Intelligent irrigation saves water and fertilizer without reducing yield or quality

The outcome of the FLOW-AID project

The 9th New Ag International Conference and Exhibition

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8.30 h opening lecture

Jos Balendonck

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FLOW AID

Outline

- Introduction
- Technology “building blocks”
  - Sensors, Fertigation, Decision Support
- Case study results
  - Italy, Turkey, Jordan, Lebanon, the Netherlands
- Conclusions

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No restrictions on water use

- Full irrigation practices:
  - Irrigation linked to water availability
  - Water and fertilizer use aimed at maximizing crop yield
  - Over-irrigation to deal with variability (safety)
- May result in …
  - Good crop yield and income
  - Leaching or run-off of water and fertilizers
  - Higher costs due to over use of water and lost fertilizers

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Restrictions Fresh Water or Leaching

- Deficit Irrigation practices:
  - Use of: less fresh water
  - marginal water (saline water)
  - reclaimed water (N,P-rich)
  - less fertilizer
- May result in:
  - crop damage
  - diseases
  - yield loss
  - higher costs and lower income

Ground water

Reclaimed (saline) water

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Objectives

- SAVE WATER
  - Efficient use of available water
- SAVE NUTRIENTS
  - Rational use of nutrients and marginal water resources
- SAVE THE ENVIRONMENT
  - Prevent leaching of chemicals
- SAVE FARMER INCOME
  - Maintain crop yields at affordable costs

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The approach

- Adaptation of growing system
  - Choose strategy based upon local constraints
  - Grow more detached or independent from soil/climate
- Precision Fertigation (DSS)
  - Optimize your irrigation and fertilization strategy
  - Advice when and how much to irrigate
  - Advice when and how much to fertigate
- Tools to determine amount and source of water
  - Feed-back about crop, soil water/nutrient and climatic conditions (Sensors and observations)
  - Irrigation: controllers, computers, software

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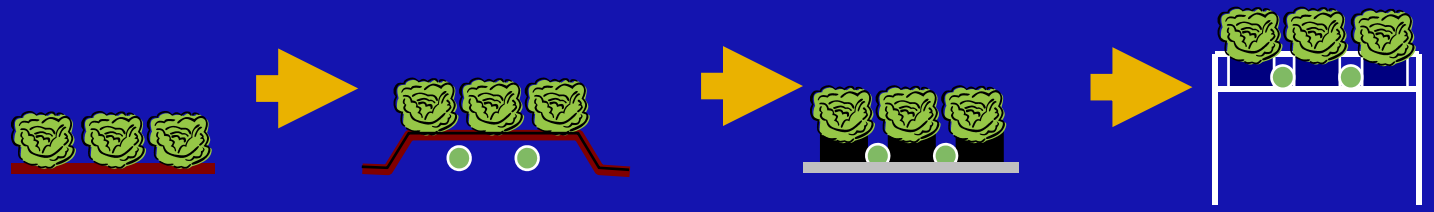
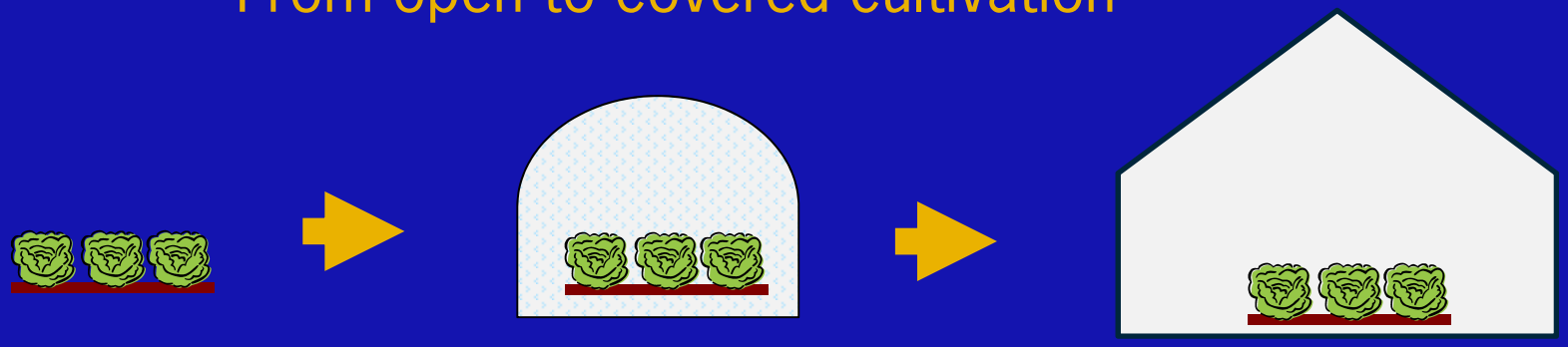
More independent from soil and climate

From soil to substrate



From open to covered cultivation



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Examples

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Adaptation of the water system

- Water harvesting and use buffering
- Use reclaimed or desalinated water
- Use drip irrigation with fertigation
- Smart irrigation scheduling
  - ET or sensor control, water metering
  - Apply a deficit strategy
- Closed systems (reuse water & nutrients)
- Clean effluents
- Regular maintenance

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Fertigation Control

- Recipies and dosis following plant demand (growing stage) rather than using bulk fertilization in advance.
- Automate this process

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Irrigation monitoring and control

- Remote monitoring
  - Wireless
  - Solar powered
  - Data logging, graphs
- Irrigation Controllers
  - Stand-alone operation
  - Programmed by grower or DSS
  - (Multiple) sensor activation
  - Multiple nodes, valves/water sources

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DSS-Irrigation Scheduler

- Daily planning by farmer (farm PC)

  or:
- Upload data to remote DSS
  - Manually or automatic
  - Integrate weather forecasts
  - Use of plant and soil and ET-modeling
- Receive e-mails from DSS
  - Advice fertigation strategy
  - Calculated doses and timing
  - Safety (warnings)
- Set Irrigation Controllers
  - Manual or automatic

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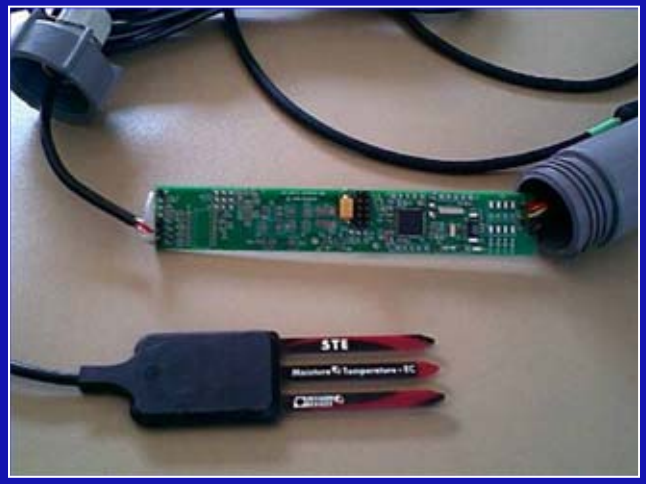
WET-sensors indicate more than soil water

- Water Content
  - Indicates “Available Water”
  - For medium wet to saturation
  - Soil calibrations
- Electrical Conductivity (EC)
  - Total nutrient concentration
  - Pore Water EC
  - Monitoring salinity stress
- Temperature



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Electronic Tensiometers (for dryer soils)

- Water filled tensiometer
- Limited range (air entry)
- Installation and maintenance
- For dry soils

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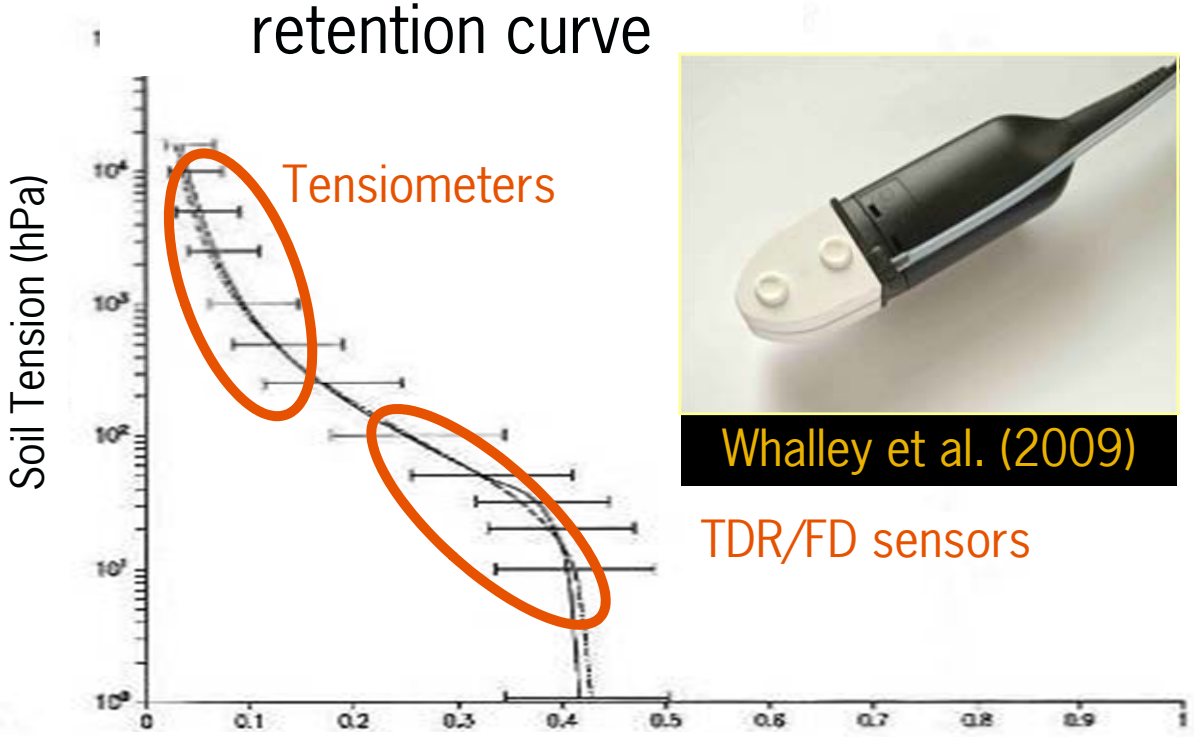
- Porous Matric Sensor (prototype)
- Extended dry range
- Easy installation - Low maintenance
- For wet to very dry soils

retention curve



Whalley et al. (2009)

TDR/FD sensors

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10.10h: Case Studies from Jordan, Lebanon and Turkey

by: Prof Munir Rusan

Lebanon - South Bekaa Valley, Litany River

- Limited water availability
- Poor water management
- Surface irrigation, sprinkler, drippers
- Soil grown potato, eggplant

- Approach
  - Enhance Water Use efficiency
  - Deficit irrigation strategy

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Jordan - Irbid, Jordan Valley

- Very limited water resources
- Poor water management
- Low water use efficiency
- Soil grown tomatoes

- Approach
  - Enhance Water Use Efficiency
  - Use of Reclaimed Water
    - Treated Waste Water (T)
    - Fresh Water (F)
  - Treatments
    - FULL (F)
    - DEFICIT (D)

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Turkey - Izmir (Tahtalı Dam)

- Preservation area (no leaching)
- Water from wells
- Greenhouses
- Cucumber

- Approach
  - Prevent leaching by using deficit
  - Fixed set-points
  - Irrigation amounts: Full, 60%, 40%

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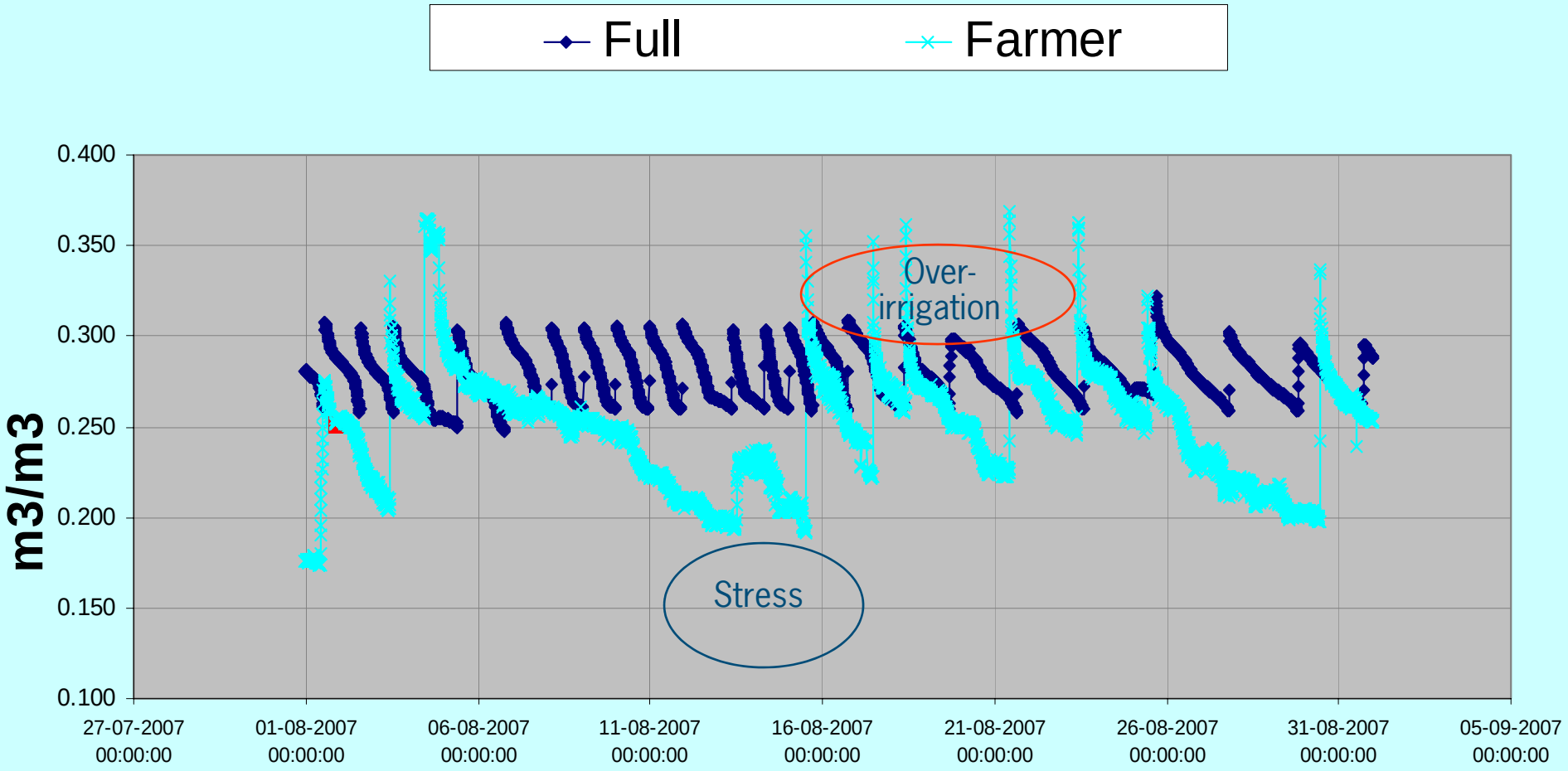
WET



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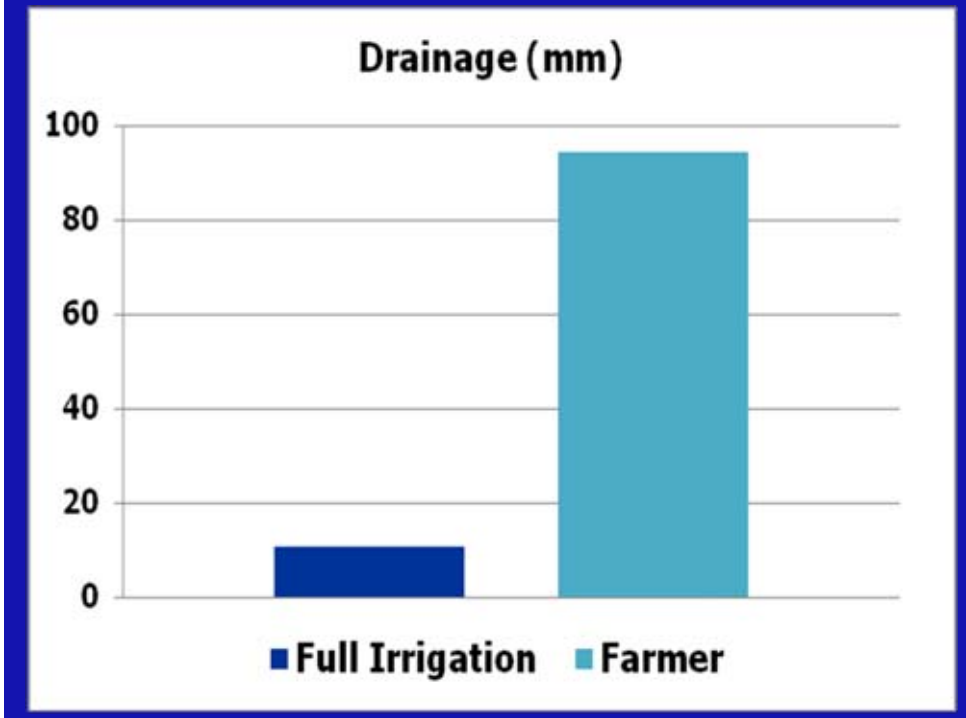
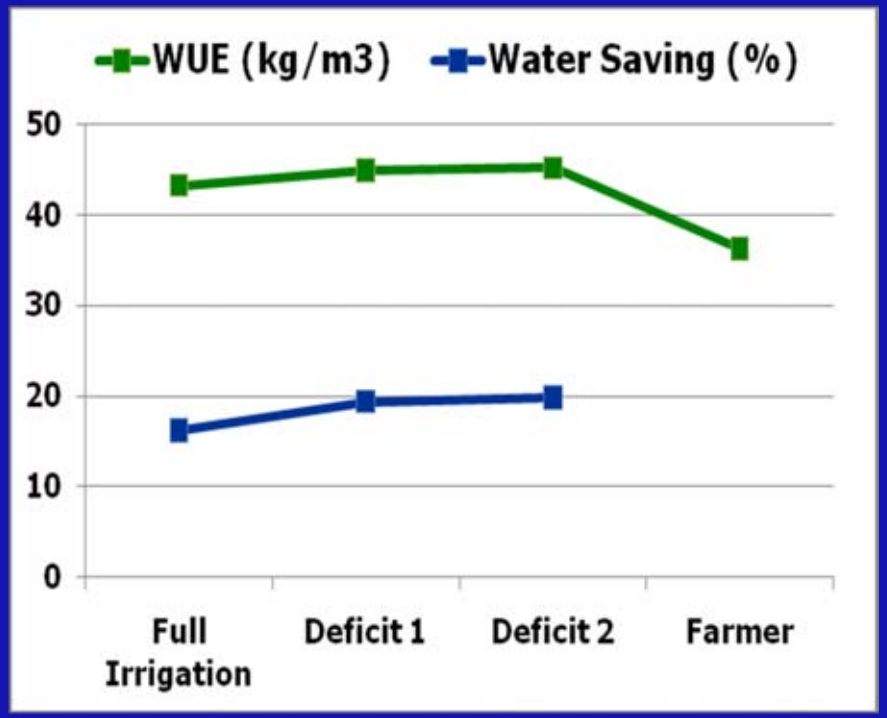
Water Use Efficiency and Leaching





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Italy – Pistoia, Tuscany

- Nursery stock production (container ornamentals)
- Saline water sources
- Sprinkler or drip irrigation

- Approach
  - Use of high EC reclaimed water and additionally fresh water
  - Maintain upper limit for EC in container (WET-sensors)
  - Adjust fertigation to irrigation water quality (level of EC)
  - Use fresh water only when needed (flushing or mixing)

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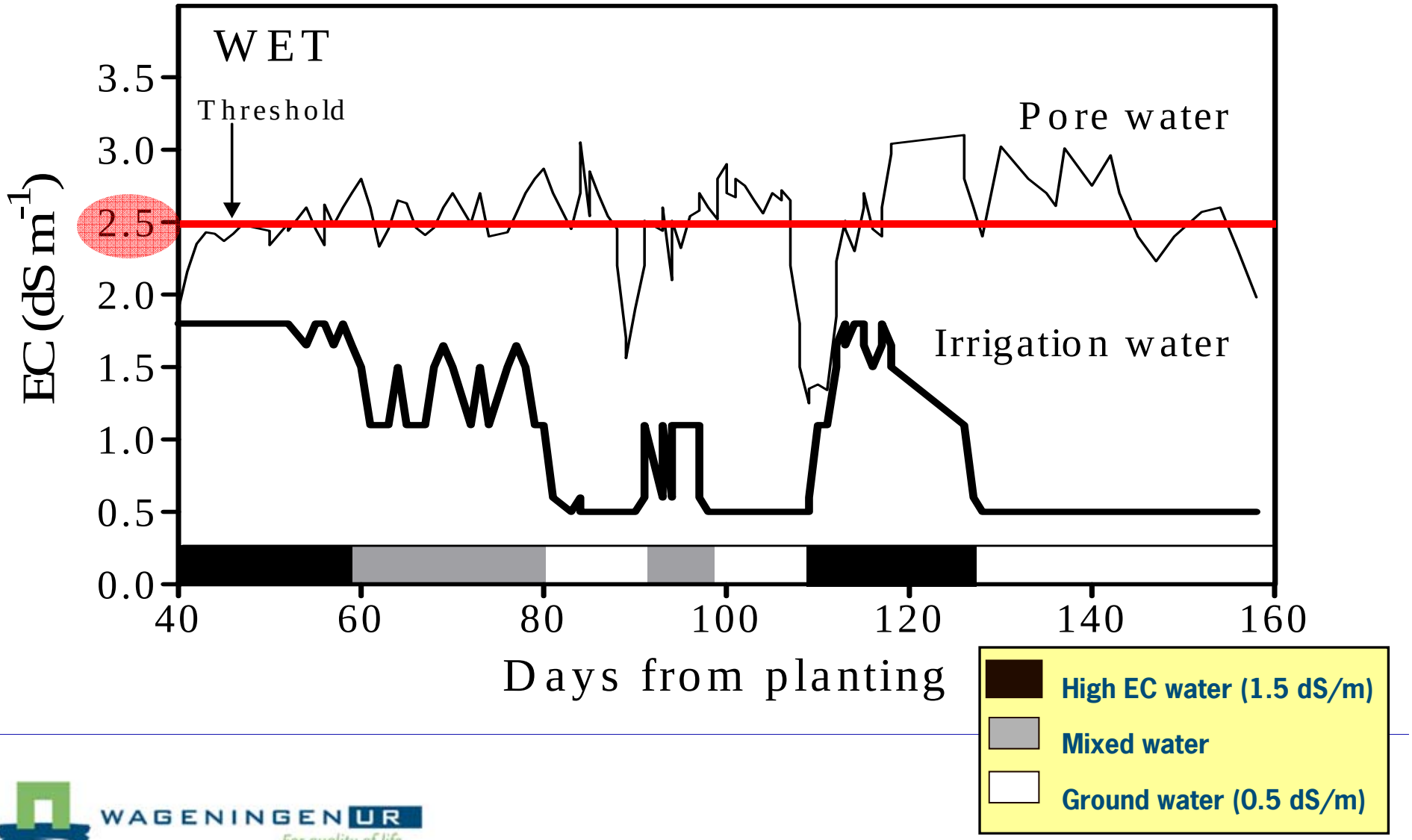
Dual water irrigation with EC feedback



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The Netherlands – Vredepeel

- Slight loamy-sandy soils
- Rain-fed agriculture
- High water tables
- Leaching

- Approach
  - Prevent nitrate leaching
  - Iceberg lettuce
  - Plastic foil cover to block rain
  - Root zone sensor: Start irrigation
  - Deep sensor:
    - DSS adapt irrigation dose
    - Irrigate more often with a smaller dose !

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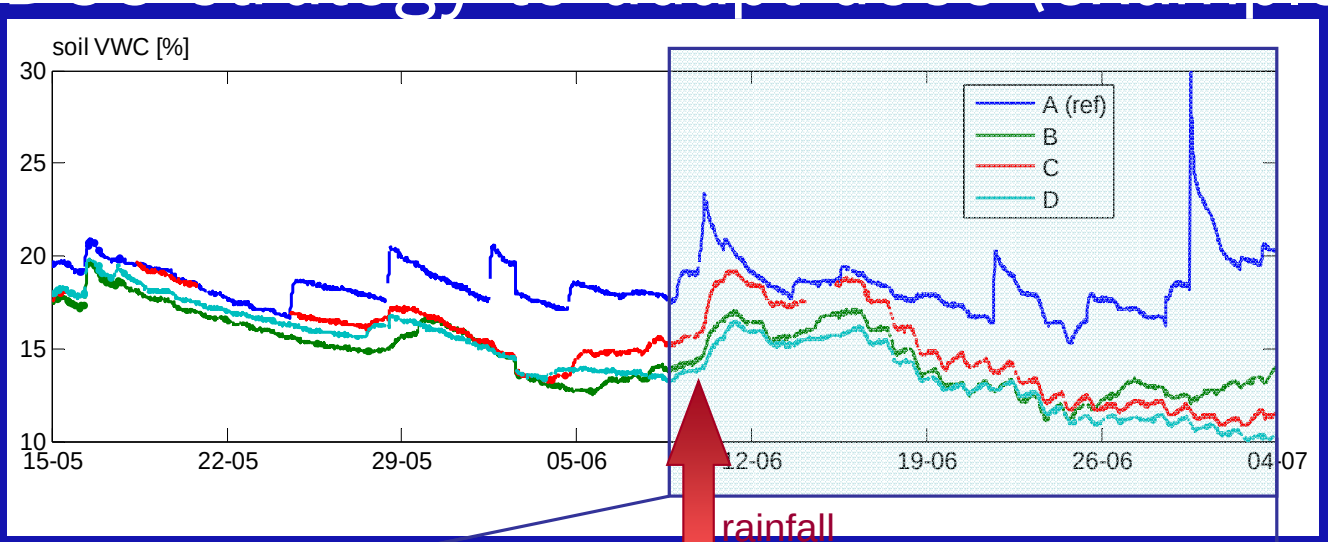
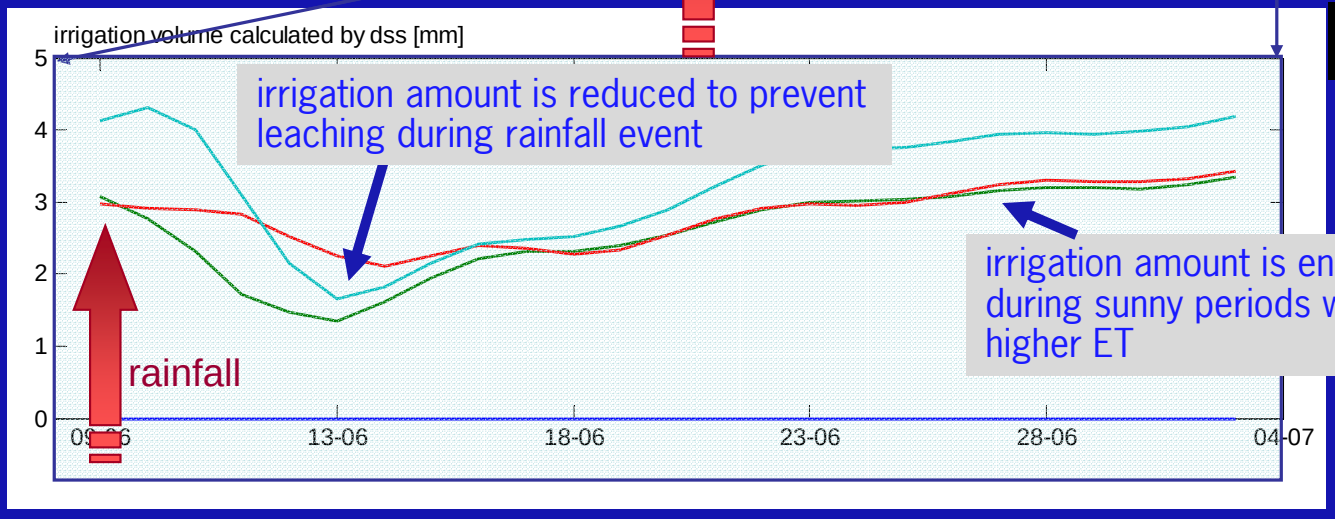
DSS strategy to adapt dose (example)



Soil Volumetric Water Content



Irrigation Amount

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Summary of water use efficiencies

Crop	*Water Use (mm)*	*Drainage (mm)*	*Ratio Fresh to Total Water (%)*	*Marketable WUE (kg/m^3)*	*Water Saving Index (%)*
Ornamentals	413 (540)	119 (237)	66	-	24
Cucumber	545 (717)	10 (92)	100	44 (35)	19
Tomato	275 (425)	-	0	8 (6)	25
Egg plant	71 (95)	-	100	54 (36)	35
Lettuce	66 (186)	-	58	73 (22)	69

(* * *) values obtained from farmer practices used as reference

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Conclusion

Even while using a deficit strategy, Sensor Activated Irrigation Scheduling offers farmers, under sub-optimal growing conditions, more possibilities to:

- Efficiently use water and nutrients
- Minimize run-off, percolation losses
- Prevent crop damage
- Achieve good and even higher crop yields
- Reduce labour

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Recommendations to farmers and companies

- Optimize cropping and irrigation system
- Match crop water and nutrient needs closely in time
- Slight deficit irrigation when the water is scarce
- More irrigations, smaller doses to prevent leaching

- We need a fail-safe DSS
- Technical support and training for farmers
- Reduce costs of systems and equipment

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Thanks for your attention …

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