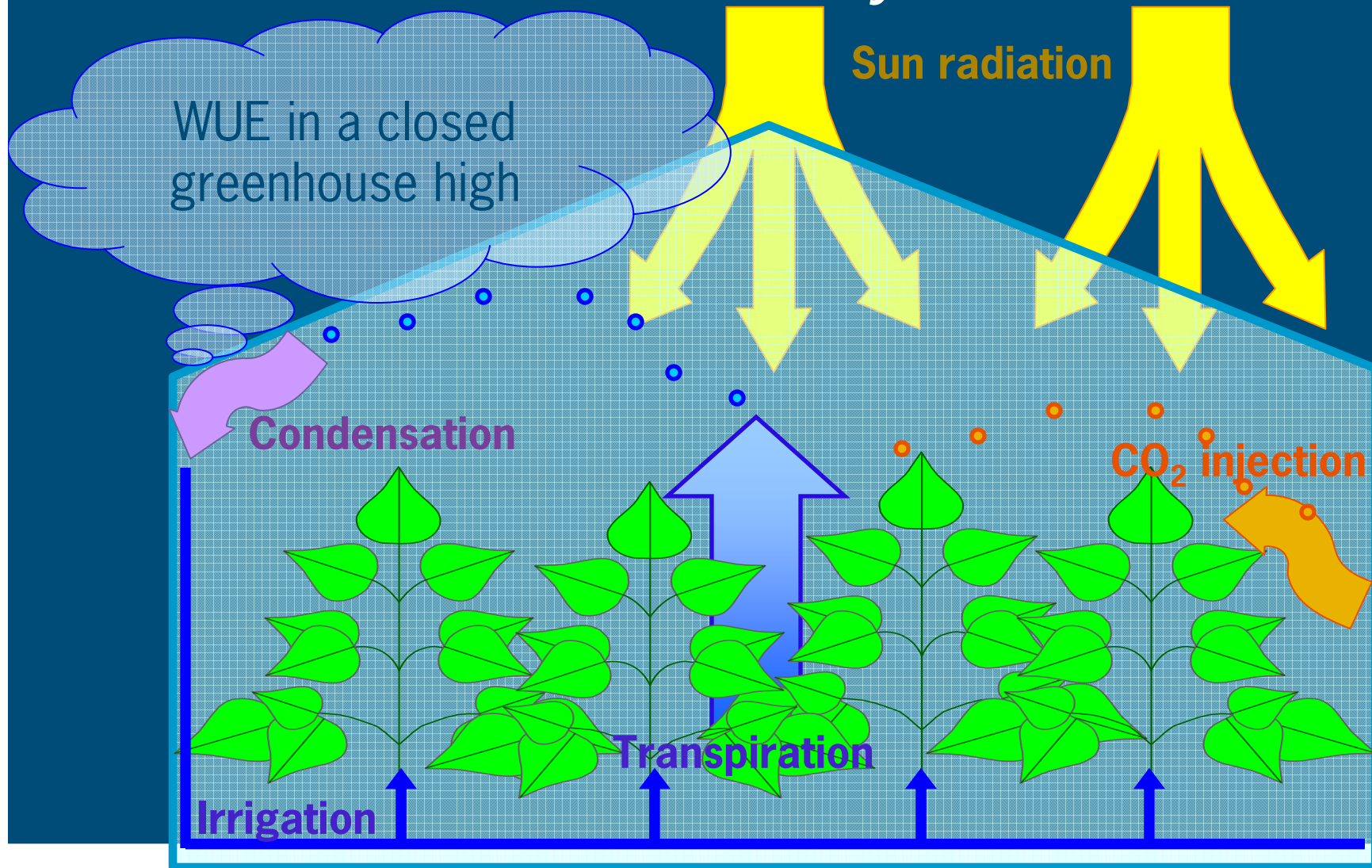
refill/rain



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For quality of life

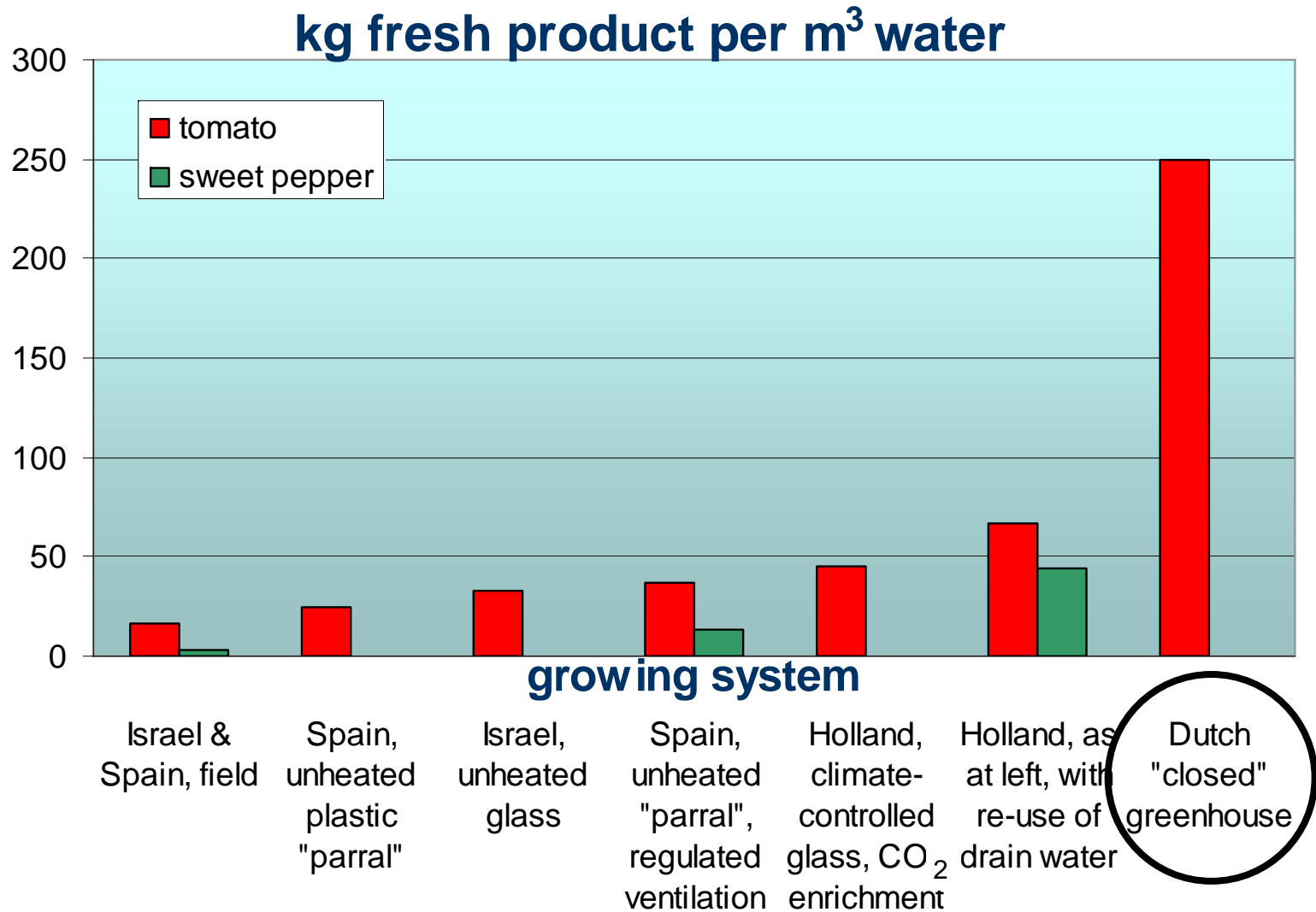


# Water losses to air – “really closed” water cycle





# Water use efficiency closed greenhouse





# Closed greenhouse

Minimum ventilation openings, keep ventilation as close as possible

Temperature and humidity regulation with heat exchangers and recovery



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For quality of life



# Water losses to soil - emissions



- Policy
- Directive water and emissions in Europe
- Directive about emission of nitrate, phosphate, chemicals and heavy metals
  - GLAMI emission norm of N and P to surface water
  - Emission of chemicals important
  - Goal 2027: Zero emission from a greenhouse
  - Minimum emission to ground, water and air





# Water recycling in greenhouses

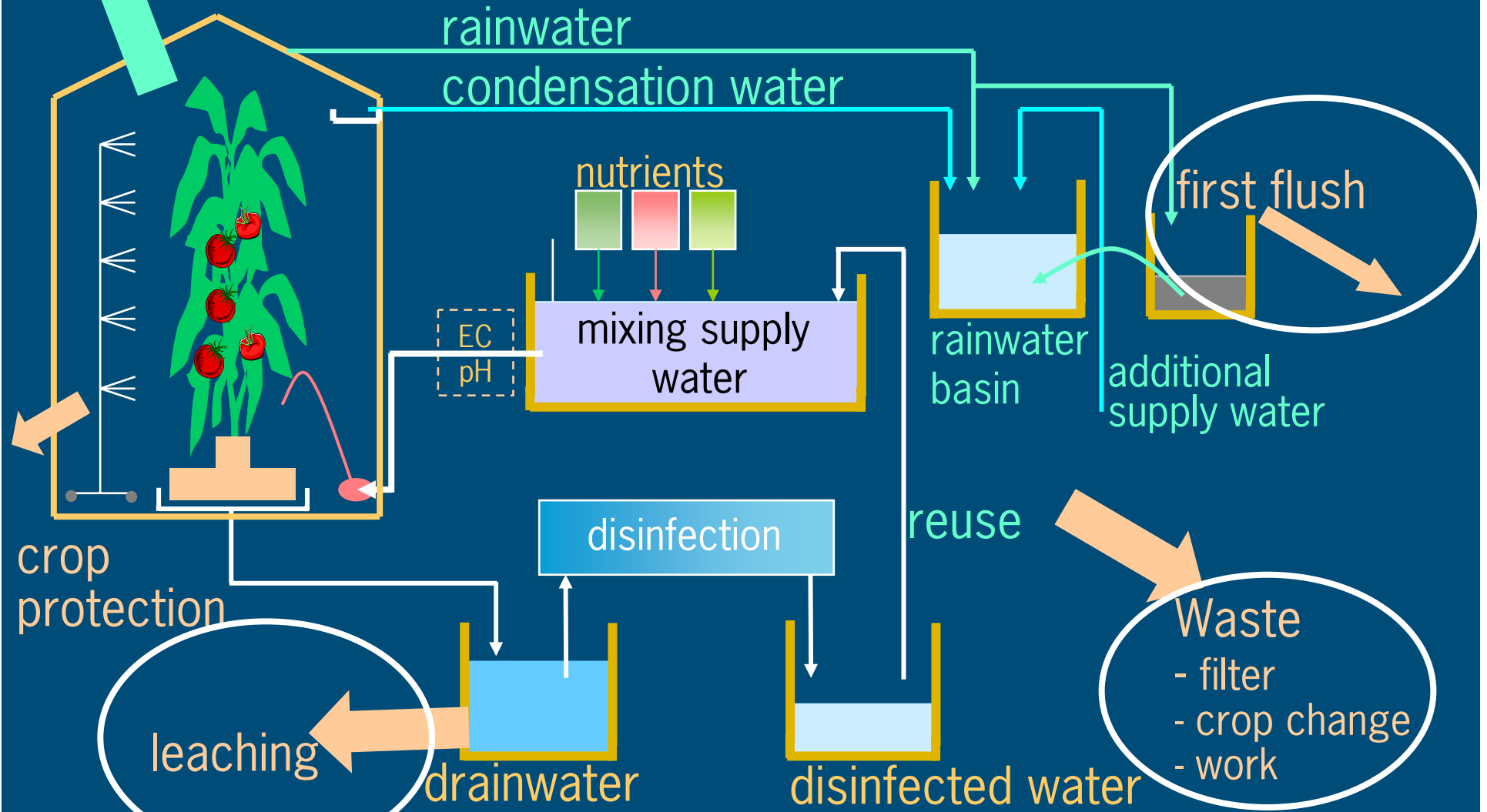
**Water saving potential  
of closed hydroponics in %**

	<b>Water</b>	<b>Nutrients</b>
<b>Cucumber</b>	<b>21</b>	<b>80</b>
<b>Roses</b>	<b>28</b>	<b>42</b>
<b>Chrysanthemum</b>	<b>15</b>	<b>64</b>





# Water losses to soil - emissions







Water recycling

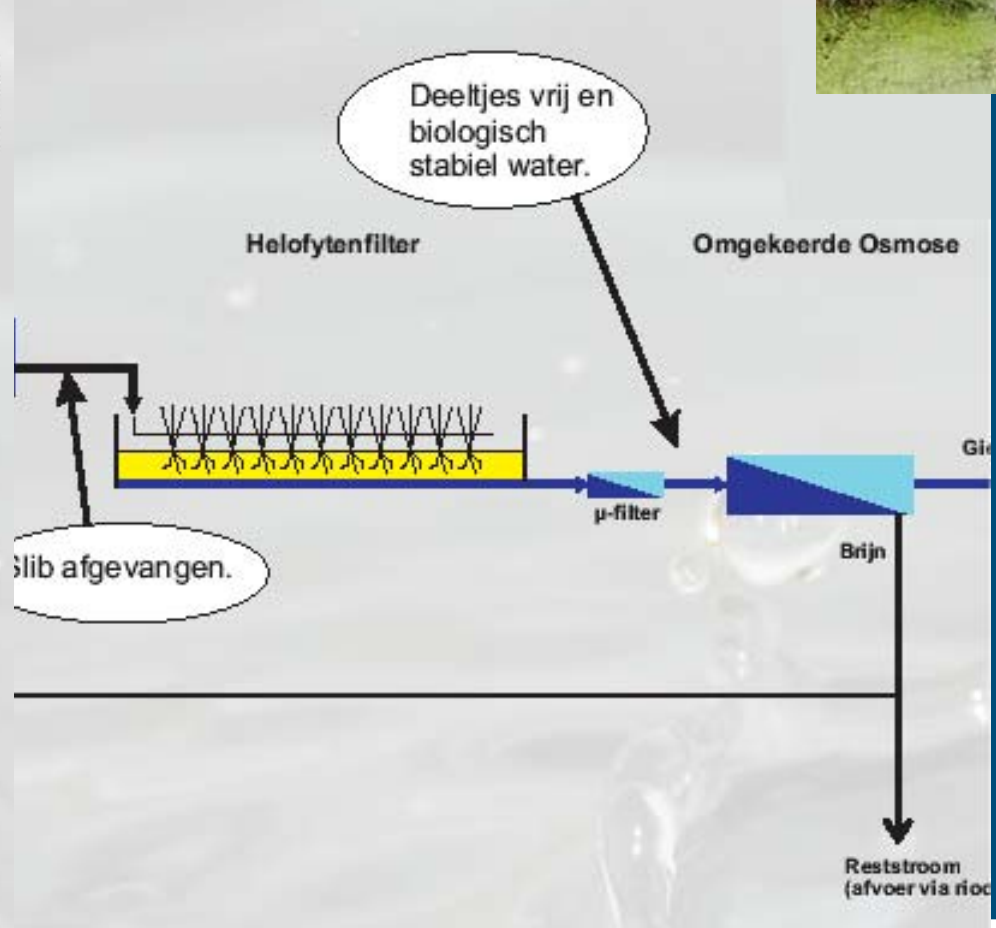
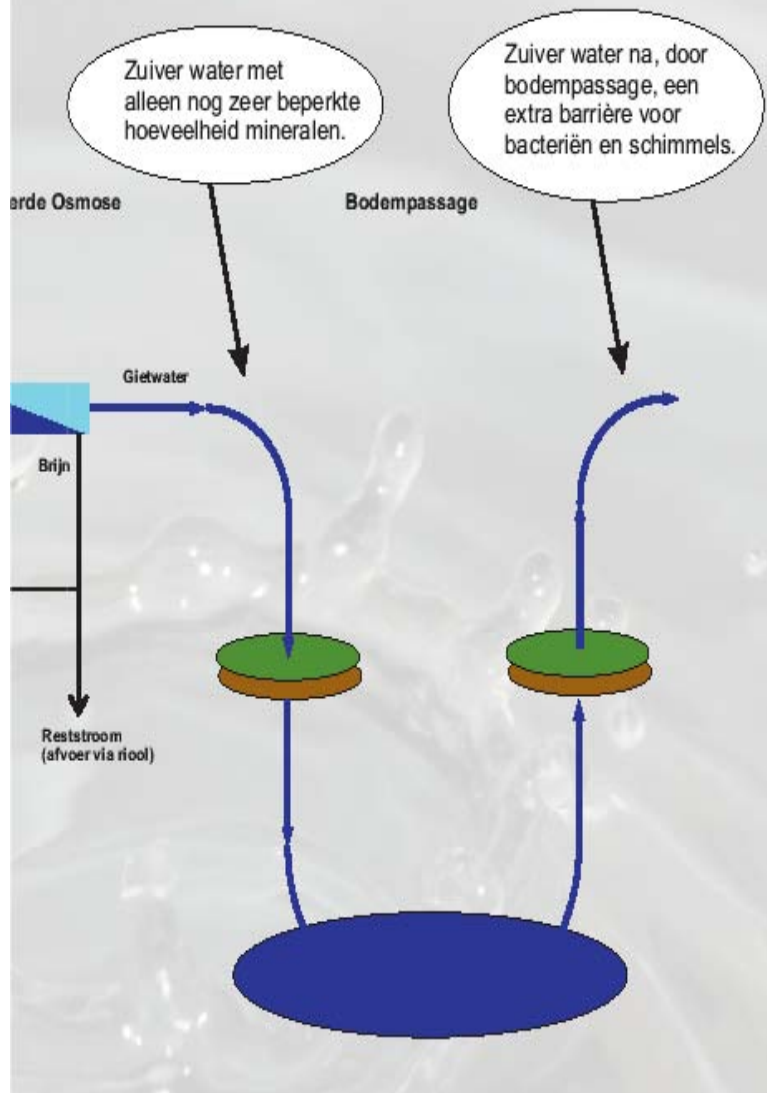
The image shows an industrial water recycling facility. In the foreground, there is a large, complex system of green cylindrical filters mounted on a metal frame. A man in a plaid shirt and jeans is standing to the left, looking at the equipment. The background shows more industrial structures and pipes. The text is overlaid on the image in yellow and white.

**Waste water processing:**  
**UV+H<sub>2</sub>O<sub>2</sub> against chemical residues (today)**  
**Carbon filter (today)**  
**Inverted osmosis, helophyte filter, bio filter**

**Water processing unit of a  
consortium of 4 growers  
(up to 64 ha). Price of water:  
0.7 to 0.8 €/m<sup>3</sup>  
depending on consumption**



# AquaReuse: Water recycling on regional level





# Water losses to soil – emissions

## ■ Projects in greenhouses

- Recirculation roses
- Chrysanthemum on substrate
- Lysimeter use in chrysanthemum

## ■ Project open field crops

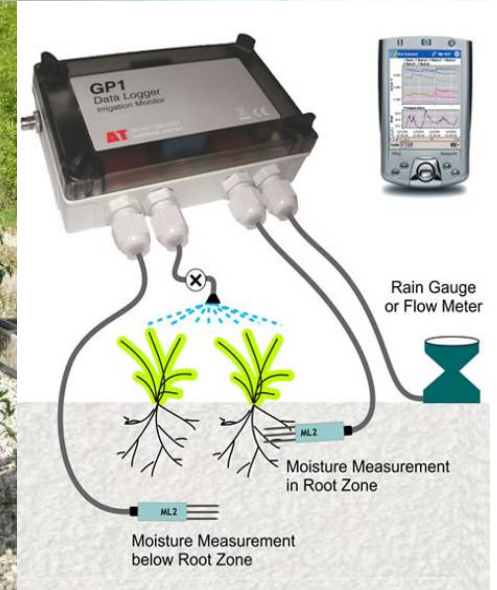
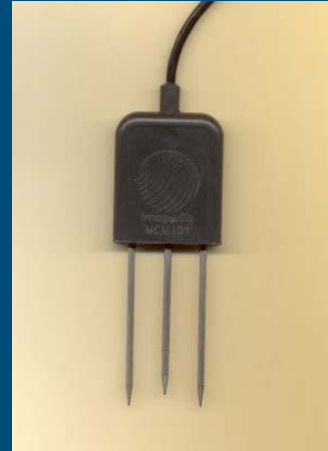
- Leech out of the soil
- Trees on gutters



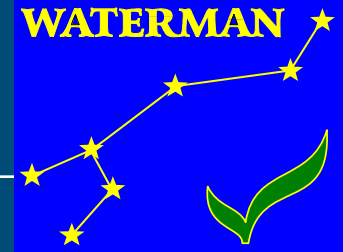


# Water losses to soil - sensors and control

- Sensors:
  - Tensiometer
  - WET-sensor (Water content, EC, Temperature)
  - Wireless sensor network
- Control:
  - Time
  - Sensor based
    - Model based (e.g. ET)
    - Water sources with different quality



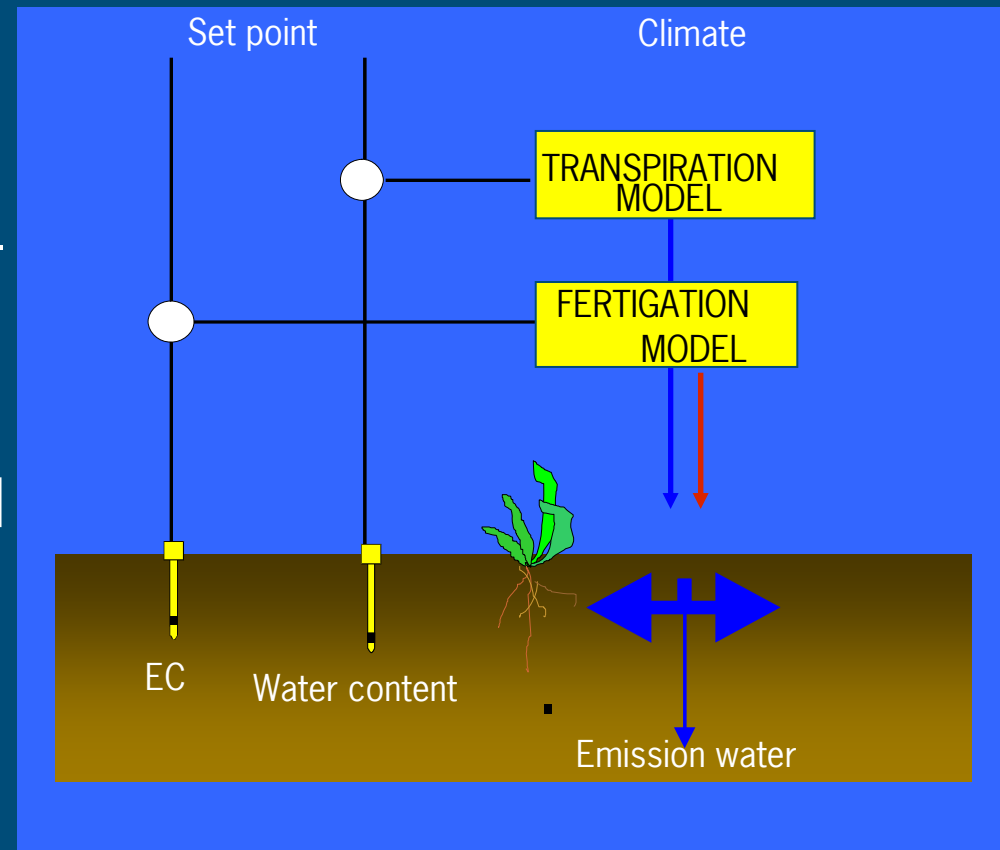




# Water losses to soil – sensors and control

## Waterman = Soil Sensor Activated Control for Water Management

- Goal: minimum penetration of water in ground water in open-field
- Virtual closed system
- Sensors for water content and EC
- Models for evapotranspiration and nutrient uptake





# Decision Support Systems



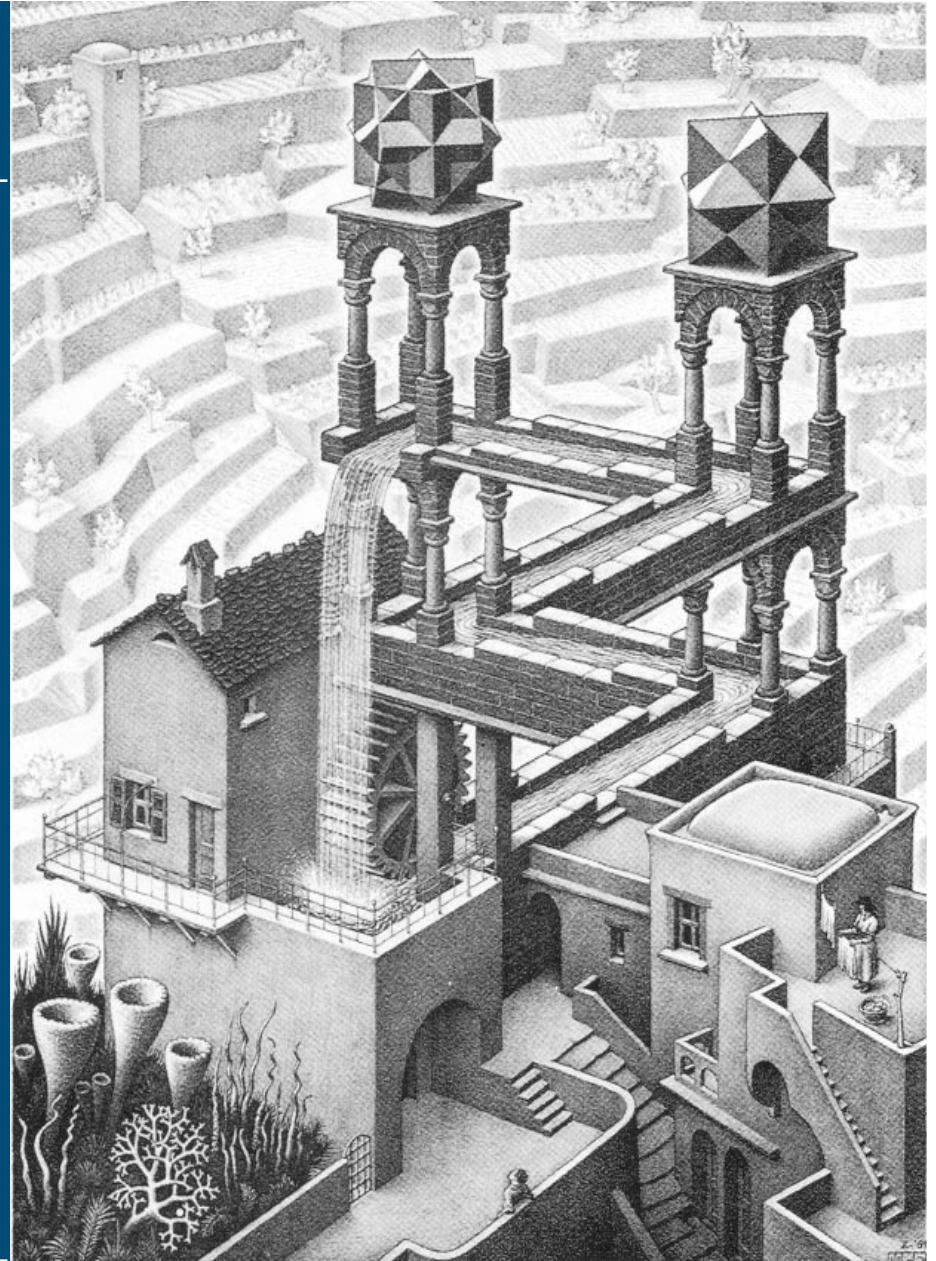
## Flow Aid = Farm Level Optimal Water management

- Combining different information from
  - Weather forecast
  - Water storage
  - Climate data (temperature, irradiation, wind)
  - Economical data of farming system
  - Soil based sensors (water content, EC, temperature)
  - Crop models (growth, transpiration, salinity tolerance)
- Support decision of grower → „apply water now“



# Water efficient systems

- Protected cultivation improves water use efficiency
  - Closed greenhouses reduce water losses to air
  - Recycling in hydroponics reduces water emission to soil
  - Regional water recycling
- Sensors and intelligent control
- Models and decision support system





# Thank you for your attention!

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