Growing vegetables in salinated areas

freshwater availability & combatting salinization

Arie-Jan Broere
Broere Beregening
Design & consultancy and realisation of irrigation water projects.

DYNAMIC WATER SYSTEMS

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Contents

- Salinization in the Netherlands
- What can we expect in the future
- Enough water, but . . .
- Examples of succesfull solutions for farms
- Concluding remarks

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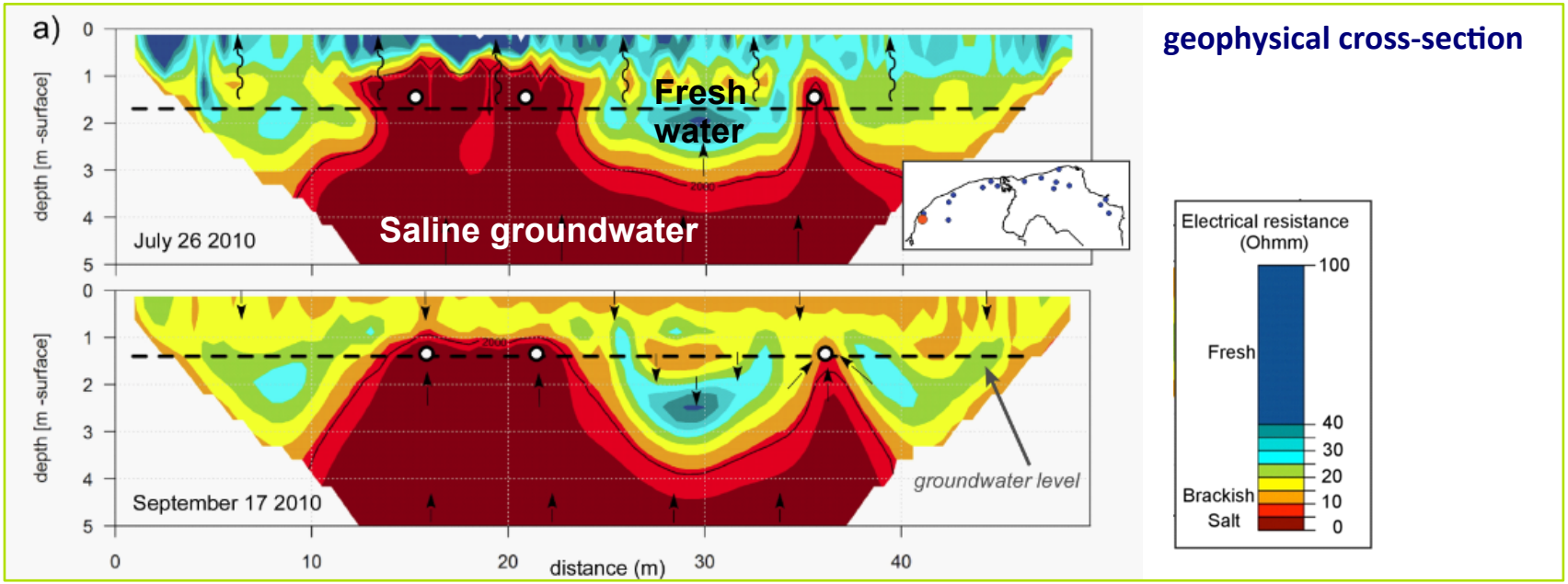
Fresh rain water lens

- Agriculture possible by the existence of fresh rain water lenses which ‘float’ on saline water
- Expected to dissappear, due to (1) sea level rise,

  (2) land subsidence and (3) climate change



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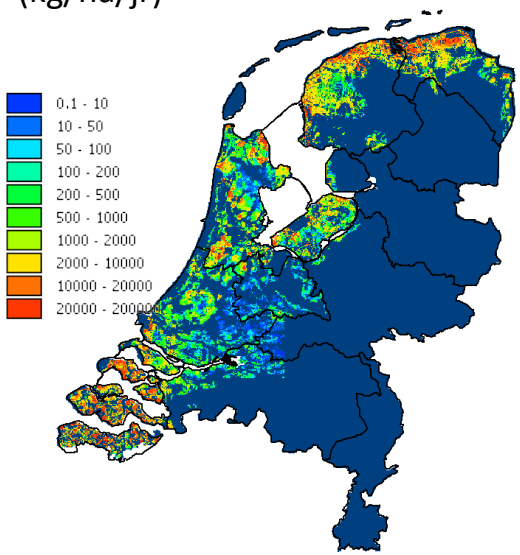
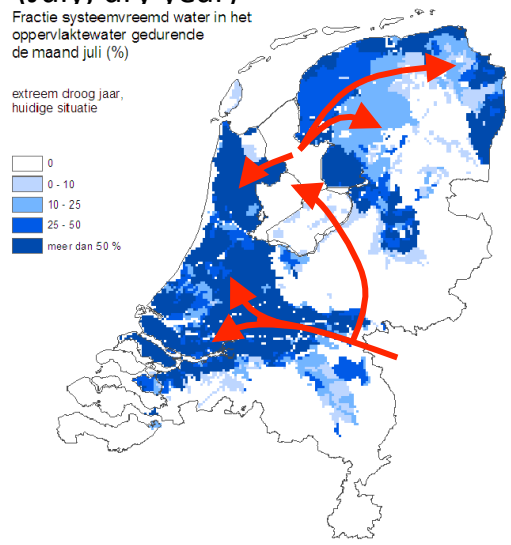
Dependency on inflow of fresh water

- Large areas with diffuse upward seepage of saline groundwater
- Waterquality maintained by flushing with fresh water from the river Rhine, main source of irrigation water.

Salt load from diffuse seepage (kg/ha/jr)



Area provided with water from Rhine (July, dry year)



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Example Uganda
area with high food insecurity.

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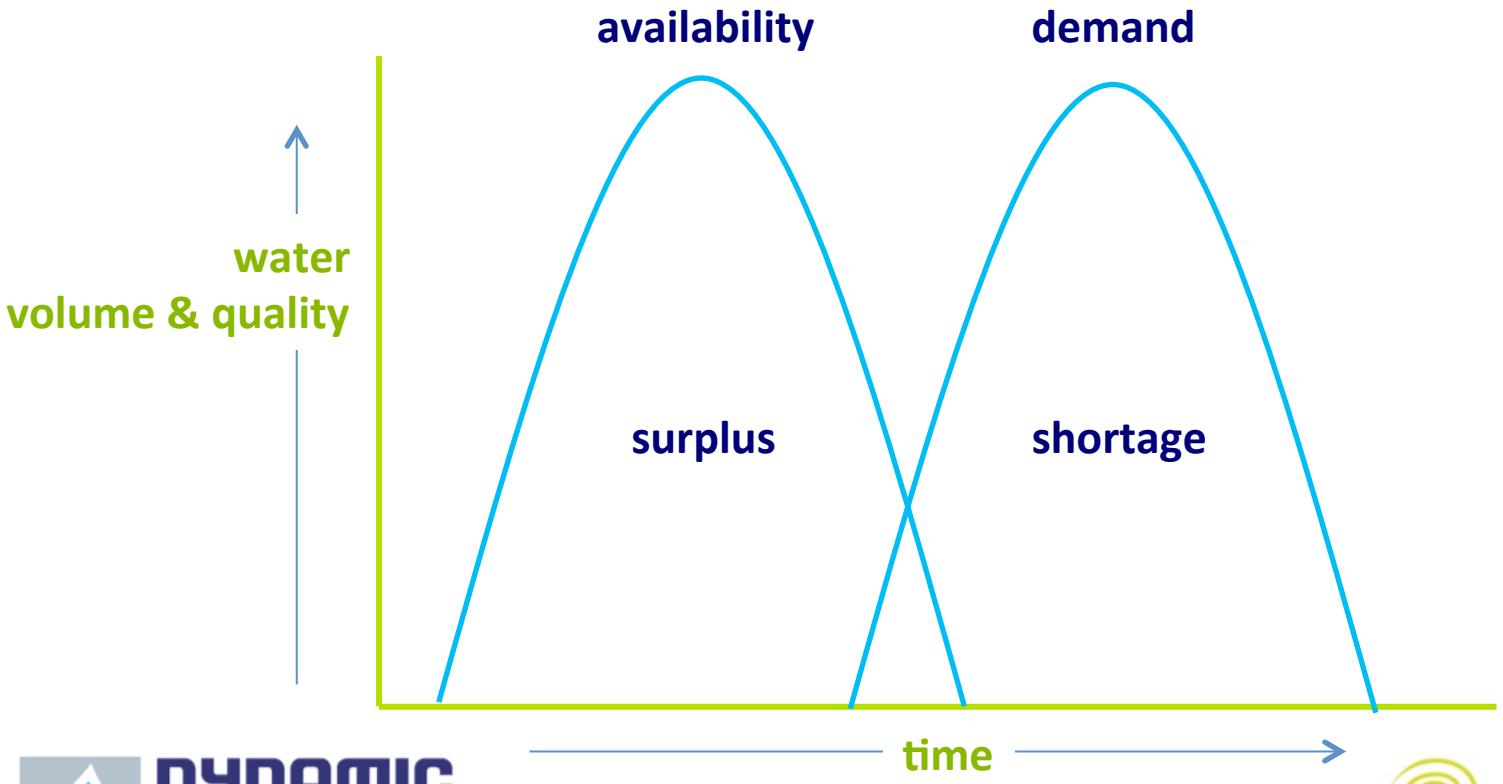
Enough water, but in the wrong place at the wrong time

- River discharge becomes less reliable due to melting of glaciers
- Salinization of surface water (=irrigation water)



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Example Uganda
area with high food insecurity.

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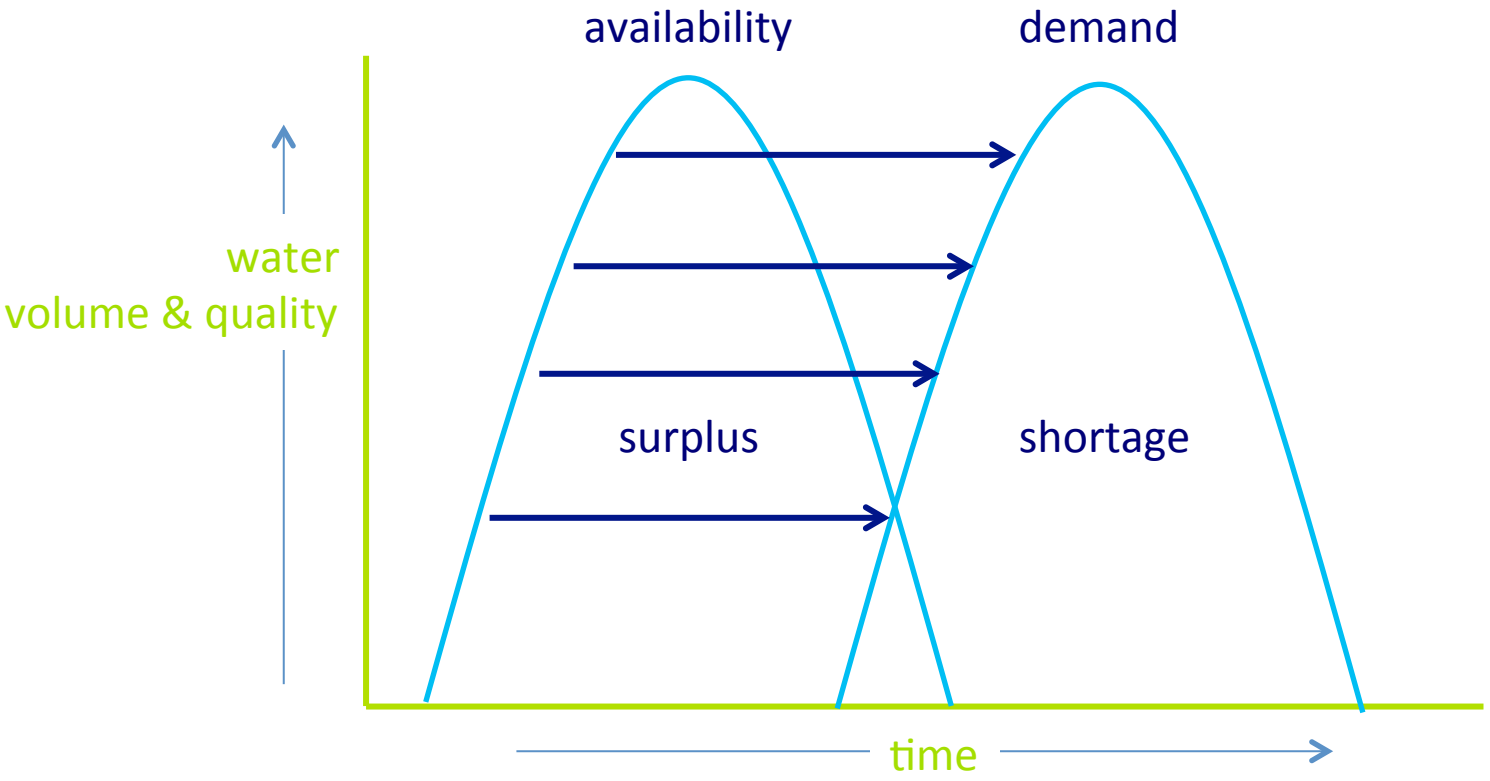
Enough water, but in the wrong place at the wrong time

- Solution is in making water surplus available in times of shortage



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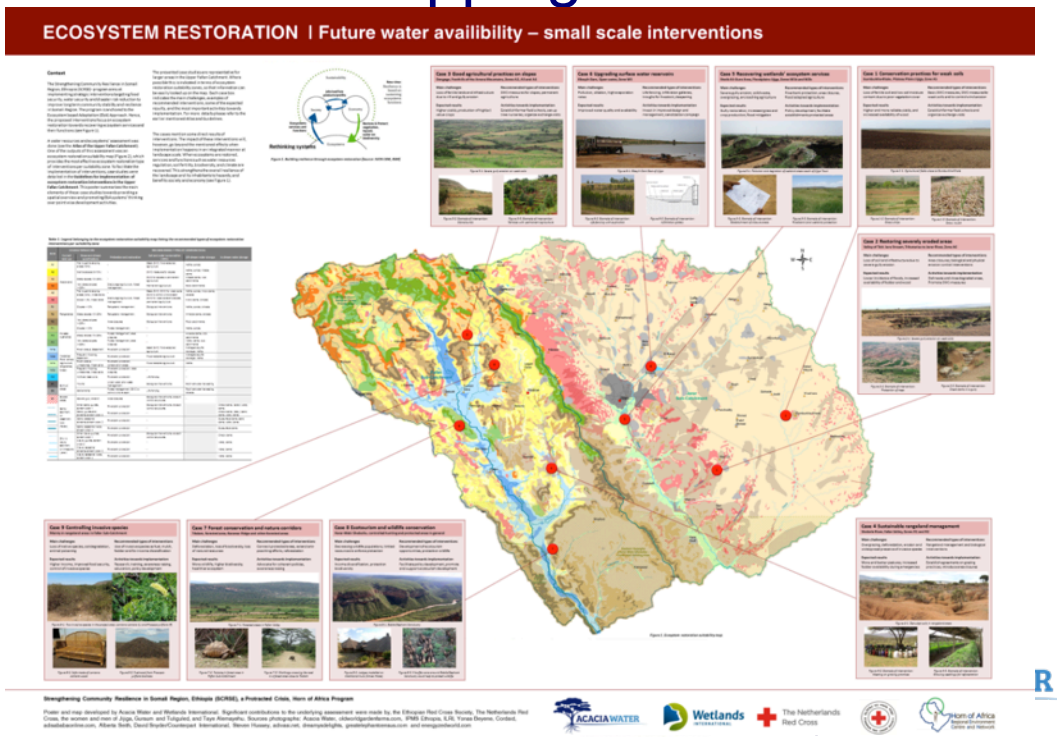
Succesfull smale scale local solutions

Sand dams – Kenia & Ethiopia
Making safe water available

Subsurface storage – Bangladesh
Making safe water available

Practical maps with small scale solutions with a regional impact

- Long term solutions!!!
  - Water security
  - Food security
  - Disaster risk reduction
- Combine succesfull solutions and mapping suitable regions



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Same principle applies to agriculture

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Local solutions for farms

Source	Storage	Use
Tile drainage	Open storage pond	Surface drip irrigation
Roof top	Shallow subsurface storage	Subsurface drip irrigation
Paved surface	Subsurface storage (ASR)	Sprinkler irrigation
		Subirrigation (tile drainage)
		Fertigation

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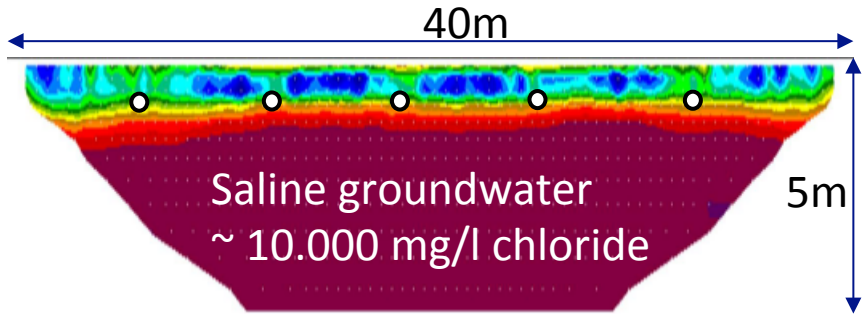
1 (Remote) controlled drainage

- Hornhuizen – Groningen
  - Wheat and bulbs
  - No fresh rainwater lens present



Source	Storage	Use
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		Subirrigation (tile drainage)
		Fertigation

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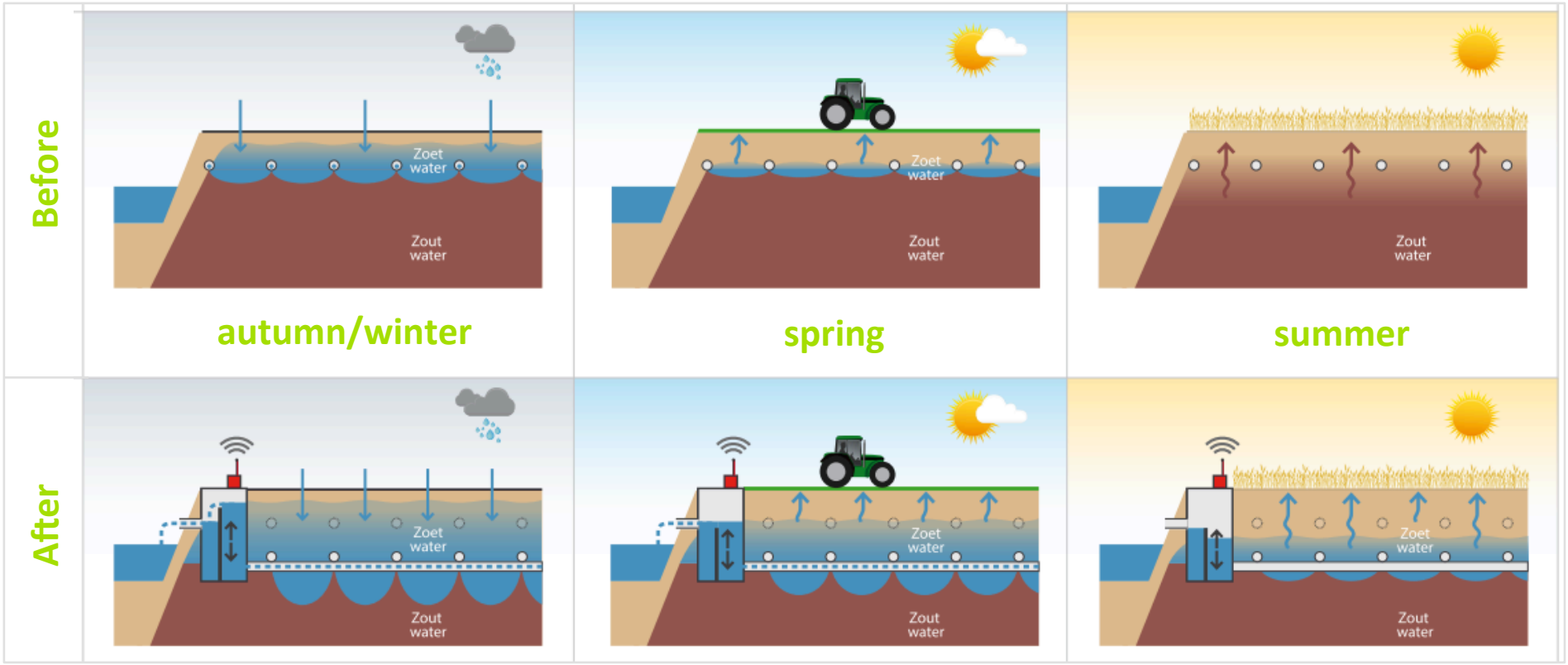
1 (Remote) controlled drainage

- Drainage depth changed from 1m depth to 1.6m depth
- Adjustable drainage level (1.0 – 0.8 – 0.6 m depth)
- Real time monitoring (groundwater and salinity)
- Remote controlled drainage level



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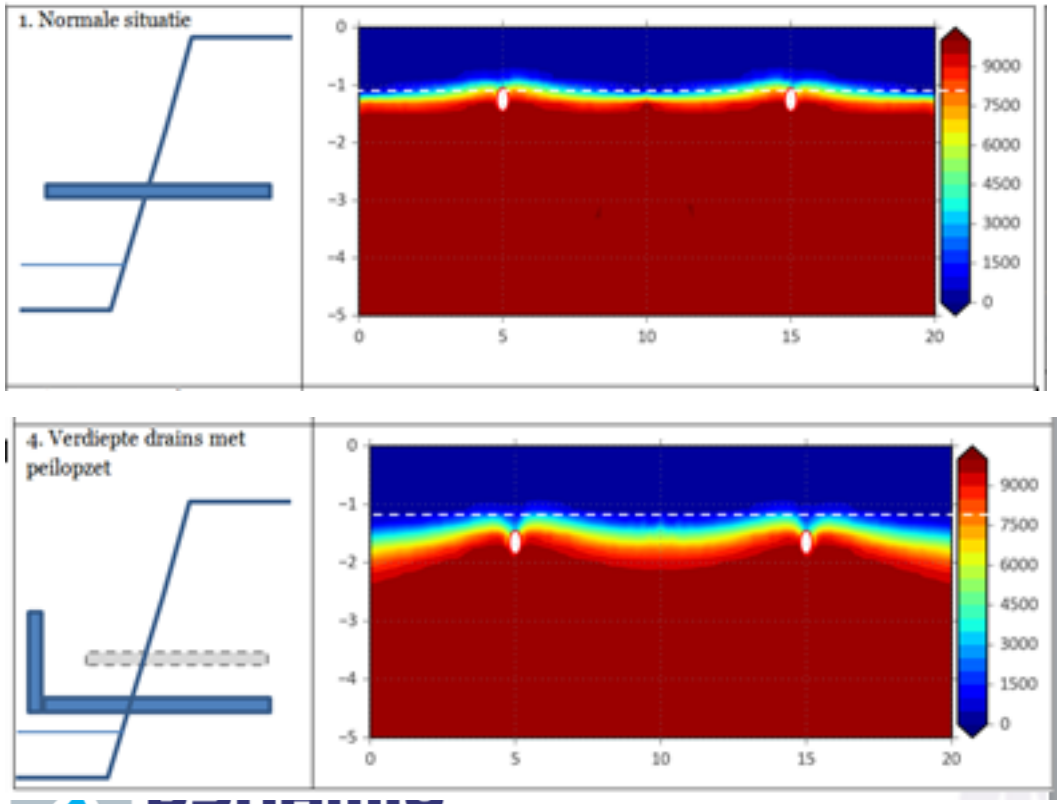
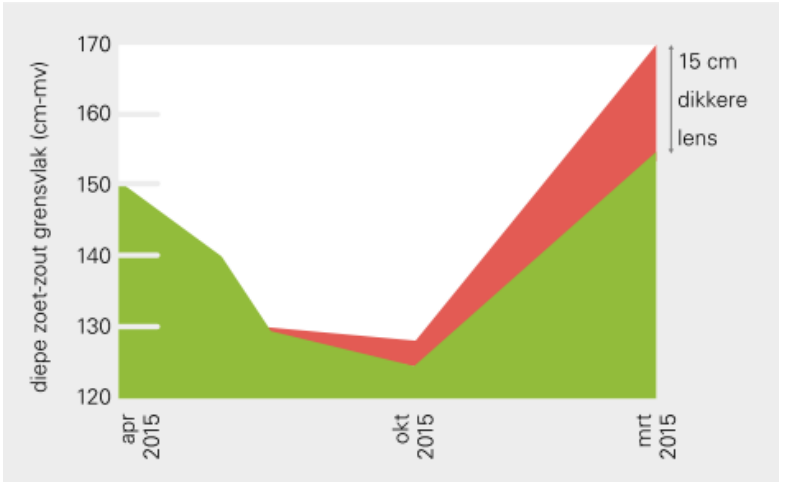
Results

- After 1 year increase in fresh water lens by 15cm





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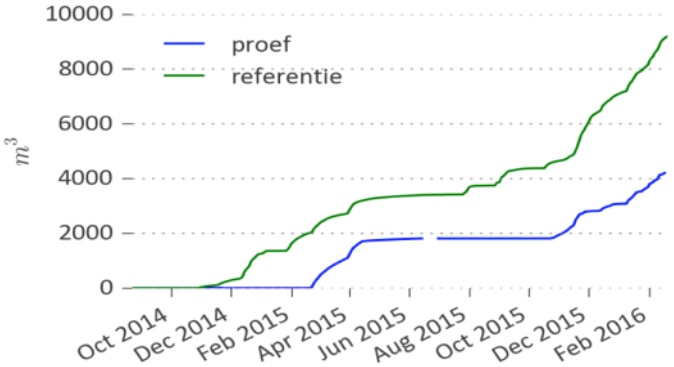
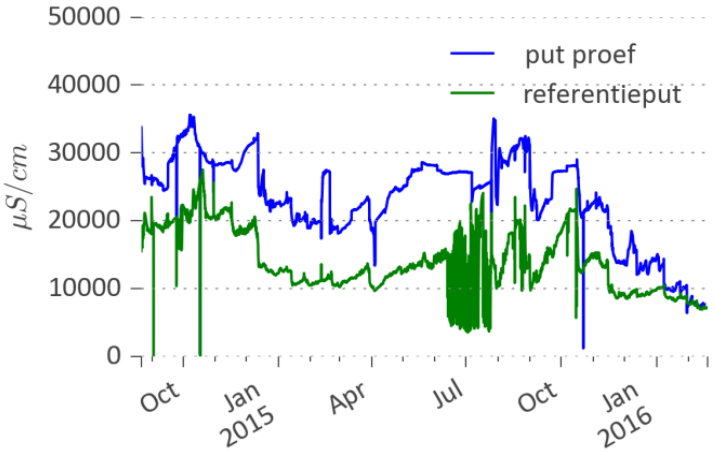
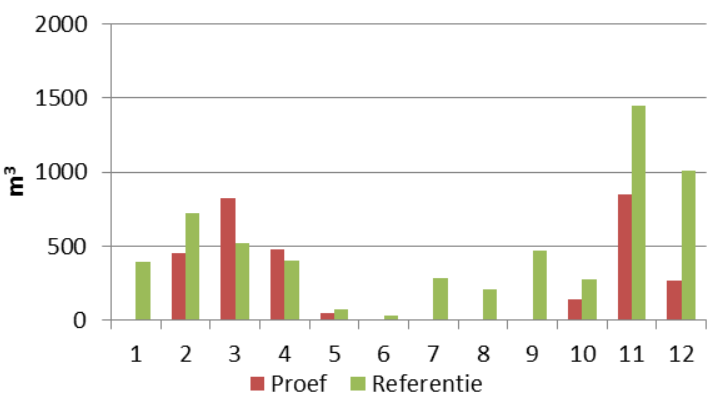
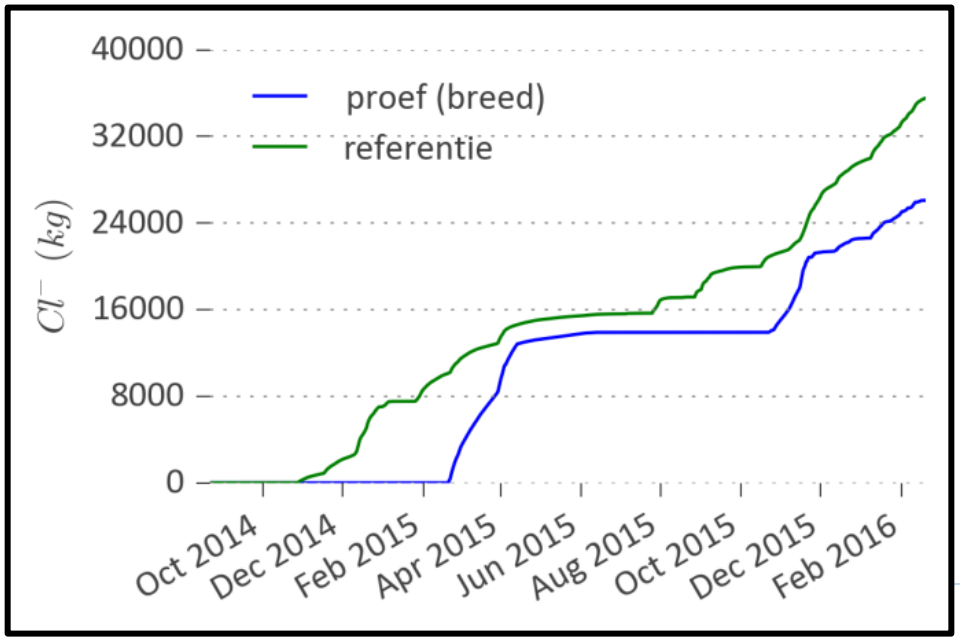
Results

- Decrease salt flux to surface water









WATER SYSTEMS

1 (Remote) controlled drainage

- Benefits
  - Increase thickness rainwater lens (fresh water buffer)
  - Prevent saline groundwater to reach root zone
  - Maintain or improve dewatering by adjusting drainage level
  - Decrease discharge of nutrients to surface water

Source	Storage	Use
Tile drainage	Open storage pond	Surface drip irrigation
Roof top	Shallow subsurface storage	Subsurface drip irrigation
Paved surface	Subsurface storage (ASR)	Sprinkler irrigation
		Subirrigation (tile drainage)
		Fertigation

DYNAMIC WATER SYSTEMS

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2 Self-sufficiency & optimized crop yield

- Island Texel
  - Tulipe bulbs, corn, sugar beets, wheat
  - Irrigation from surface water not allowed because fresh water is scarce

Source	Storage	Use
Tile drainage	Open storage pond	Surface drip irrigation
Roof top	Shallow subsurface storage	Subsurface drip irrigation
Paved surface	Subsurface storage (ASR)	Sprinkler irrigation
		Subirrigation (tile drainage)
		Fertigation

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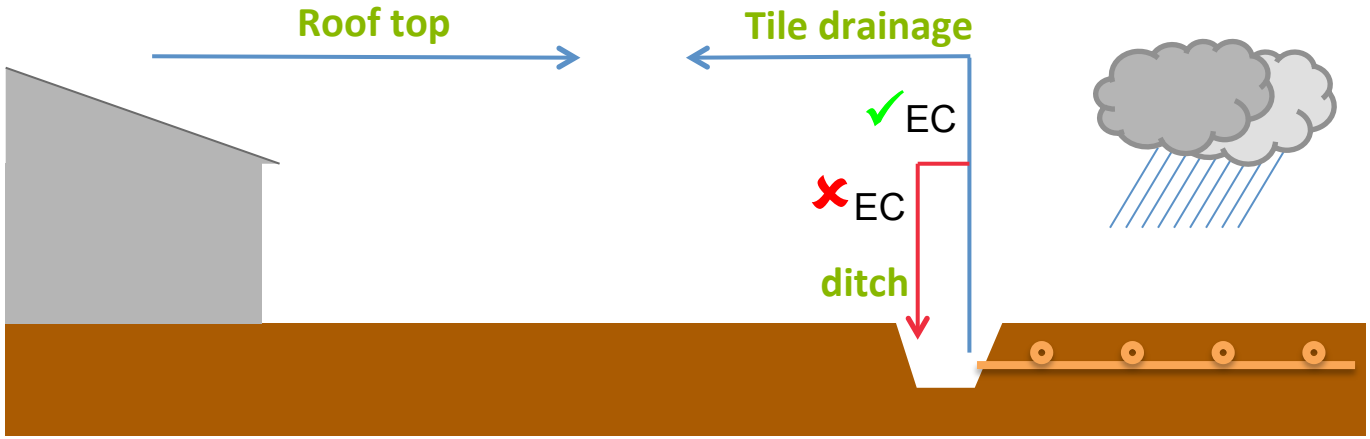
2 Self-sufficiency & optimized crop yield

- Source
  - 2.7 ha tile drainage via collectordrain
  - 0.2 ha roof top



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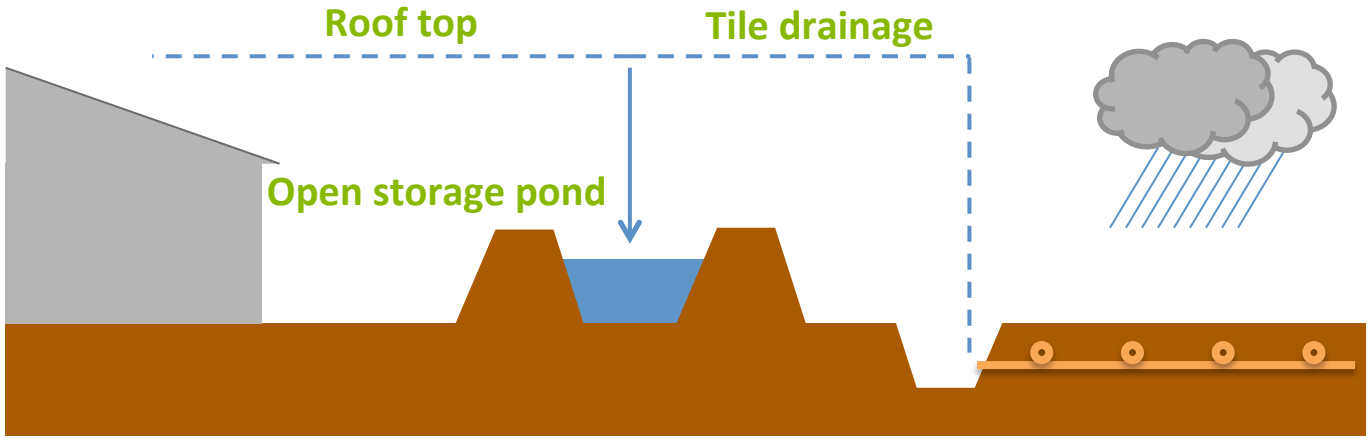
2 Self-sufficiency & optimized crop yield

- Storage
  - Open storage pond (>9000m3)



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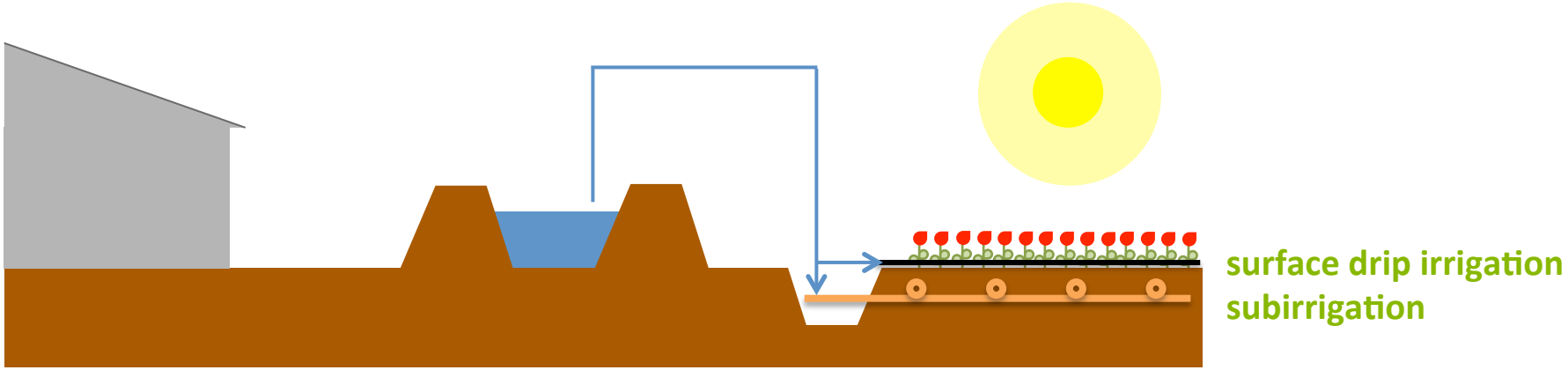
2 Self-sufficiency & optimized crop yield

- Use
  - Surface drip irrigation / fertigation
  - Subirrigation (controlled drainage) to maintain groundwater level



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2 Self-sufficiency & optimized crop yield

- Benefits
  - Self-sufficiency in water
  - Real time monitoring (groundwater and soil moisture)
  - Optimized crop yield: >15% bulbs & >25% sugar beets
  - Precision farming with fertigation
  - Decrease in nutrients to surface water

Source	Storage	Use
Tile drainage	Open storage pond	Surface drip irrigation
Roof top	Shallow subsurface storage	Subsurface drip irrigation
Paved surface	R)	Sprinkler irrigation
		Subirrigation (tile drainage)
		Fertigation

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3 Self-sufficiency & optimized crop yield

- Borgsweer - Groningen
  - Seed potatoes
  - Irrigation from surface water not allowed because of ‘brown rot fungus’

Source	Storage	Use
Tile drainage	Open storage pond	Surface drip irrigation
Roof top	Shallow subsurface storage	Subsurface drip irrigation
Paved surface	Subsurface storage (ASR)	Sprinkler irrigation
		Subirrigation (tile drainage)
		Fertigation

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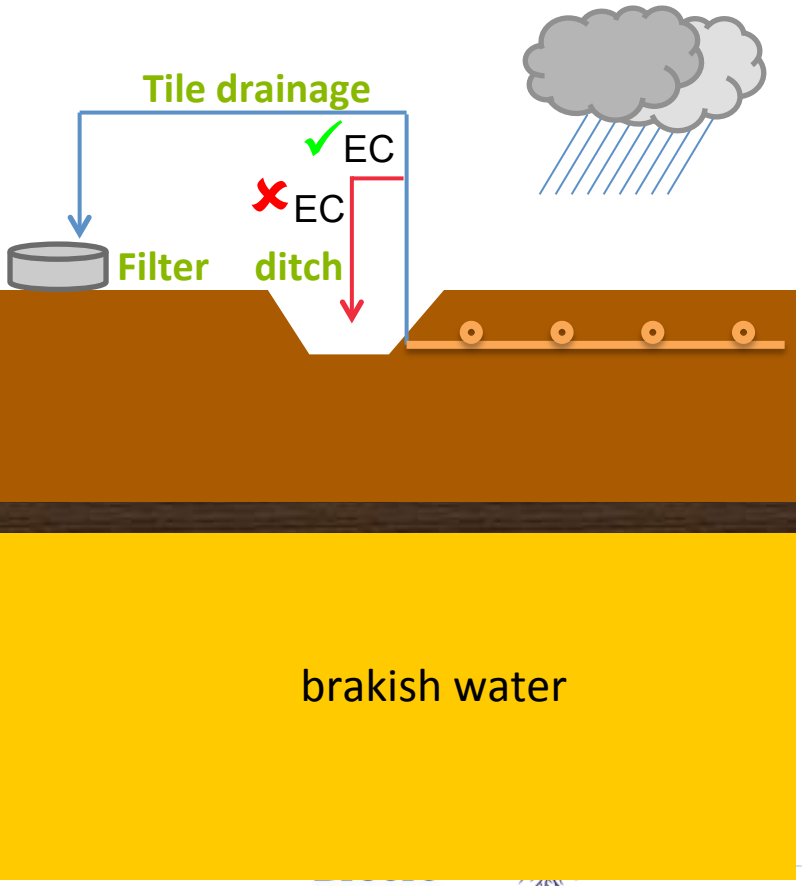
3 Self-sufficiency & optimized crop yield

- Source
  - 1.5 ha tile drainage via collectordrain



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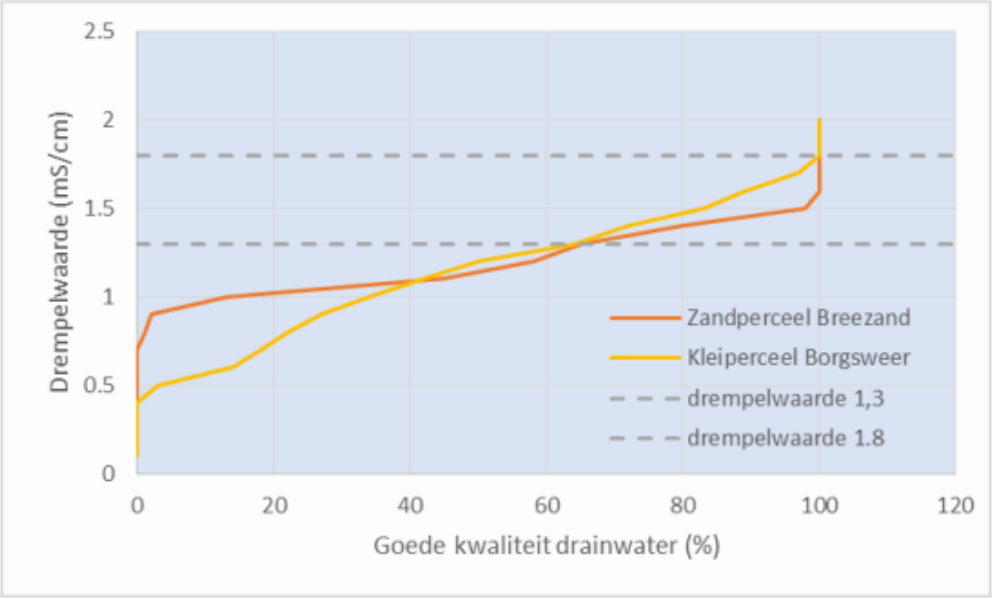
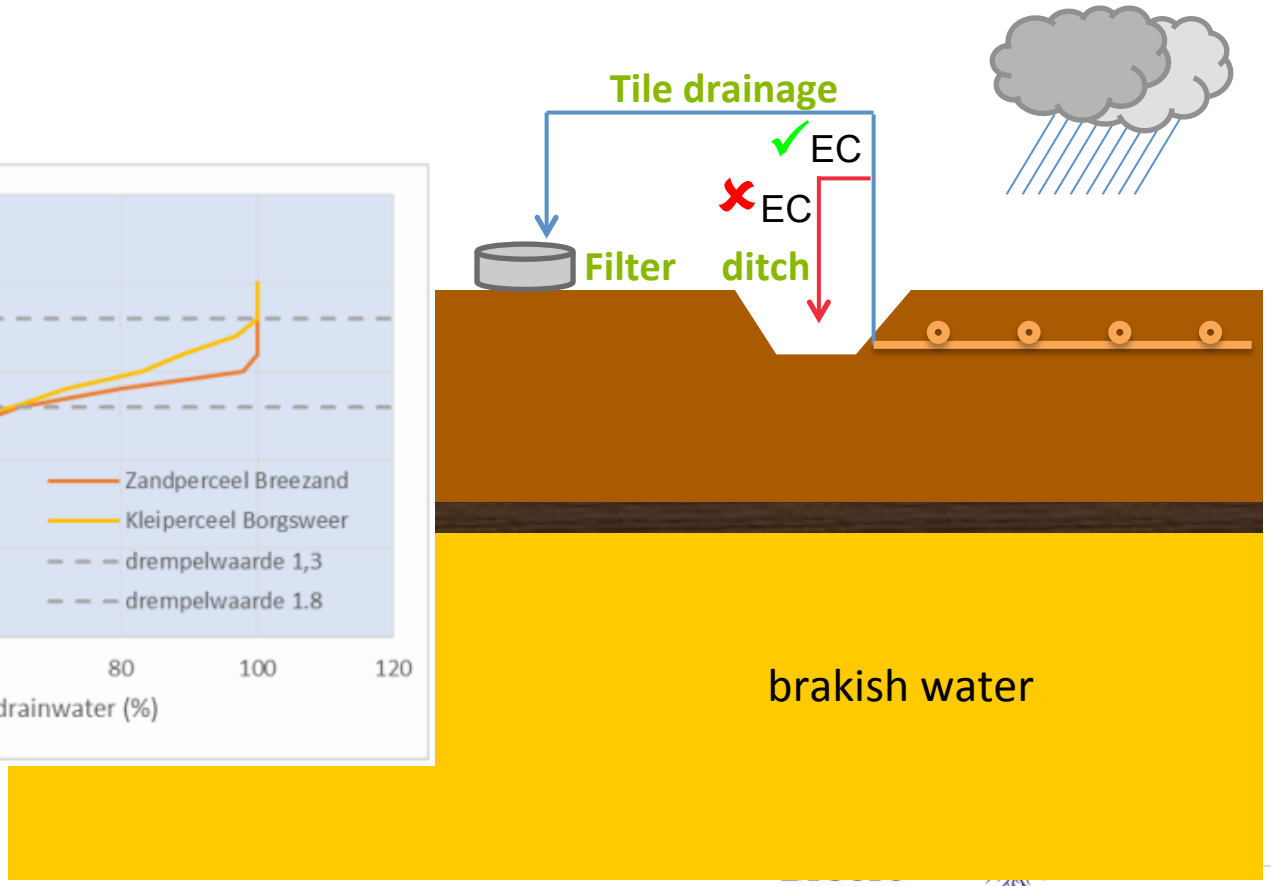
AgriMAR – self sufficiency in fresh water

- Rainwater harvesting (Source)
- 1.5 ha tile drainage via collectordrain
- Appr. 50% of total precipitation is harvested, nearly all excess water





DYNAMIC WATER SYSTEMS

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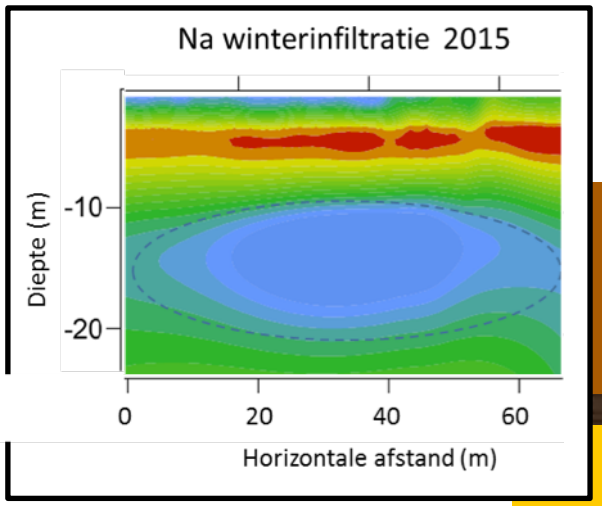
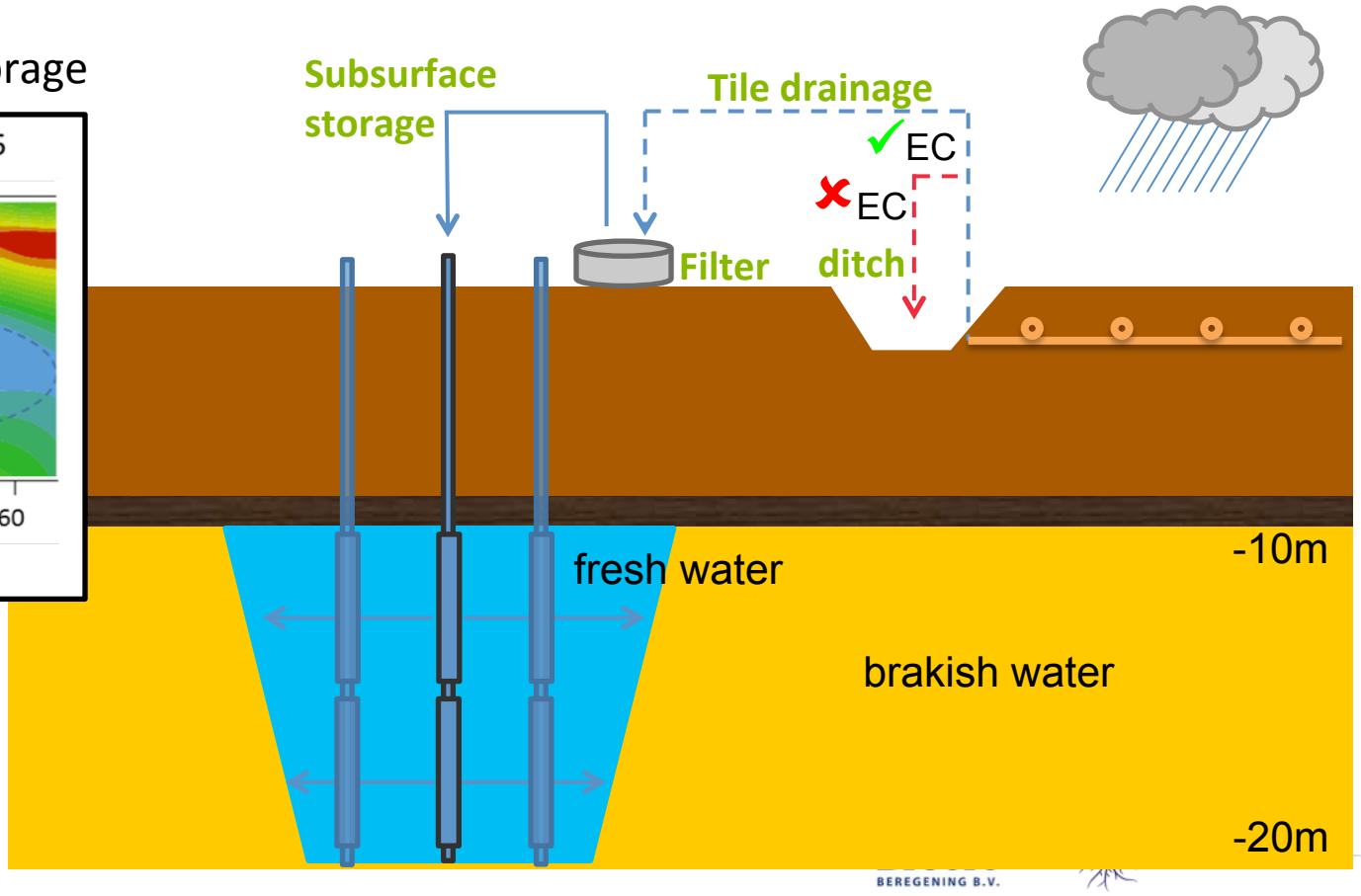
AgriMAR – self sufficiency in fresh water

- Subsurface Storage and Recovery
  - Subsurface storage (10m – 20m below surface)
  - 1 infiltration well & 3 abstraction wells (2 filters each) to enhance removal of pathogenes

Observed fresh water storage





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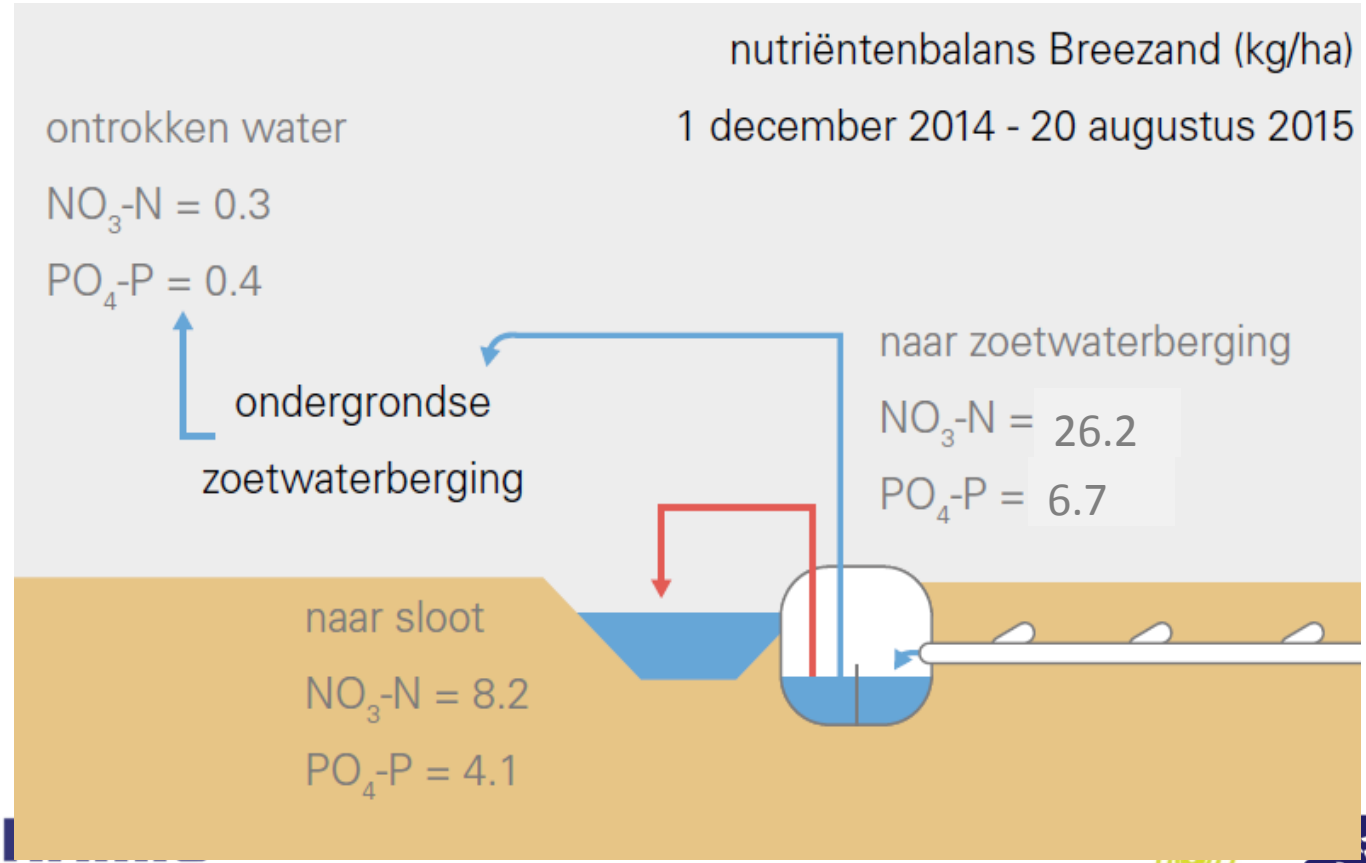
Reduction nutrient outflow

- 77% less NO3-N
- 60% less PO4-P



Traditional sprinklers inefficient

- Loss due to direct evaporation
- Unevenly distribution across the field (wind)
- Water drops on leafs which leads to infections
- High fuel usage

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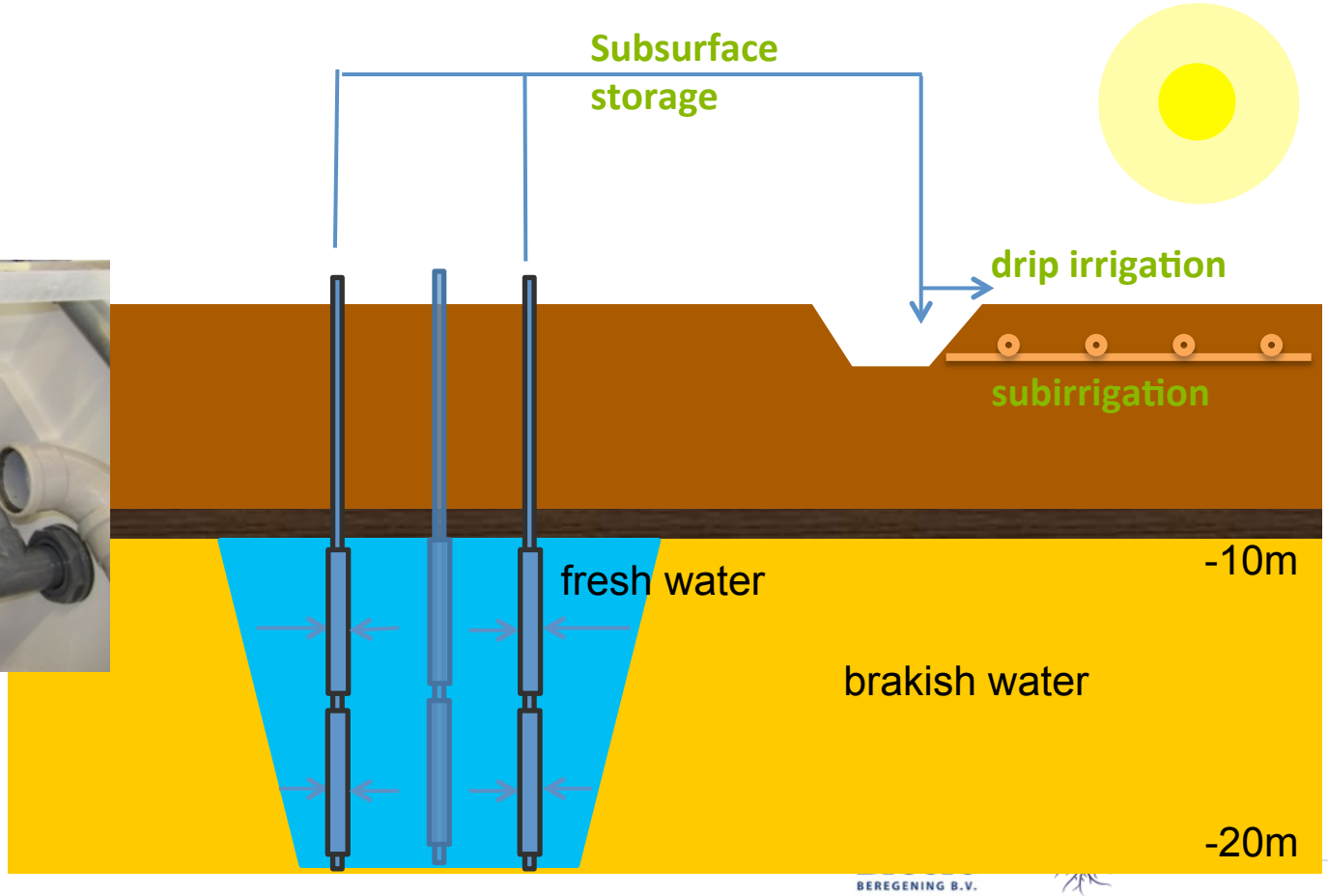
AgriMAR – self sufficiency in fresh water

- Use of water for crops by
  - Drip irrigation
  - (Subirrigation by infiltration and controlled waterlevel in tile drainage)



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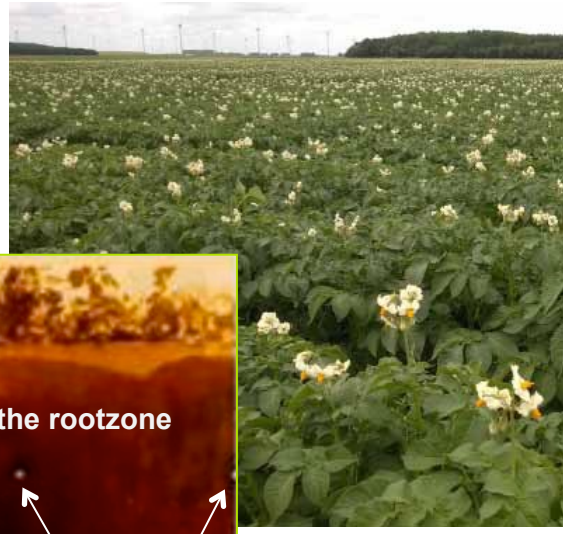
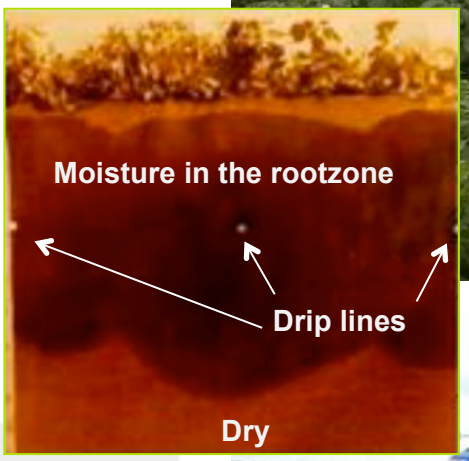
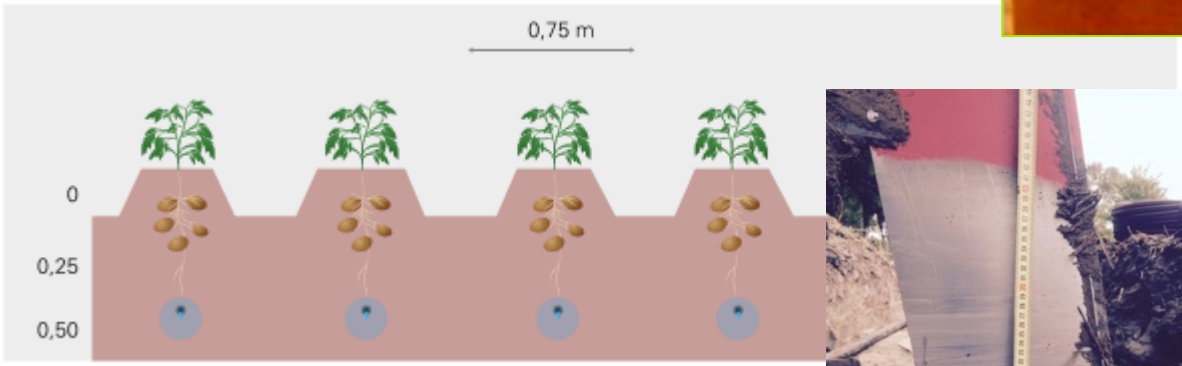
SDI (subsurface drip irrigation)

- Seed potato, clayey soil
- At 53 cm depth
- Permanent – lower labor costs
- Irrigation once every two days
  - Appr. 150 mm







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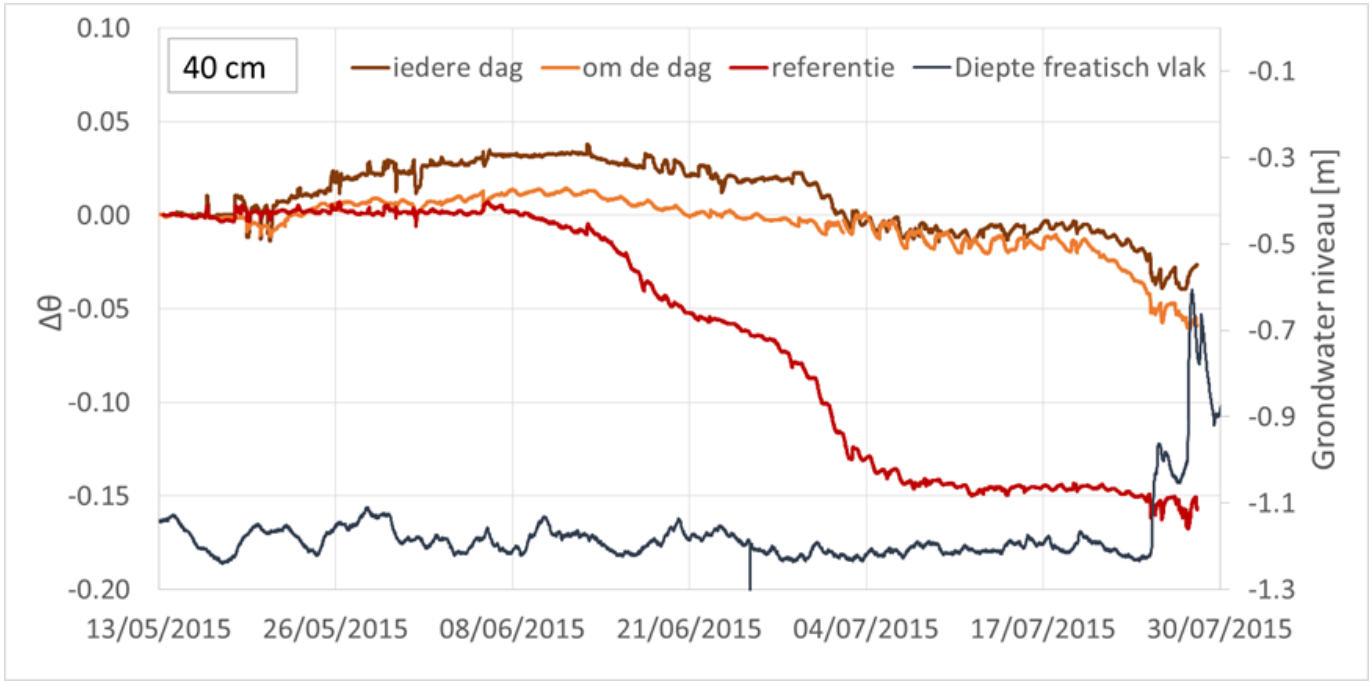
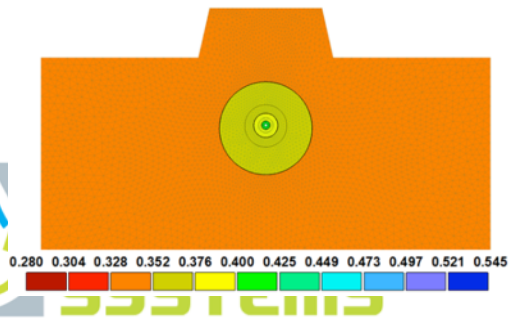
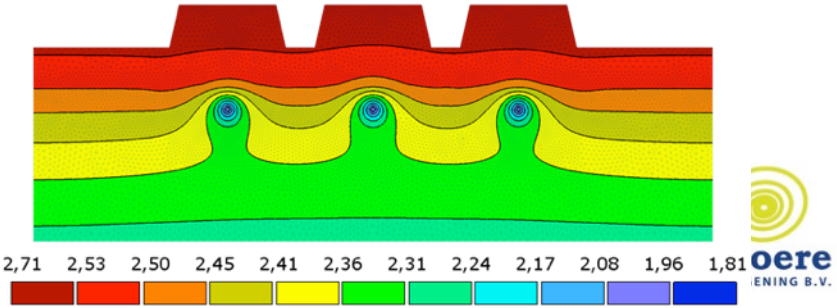
Soil moisture

- Decision upon development soil moisture, water potential and modelling with predictions

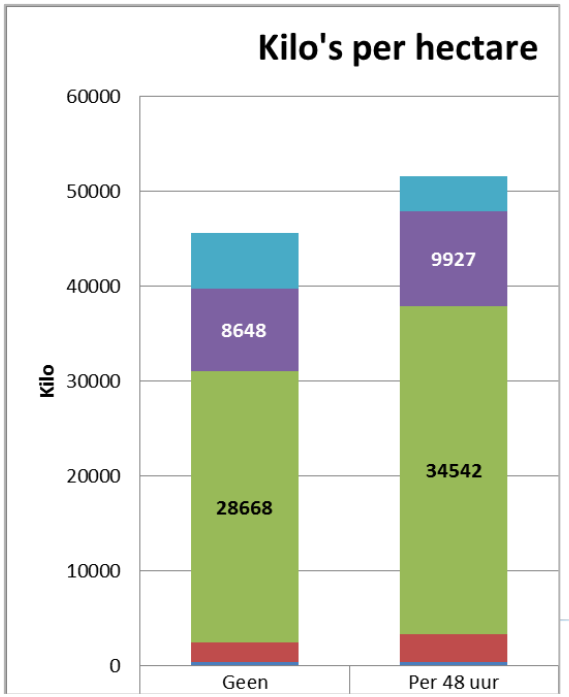






Self sufficiency in fresh water and drip irrigation

- Self-sufficiency is feasible
- **10 ha source -> ca. 12-20 ha use**
- Reduced risk of diseases (also other crop related diseases like ‘erwinia’ in bulbs)
- Expected removal of ‘brown rot fungus’ and other pathogens during subsurface storage
- **Optimized crop yield > 10% increase (appr. 3000-4000 EUR/ha)**
- Long life expectancy of subsurface drip lines



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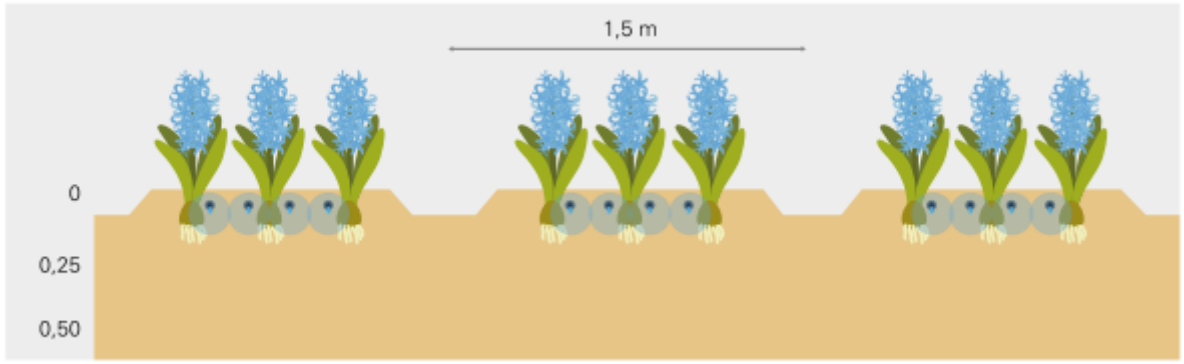
Surface drip irrigation in Breezand

- Flower bulbs, sandy soil
- Two to four drip lines every 1m
- Main focus is fertigation



WATER SYSTEMS

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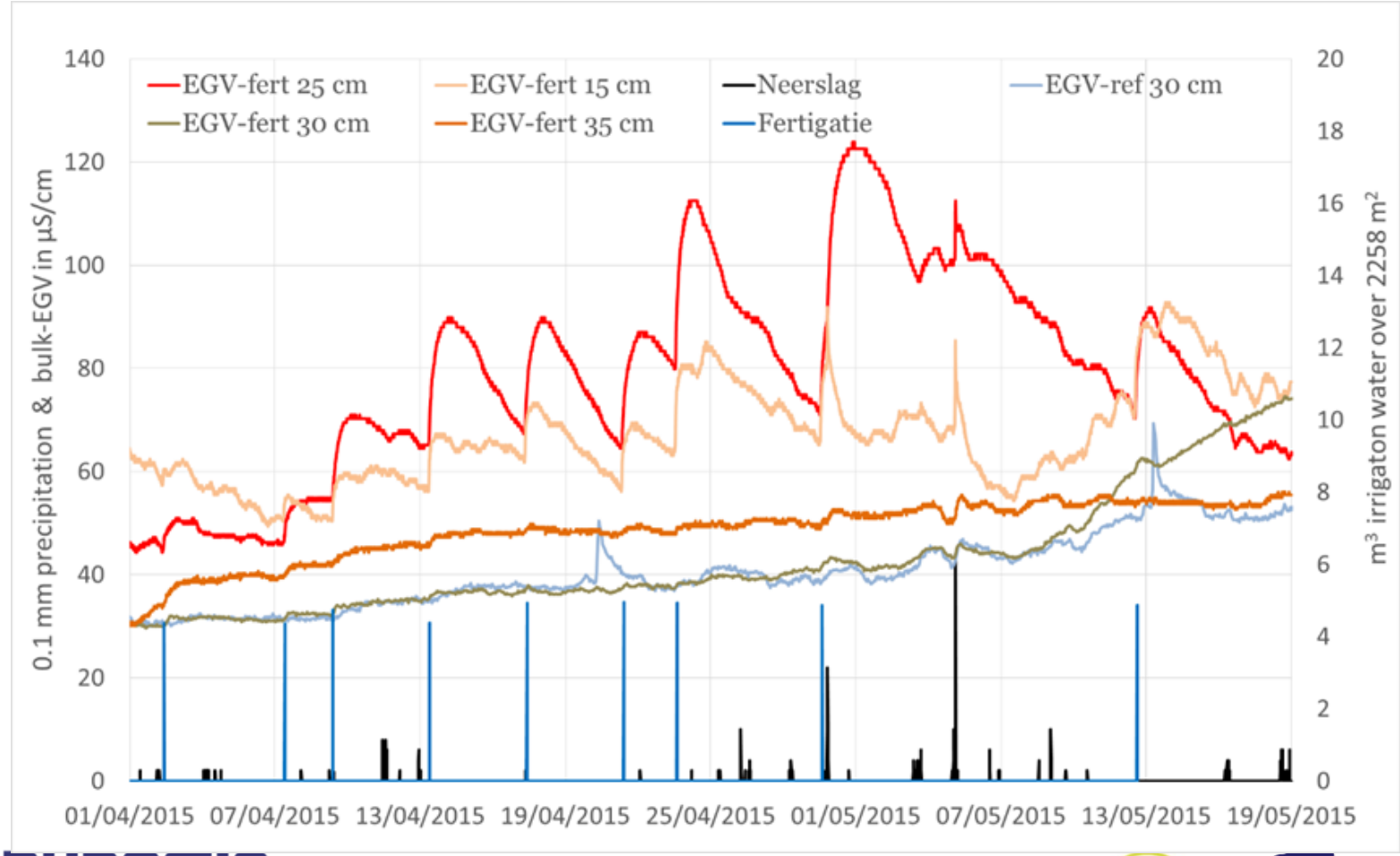
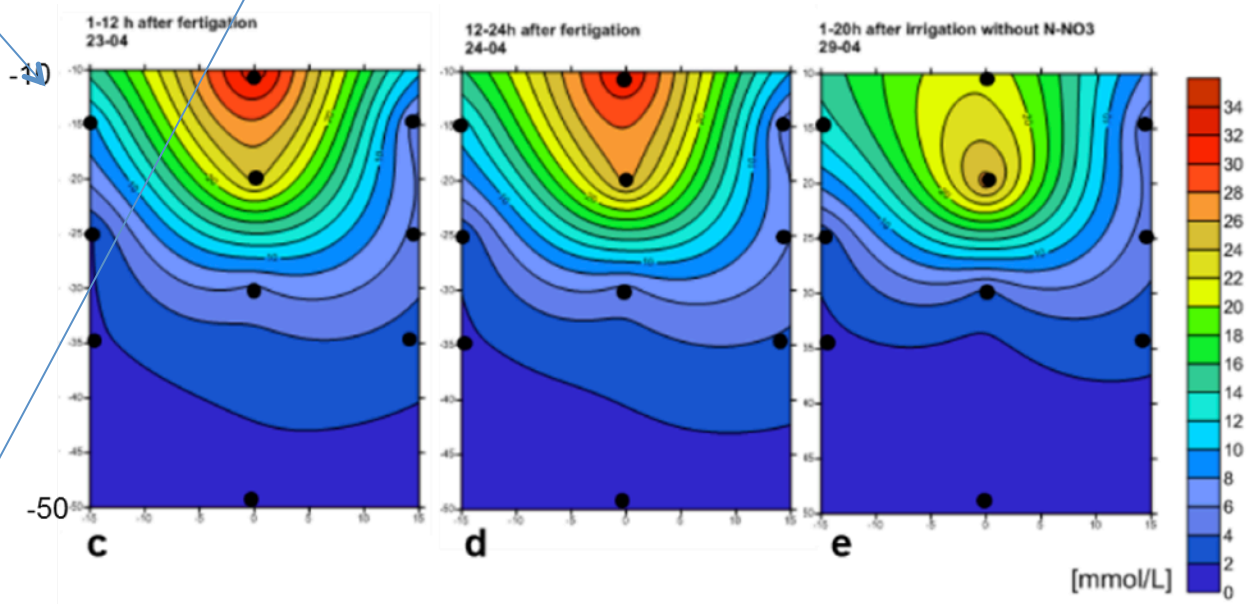
Fertigation

- Observed infiltration and uptake of nitrate in root zone



Fertigation

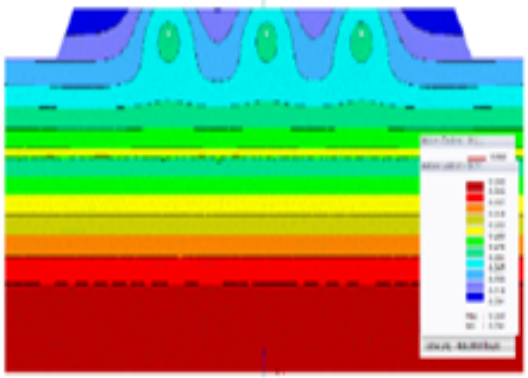
- Observed and simulated infiltration and uptake of nitrate in root zone

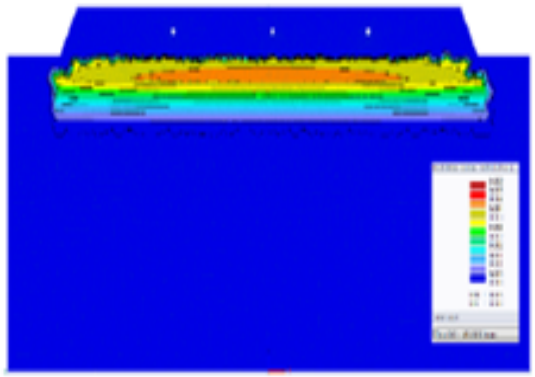


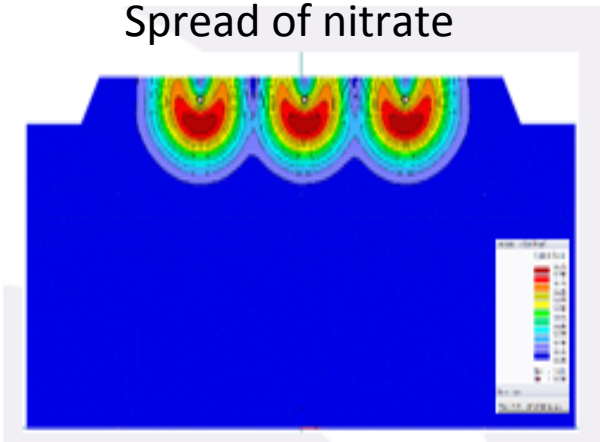
Soil moisture

Root zone

Spread of nitrate







Increased yield

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3 Self-sufficiency & optimized crop yield

- Benefits
  - Self-sufficiency in water
  - Reduced risk of diseases (also other crop related diseases like ‘erwinia’ in bulbs)
  - Expected removal of ‘brown rot fungus’ during subsurface storage
  - Optimized crop yield
  - Long life expectancy of subsurface drip lines

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		Fertigation

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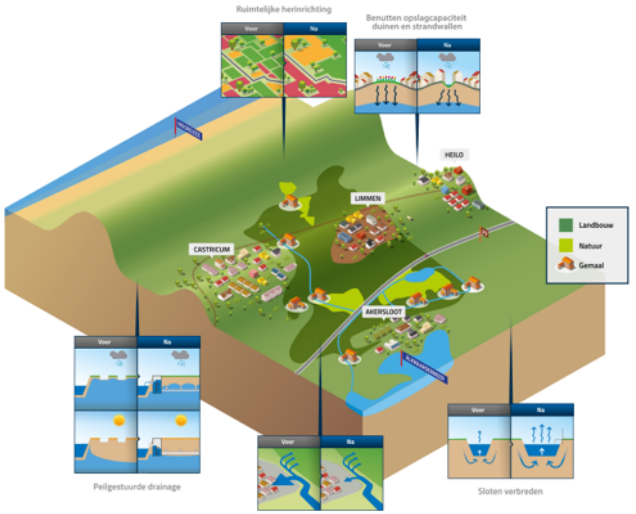
Concluding remarks

- Self-sufficiency is crucial for secure and improved crop production
- Self-sufficiency in water is within in reach using components from
  - Source
  - Storage
  - Use
- Benefits are
  - Improved water efficiency
  - Reduced risk of diseases
  - Reduced application of fertilizer
  - Optimized crop yield
  - Real time monitoring of meteorology, soil and water characteristics
  - Real time control of water and nutrient flows



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Thank you

More information on:

www.dynamicwatersystems.nl

www.spaarwater.com

www.acaciawater.com

www.broereberegening.nl

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