Irrigation management in soil grown greenhouse crops aiming at diminishing nutrient leaching

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Greenhouse Horticulture

The Netherlands

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- Initiatives
  - Re-use of drainage water
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Introduction

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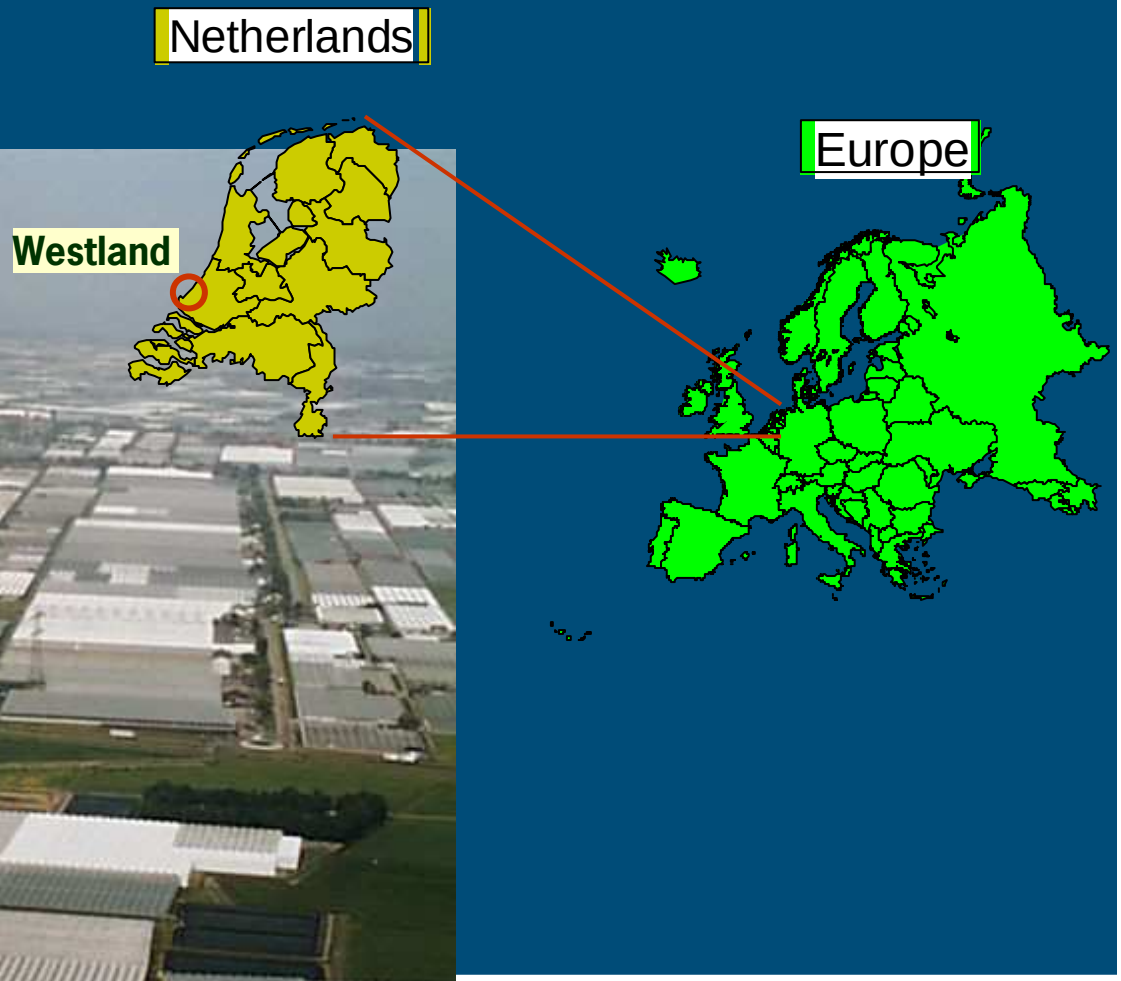
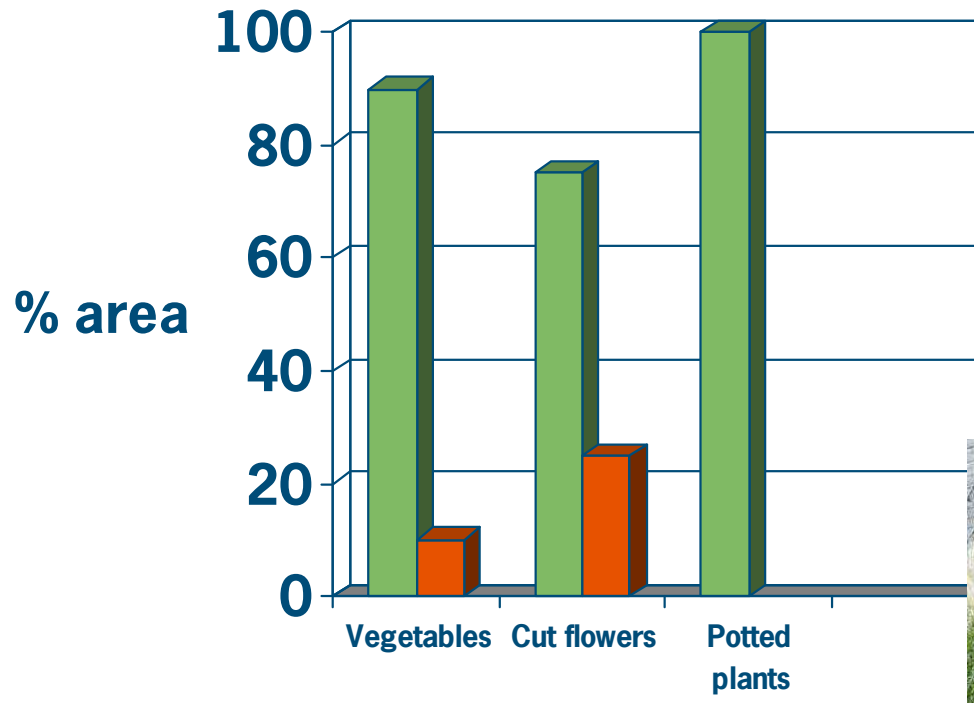
Intensive horticulture in the Netherlands



Growing systems



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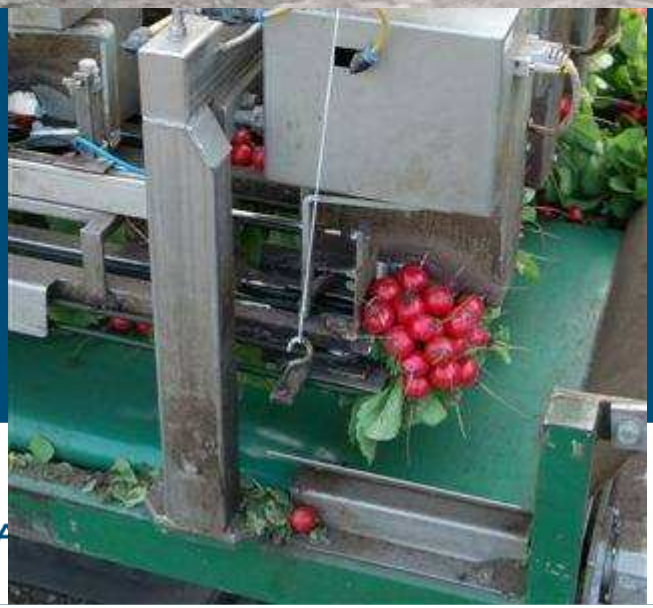
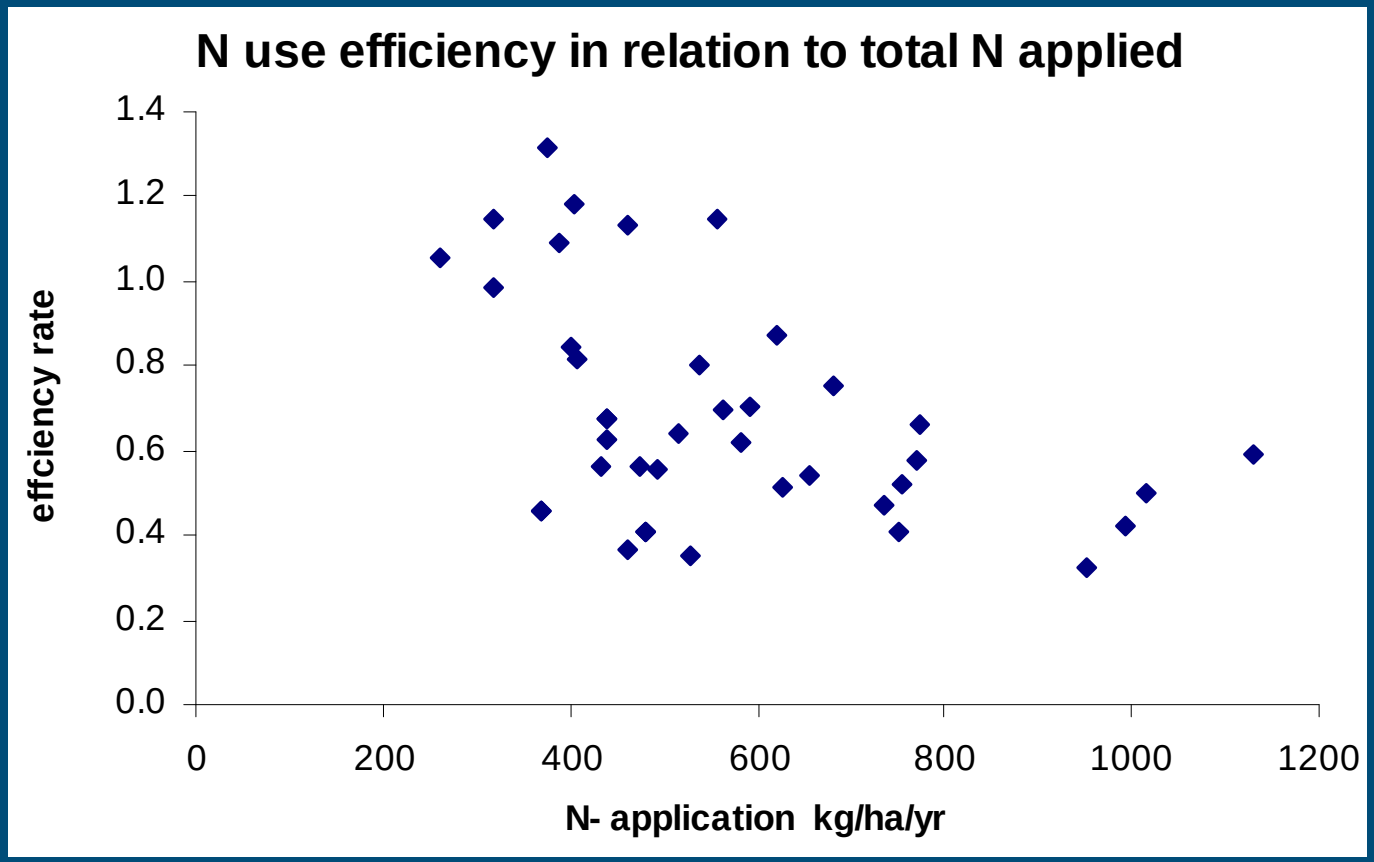


Greenhouse crops: high fertilizer use

- High growth rates, high crop requirements.
- Over-irrigation necessary:
  - unequal water distribution.
  - to prevent salinity
- High EC necessary for crop quality.
- Fertilizer costs insignificant.

Low efficiency !!



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Regulations

EU

- Water Framework Directive
- Nitrate Directive

Dutch greenhouse industry:

- 2000 – 2010 Targets for N and P use
- > 2010 Regulations on total N and P leaching from the soil
- 2027…. Zero emission from greenhouse crops

Dutch greenhouse system

How to reduce nutrient leaching ?

- Reduction irrgation surplus
- Reduction in N an P surplus

Bottle necks

- Unevenness irrgation system and crop transpiration
  dry and wet spots
- Salinity built up
  irrigation water, capillary rise
- Growers attitude towards irrigation management
  no risk

Initiatives

- Period 1995 - 2009

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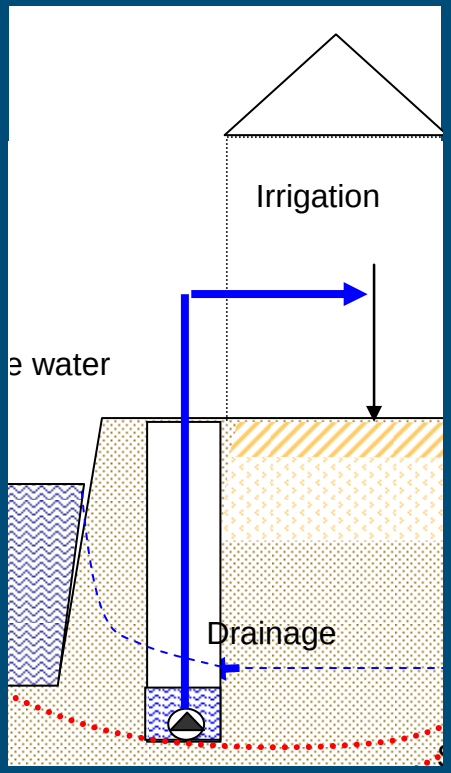
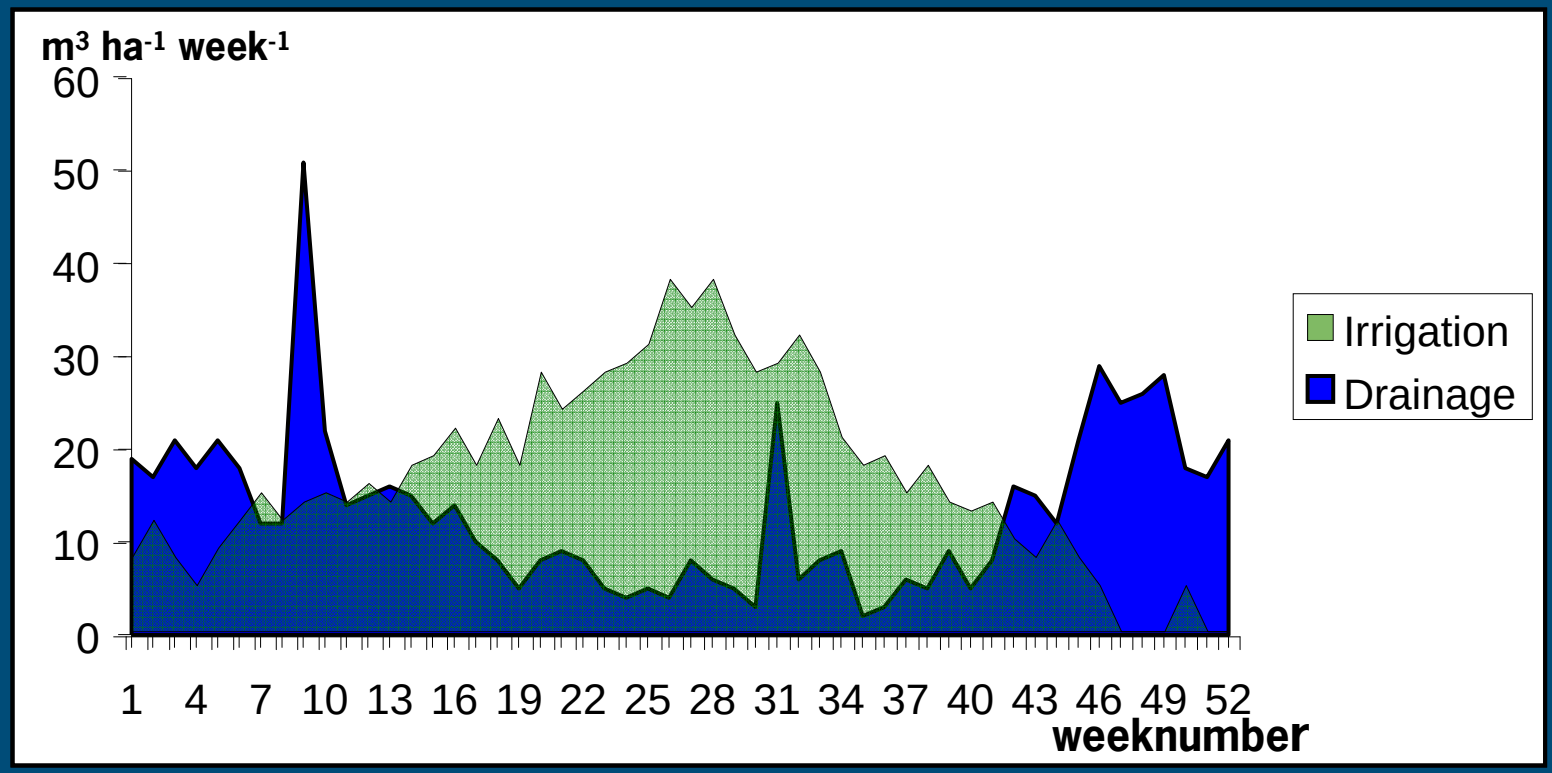
1. Re-use of drainage water



- High efficiency water and fertilisers
- Quantity problem
  - Periodically too much drain water
- Quality problem
  - Brackish groundwater

1. Re use drainage water

Synchronisation problem



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1. Re-use drainage water

other problems

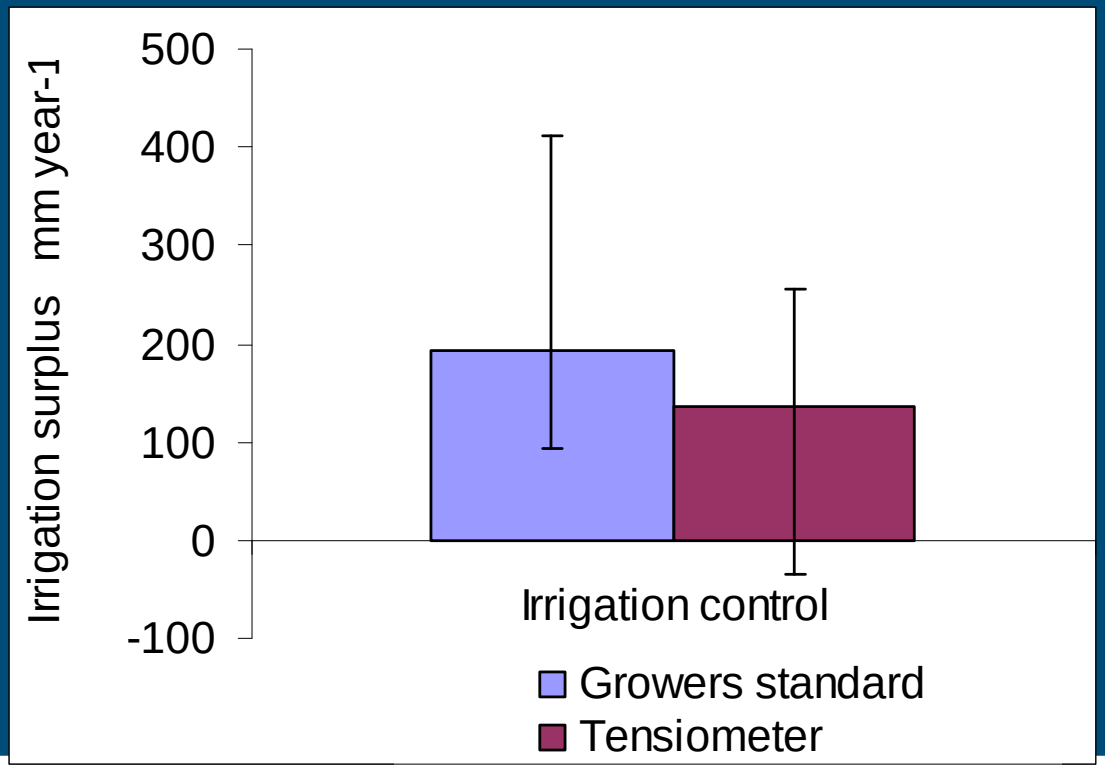
- Salt content: Na and Cl
- High Ca^{2+} + SO_4^{2-} or Ca^{2+} + HCO_3^-
- Phytopathogens ?
- Not a solution for deep ground water

2. Using soil sensors

- Tensiometers
- TDR and FD sensors

2. Using soil sensors

Results experiment 2 years cut flowers, lettuce and radish
- grower standard irrigation
- controlled by tensiometers



2. Using soil sensors

Problems

- Interpretation data
- Maintenance
- Frequent crop rotations

3. Tuning supply and demand

The **fertigation model** for soil grown greenhouse crops

3. Tuning supply and demand

Evapot. model

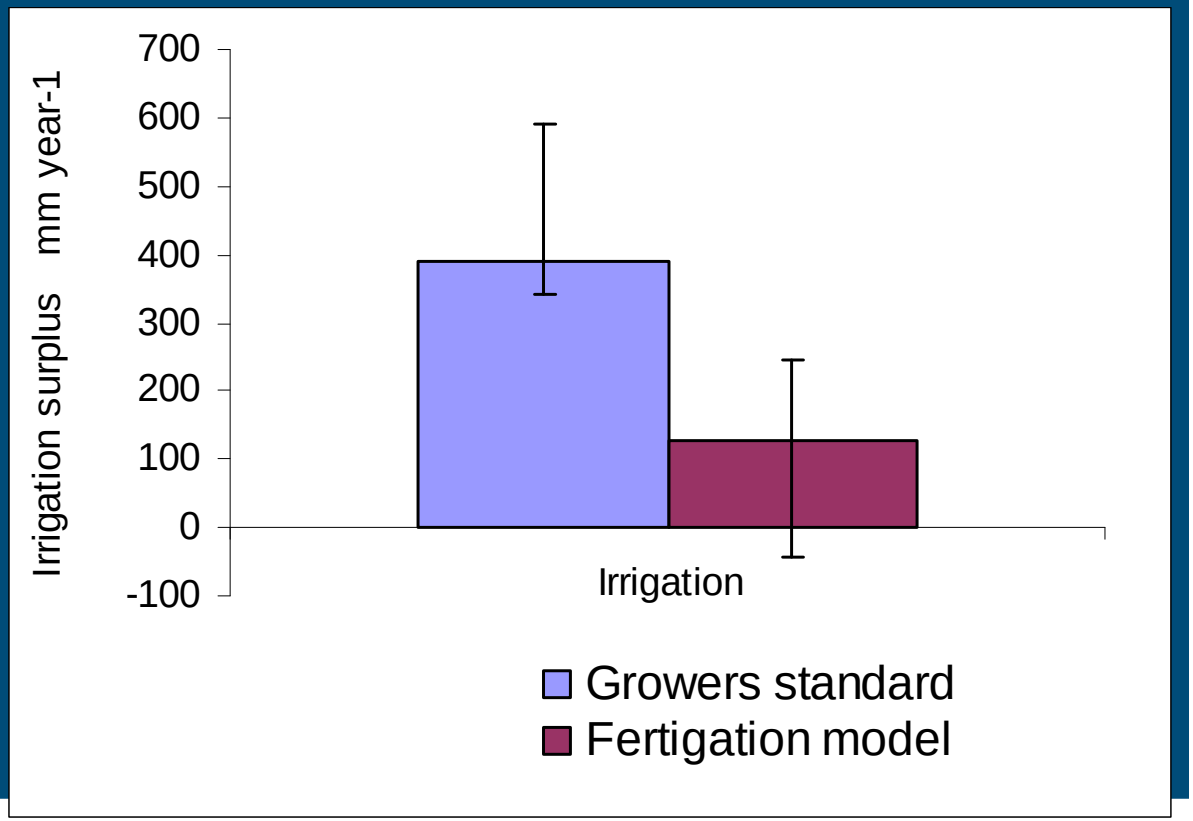
$$E = \frac{h}{m}[a\{T_g(\sum_{k=1440}^{k=1}\frac{\min_k}{1440}R + \sum_{m=1440}^{m=1}\frac{\min_m}{1440}s_t R) + \sum_{n=1440}^{n=1}\frac{\min_n}{1440}R_a\} + b\sum_{i=1440}^{i=1}\min_i(T_t - T_a)]$$

radiation screens assimilation light heating

- m = crop size
- a = specific crop type factor
- R = global radiation
- s_t = light reduction factor screens
- R_a = assimilation lighting
- Tg = greenhouse transmission
- b = specific crop factor
- Tt = heating temperature
- Ta = greenhouse temperature

3. Tuning supply and demand

Results experiment 2 years 8 chrysanthemum crops
- grower standard irrigation
- controlled by tensiometers



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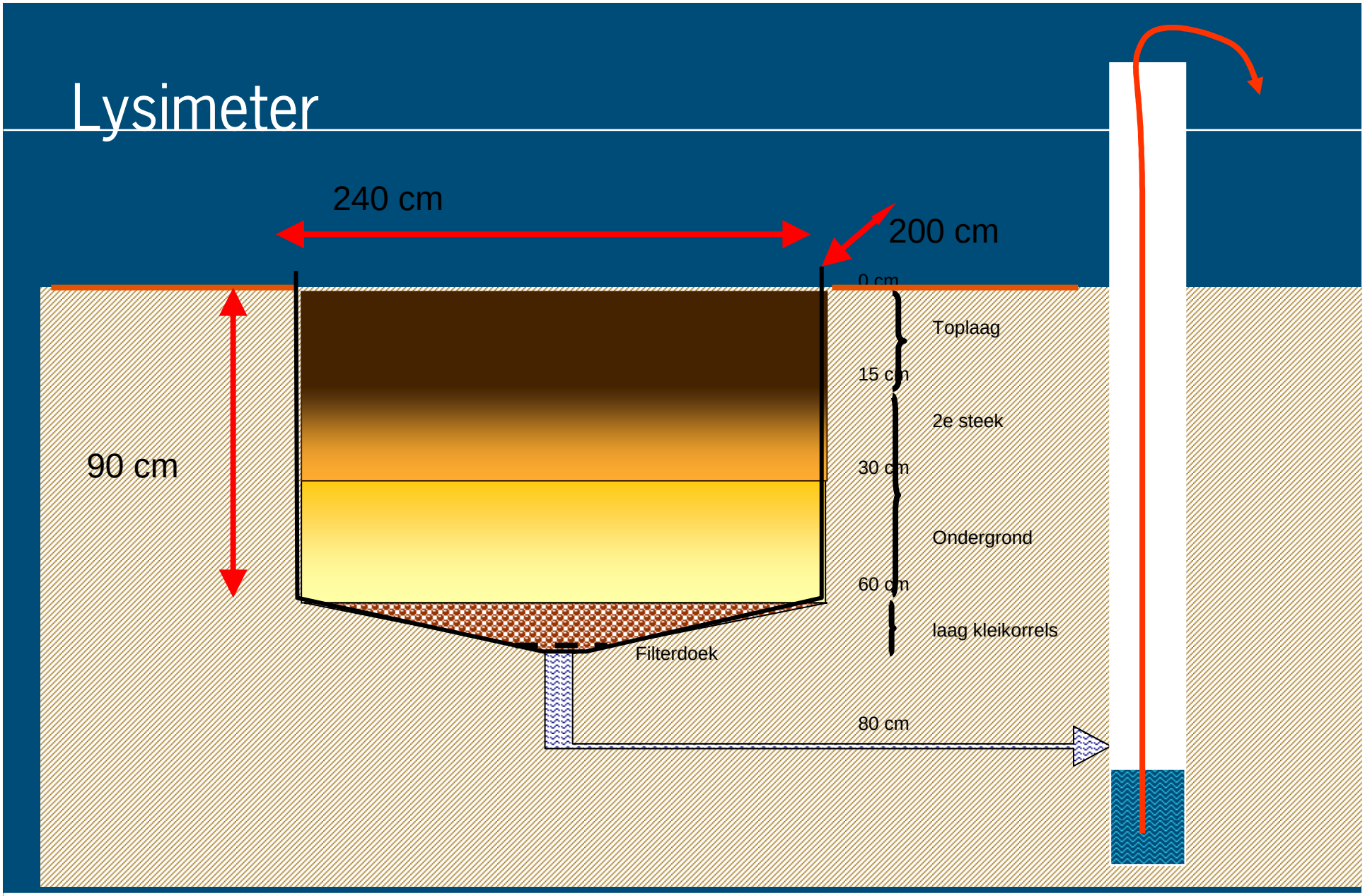
4. Lysimeters

- Designed for greenhouses
- Experiments in 2008 -2009 Purpose
- 1. emmission monitoring
- 2. irrigation management ?

Lysimeter



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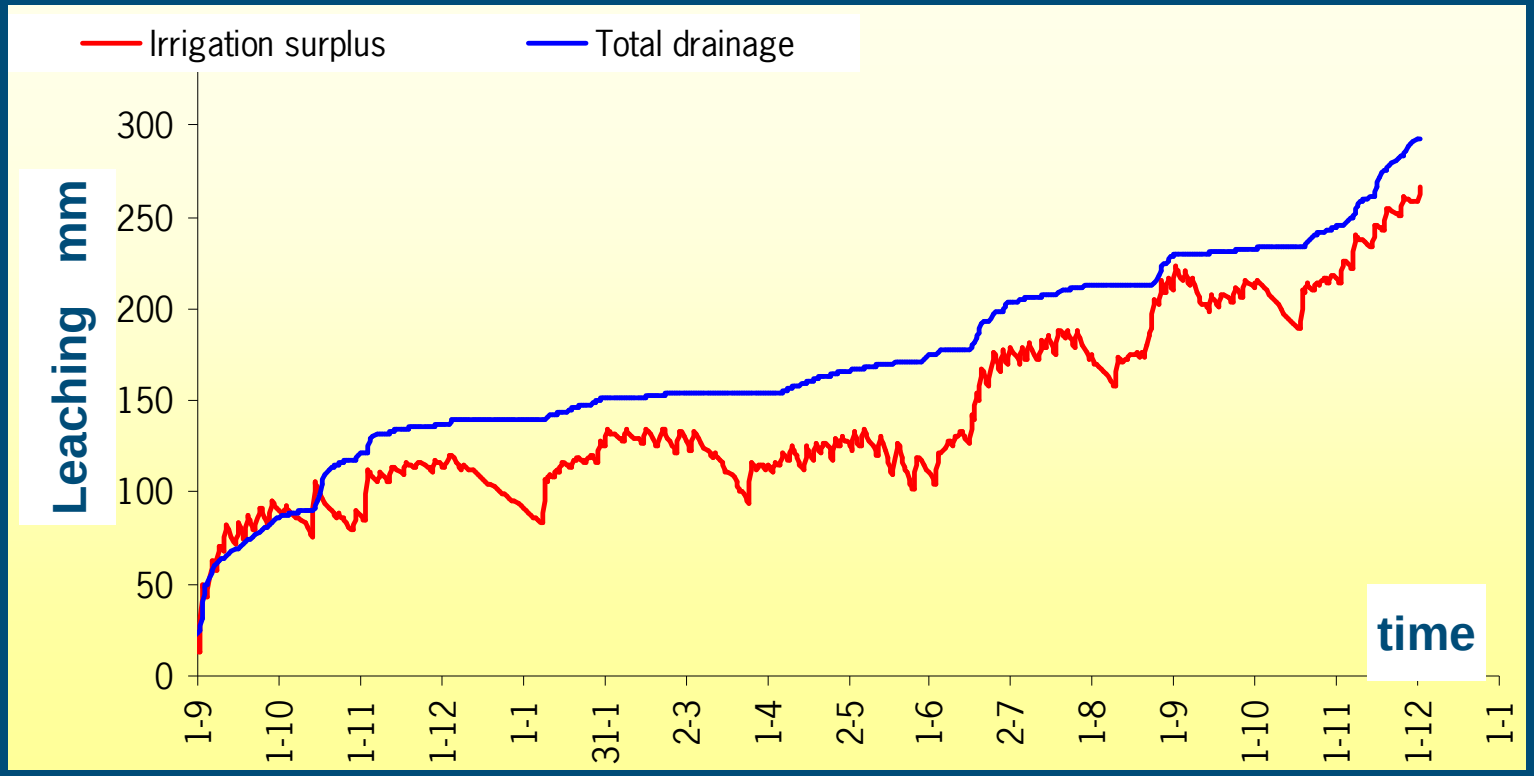
4. Lysimeters



Monitoring results experimental lysimeter in chrysanthemum.

1.5 year 7 crop cycles.

4. Lysimeters

- Results monitoring 6 nurseries

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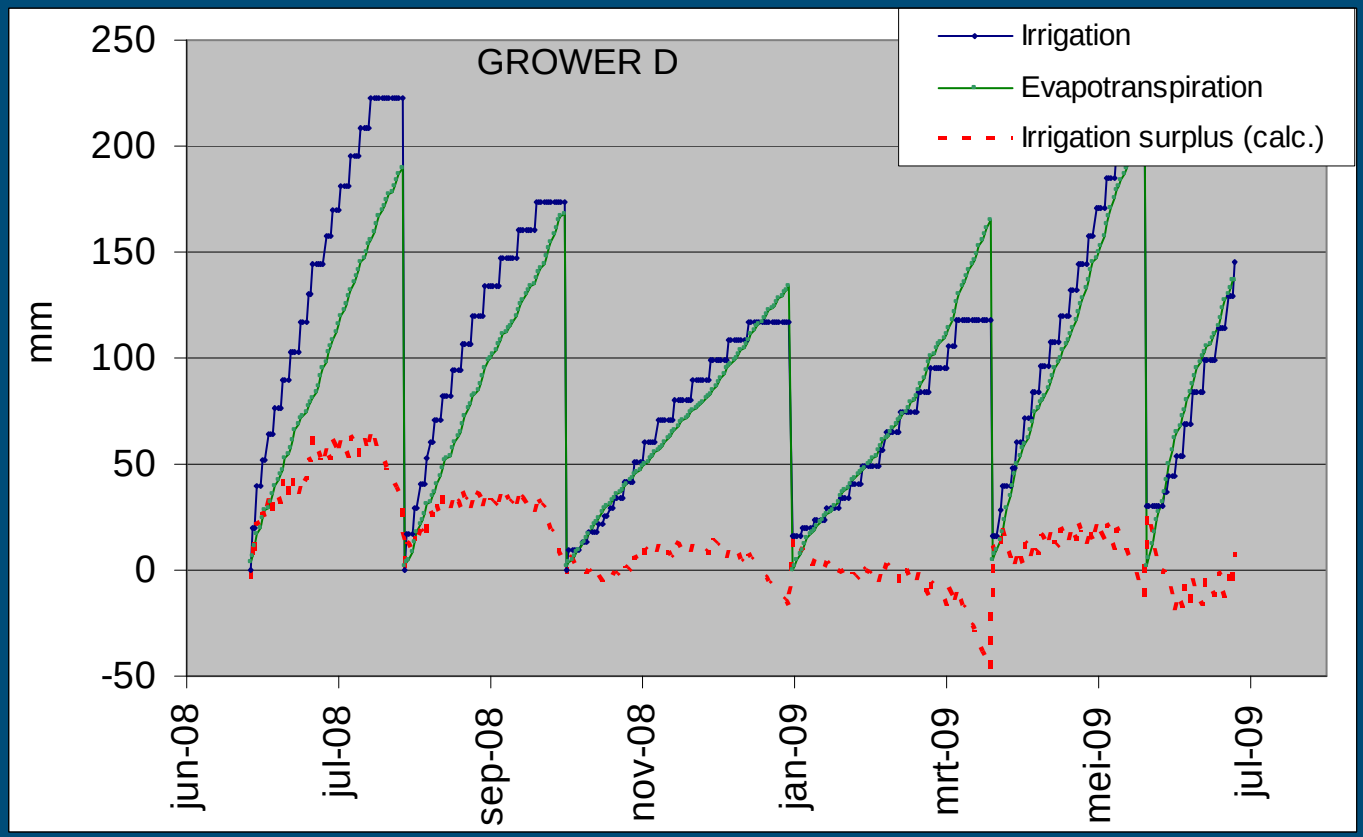
Irrigation, Evapotranspiration and Irrigation surplus

cumulative data per crop mm



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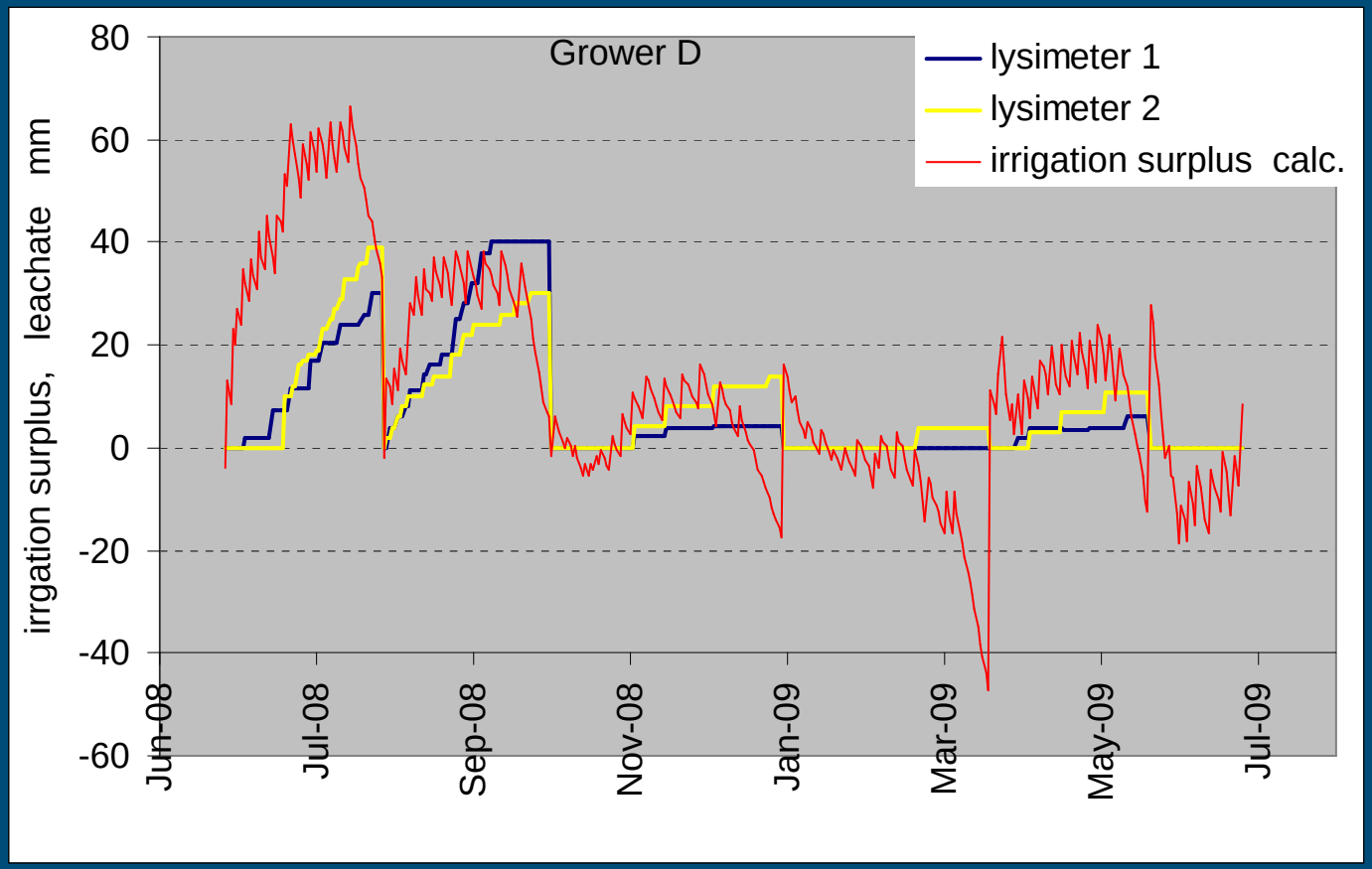
Results lysimeters
cumulative data per crop mm



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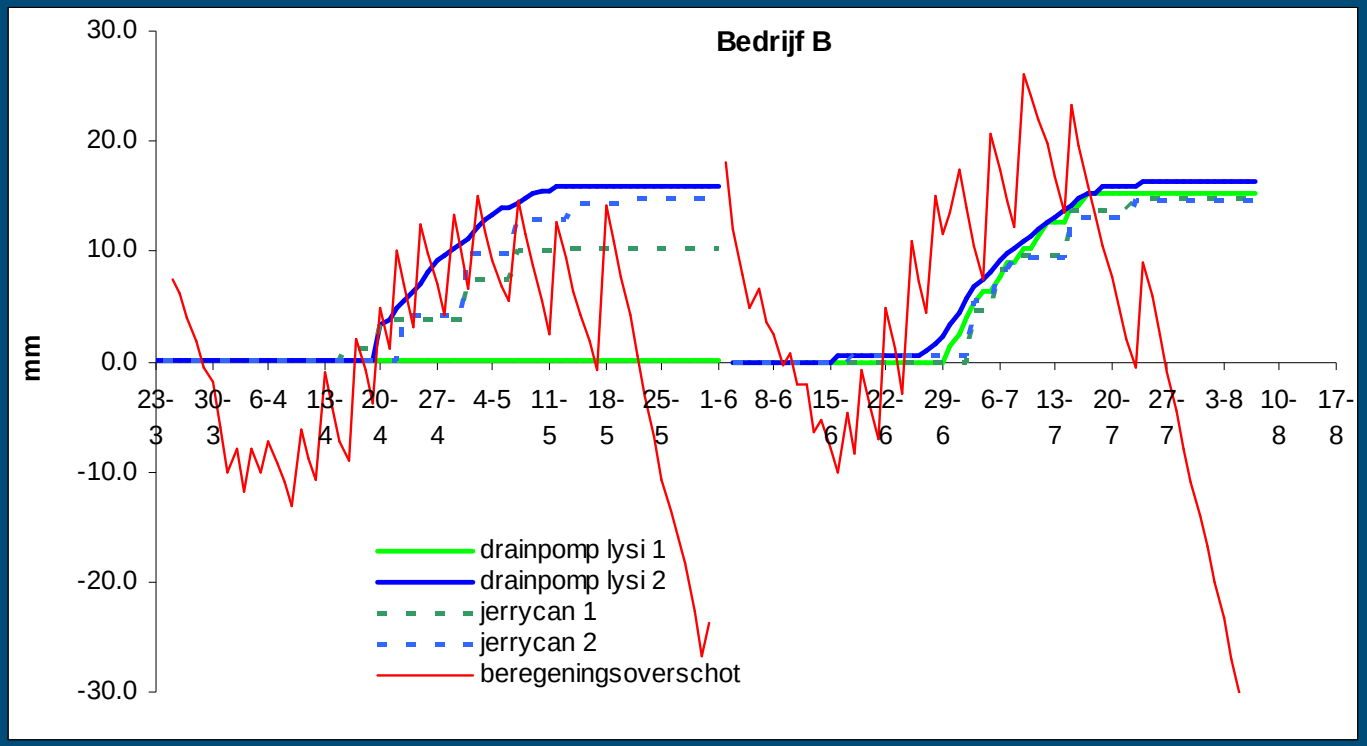
Use in irrgation management ?



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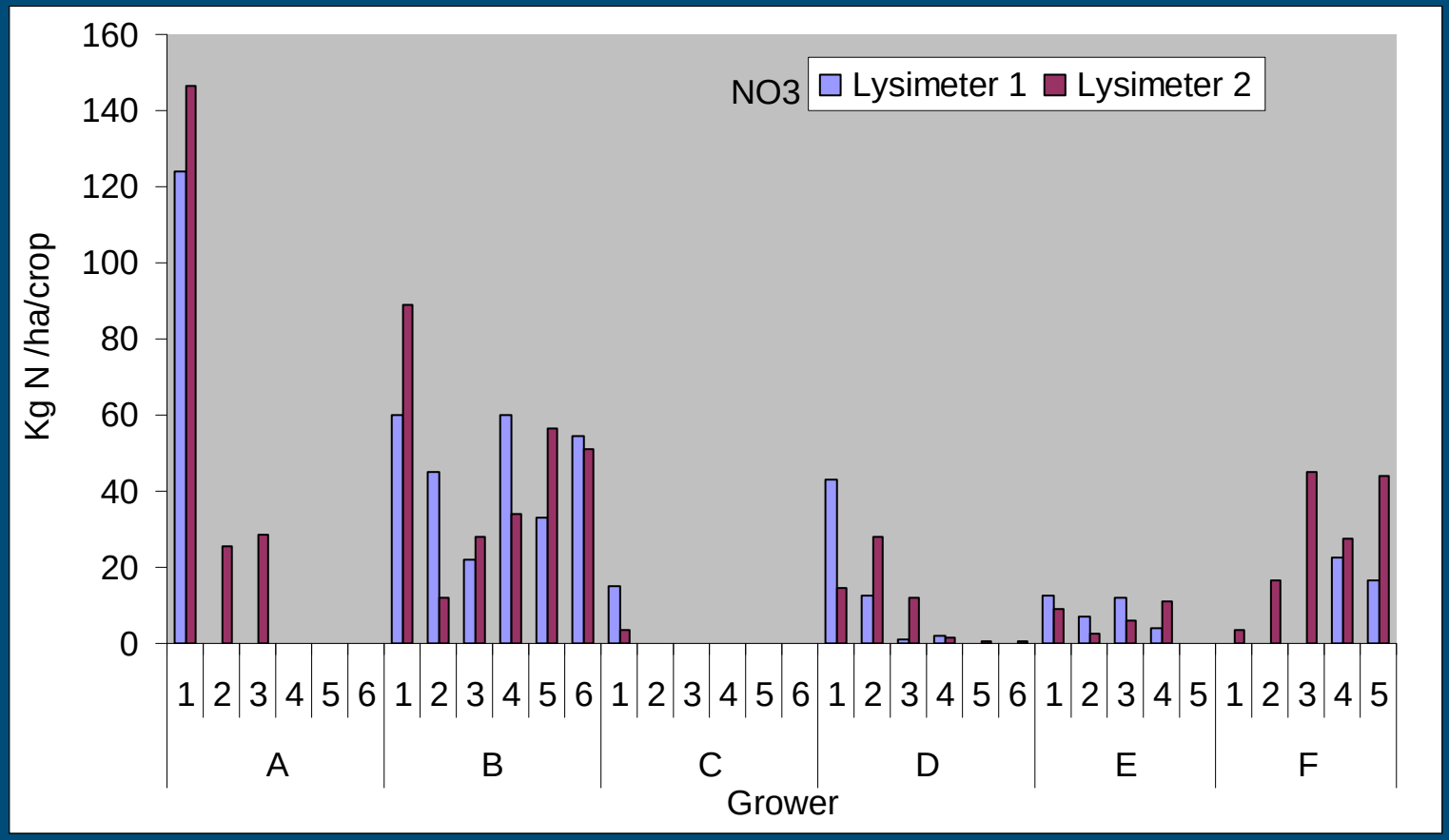
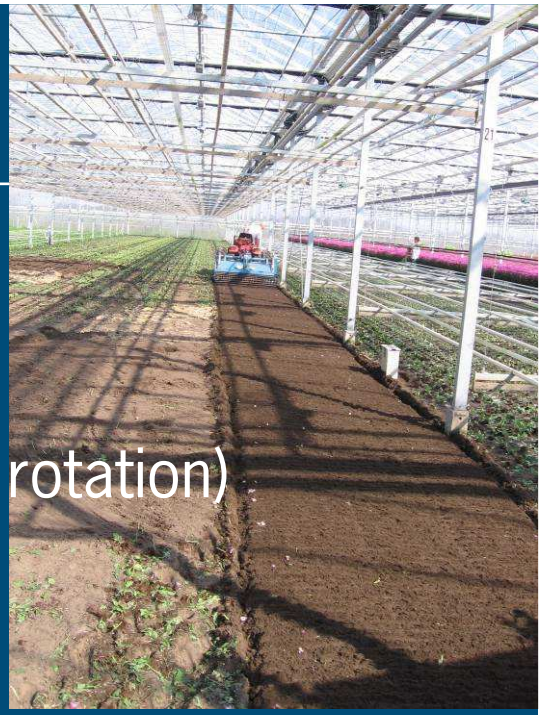
Nutrient leaching



4. Lysimeters

- Bottle necks system
  - How to adapt to growing system (frequent rotation)
  - (Steam) sterilisation
  - Dimensions (depth, sprinkler system)
- Bottle necks irrigation management
  - Time delay
  - Periods of deficit irrigation



Conclusion

- Irrigation surplus is high
- Consequently too high N emission

Solutions

- Re-use drainage water
  - Limited situations
  - Not sustainable
  - Unverifiable (regulations)
- Soil sensors
  - Too complicated
  - Unverifiable (regulations)
- Model based
  - Complicated
  - Unverifiable (regulations)
- Lysimeters
  - In development, many uncertainties
  - Complicated in implemantation
  - Verifiable (regulations)

Most important:

Change growers attitude

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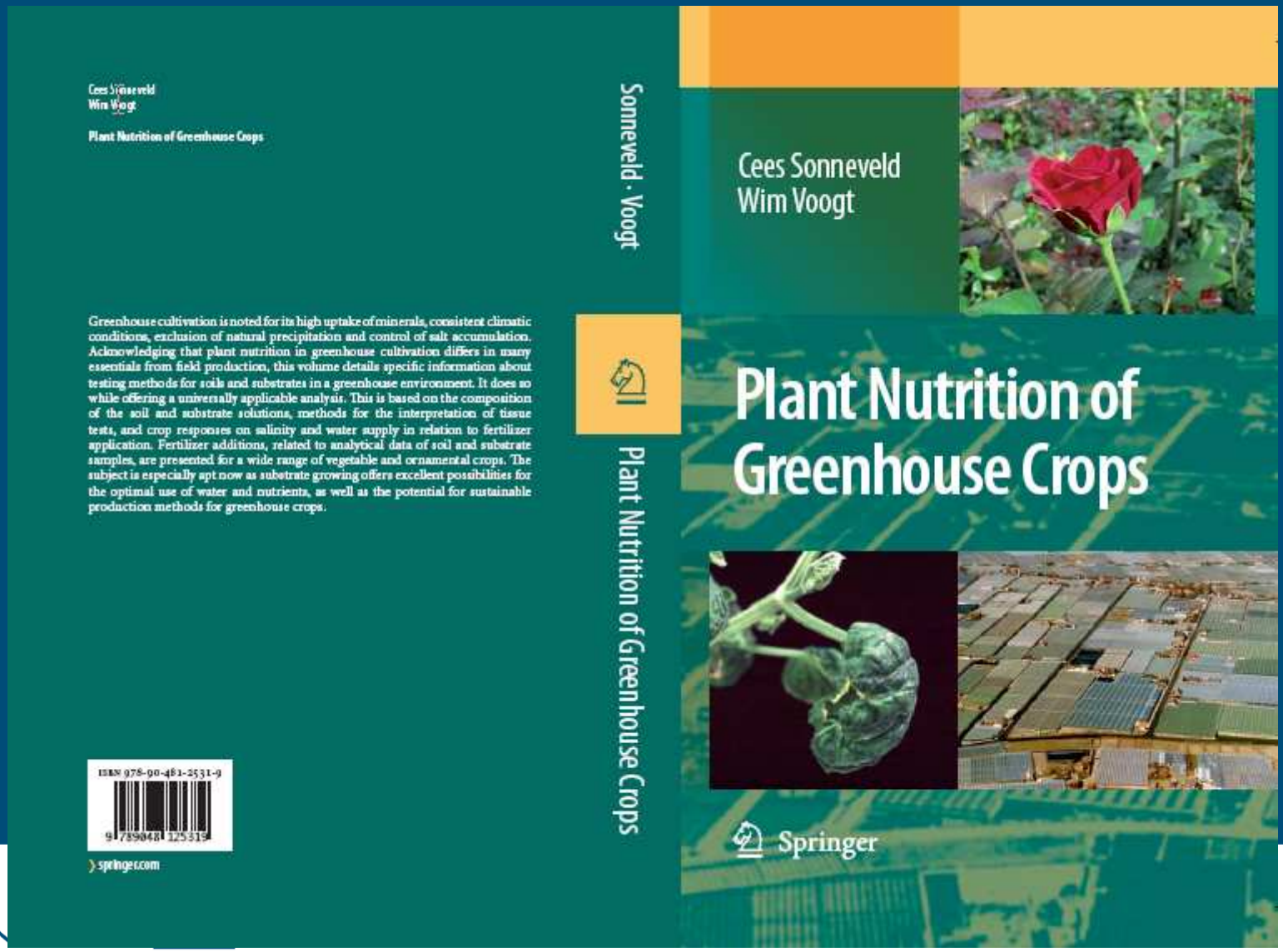
Next step

- Developing tool:
  - Emission management
  - Lysimeters, sensors combined with software tool

For those who want to know more….



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