FLOW-AID:
a Farm-based Assistant for Deficit Irrigation

"Technology and science for efficient irrigation:

The European projects PLEIADeS and FLOW-AID and accompanying meetings "

November 11th, 2009

Jos Balendonck

Overview

- Overview (objectives and framework) – Jos Balendonck
- Part 1: Technology (Building Blocks)
  - MOPECO (online) – Alfonso Dominquez, Jose Maria Tarjuelo *
  - FLOW-AID DSS – Cecilia Stanghellini *
  - Wireless Sensor Networks – Jochen Hemming
  - New Tensiometer – Richard Whalley
- Part 2: Case study results from pilot areas
  - Pistoia, Tuscany, Italy – Alberto Pardossi, Luca Incrocci
  - Menderes, Izmir, Turkey – Hakki Tuzel
  - Irbid, Jordan – Laith Rousan
  - Litany River, Bekaa Valley, Lebanon – Fadi Karam
  - Vredepeel, the Netherlands – Jos Balendonck
- Conclusions
- Demonstration MOPECO – Alfonso Dominguez
- Demonstration DSS – Axileas Anastasiou

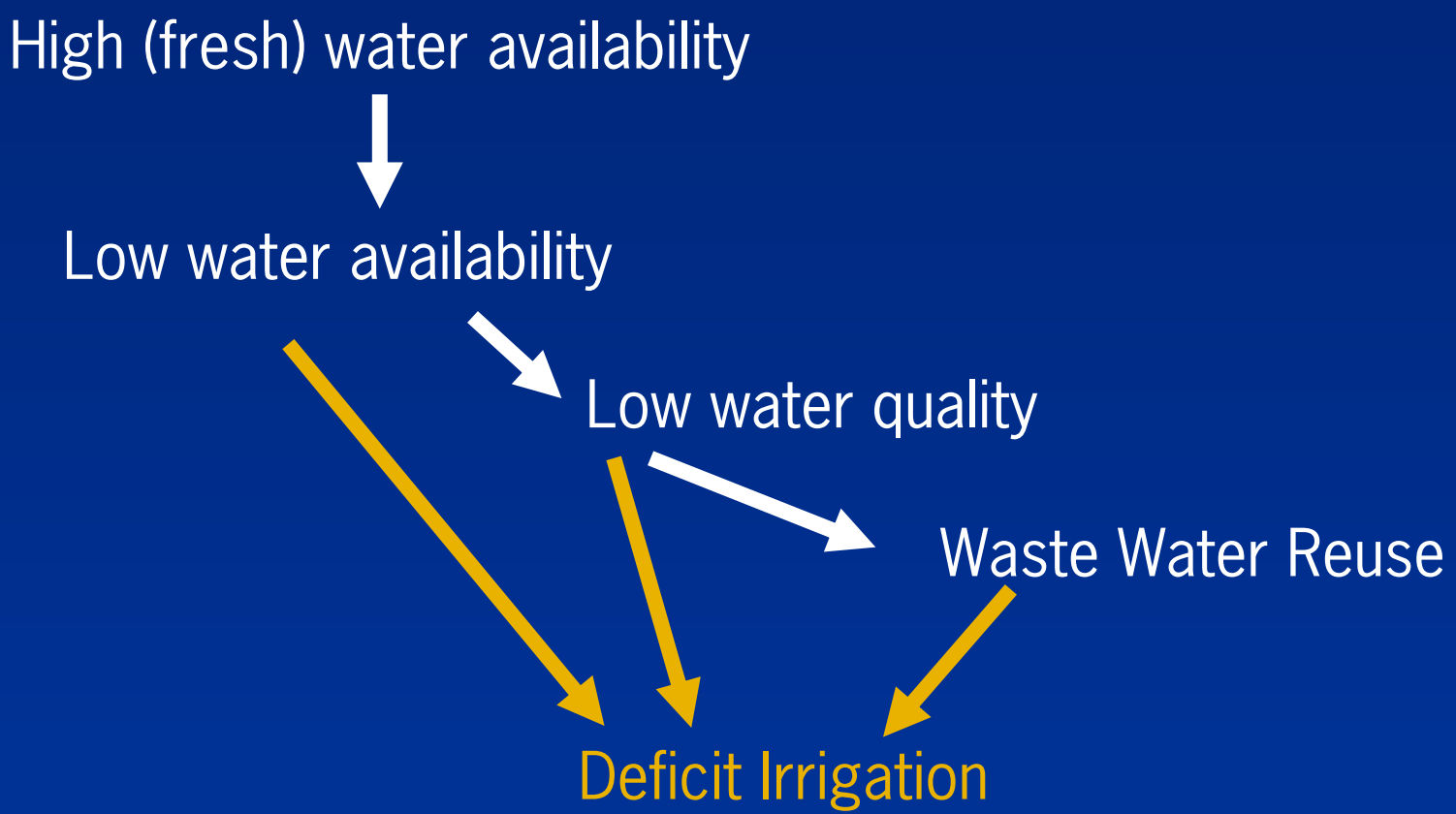
European Project

- 7 universities + 3 companies
- 8 (mainly Mediterranean) countries
- NL, UK, ES, IT, GR, TR, LB, JO

2006 - 2009

FLOW AID

Trends in Water Management



No restrictions on water use

- Farmer practices
  - Irrigation amounts depend on availability
  - Give enough water and fertilizer to maximize crop yield
  - Give more, to be sure that all plants get enough (variability)
- result in …
  - Good crop yield and income
  - Leaching or run-off of water and fertilizers
  - Higher costs due to over use of water and fertilizers

Fresh Water or Leaching Restrictions

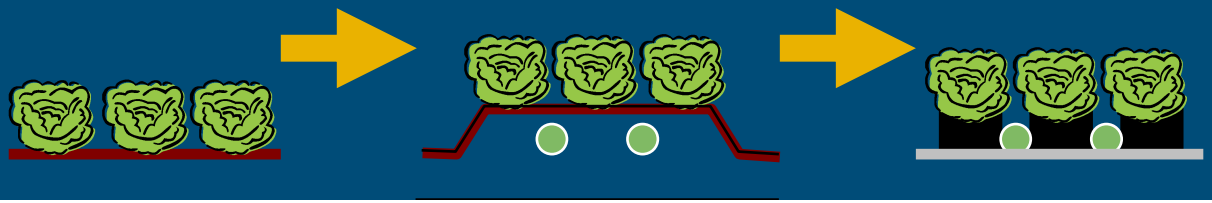
- Use of less water and fertilizer, as well as
- Use of marginal water resources may result in:
  - Crop damage
  - Diseases
  - Yield loss
  - Lower income
- Adapt growers practice to:
  - avoid or minimize crop losses by
  - optimal water and fertilizer management

Objectives of FLOW-AID

- 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 investments

Options to save water+ fertilizer

- Optimize Crop Planning
- Use drip irrigation with fertigation
- Reuse your water and nutrients
- Grow more detached from soil
- Automate the irrigation process



How to support growers?

- Decision Support System:
  - Advice when and how much to irrigate
  - Advice when and how much to fertigate
- Tools to determine amount and source of water
  - Continuous feed-back about crop status: Sensors
  - Process Automation: controllers, computer software

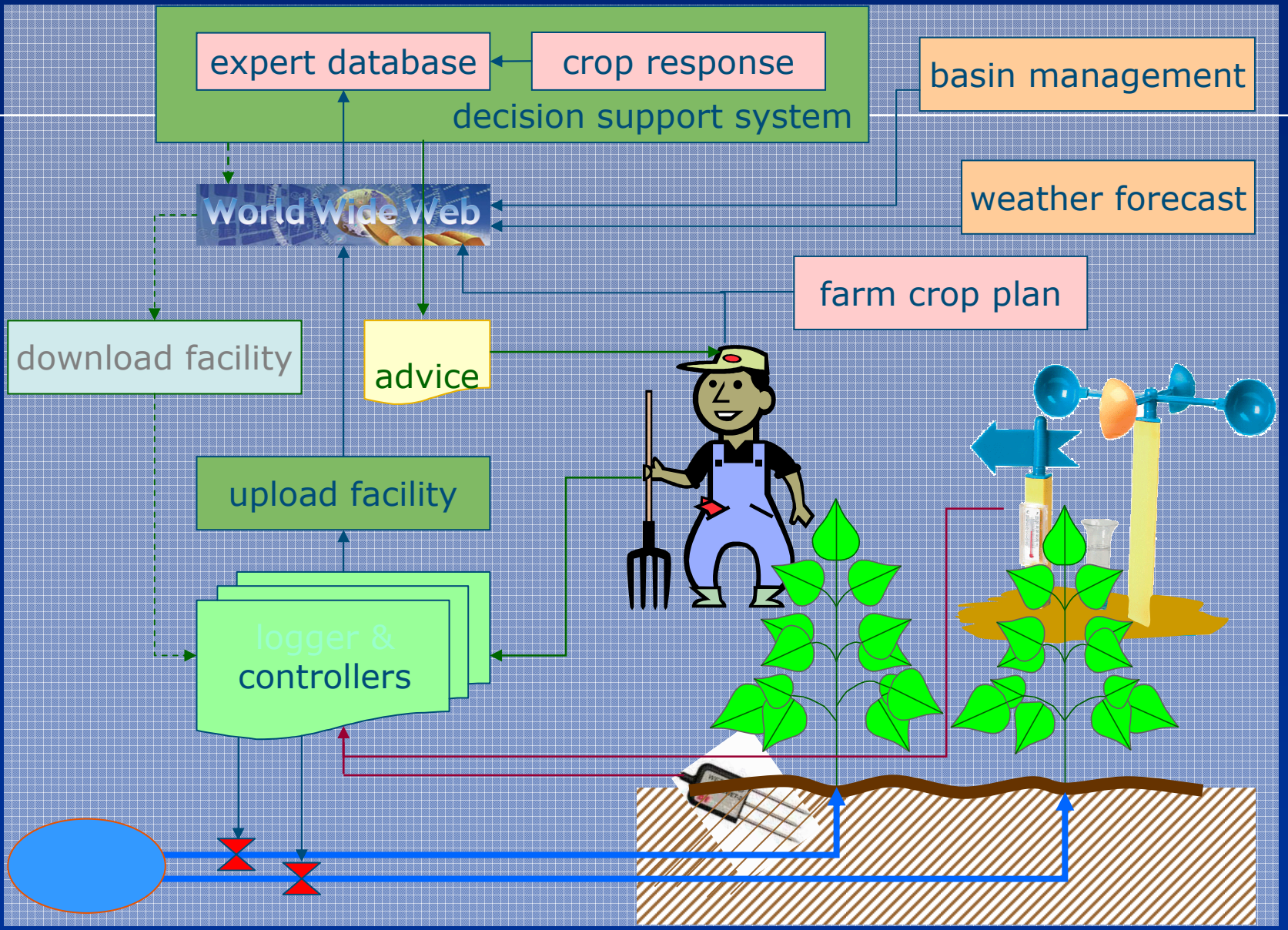
Our Approach

- Efficient management of irrigation requires concurrent evaluation of several factors:
  - crop water requirements
    - type of crop and crop stage
  - weather
  - quality of the irrigation water
  - crop response to salinity and drought
- Need for tools to combine information from various sources into a decision about timing, dose and source of irrigation for several plots

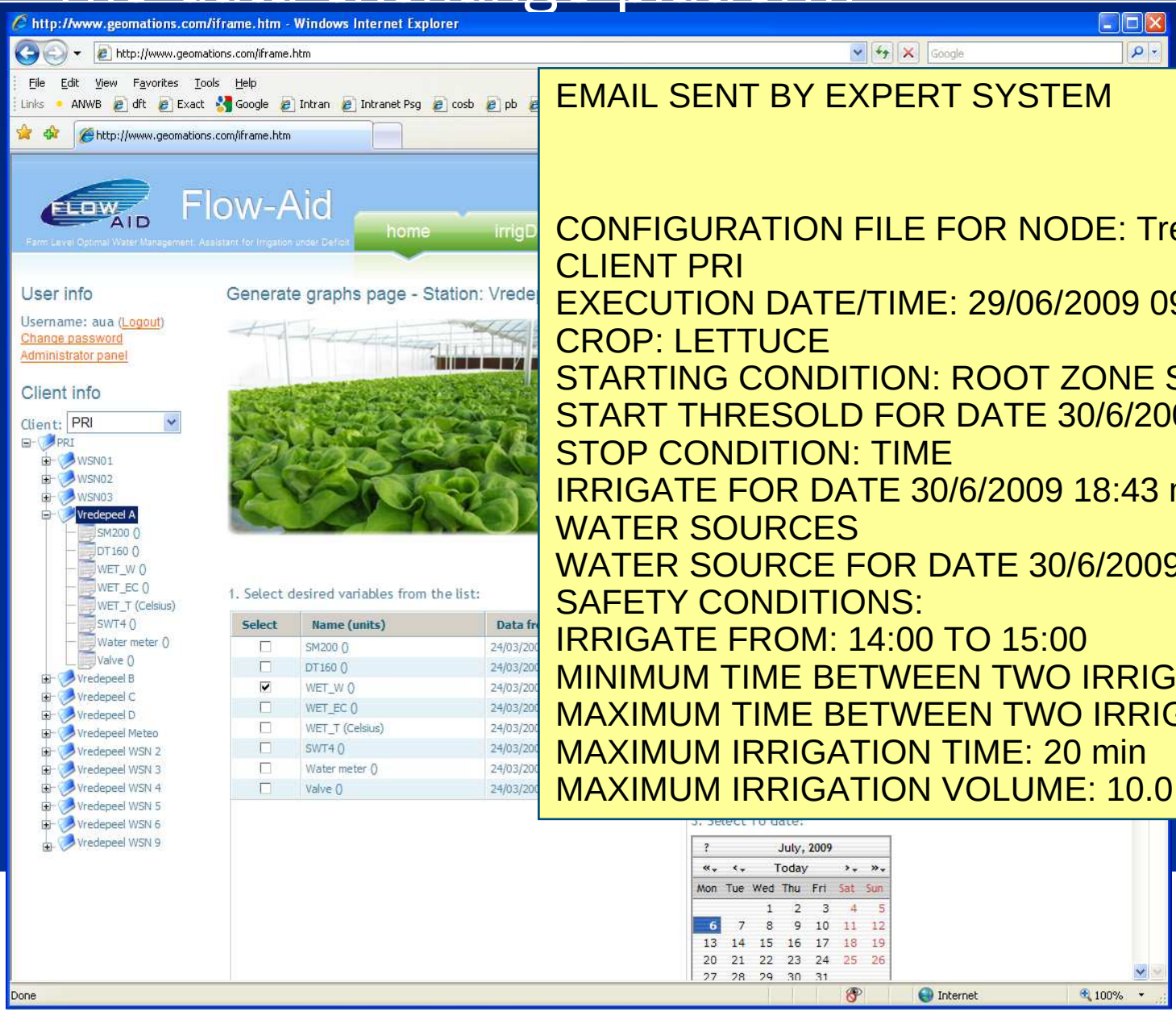
Distributed System

- Local controllers
  - Stand alone
  - Wired or Wireless
  - Start/Stop
  - Sensor based
  - Multiple valves
  - Multiple water sources
  - Programmed by grower
- Advised by a central DSS

Scheme of the DSS



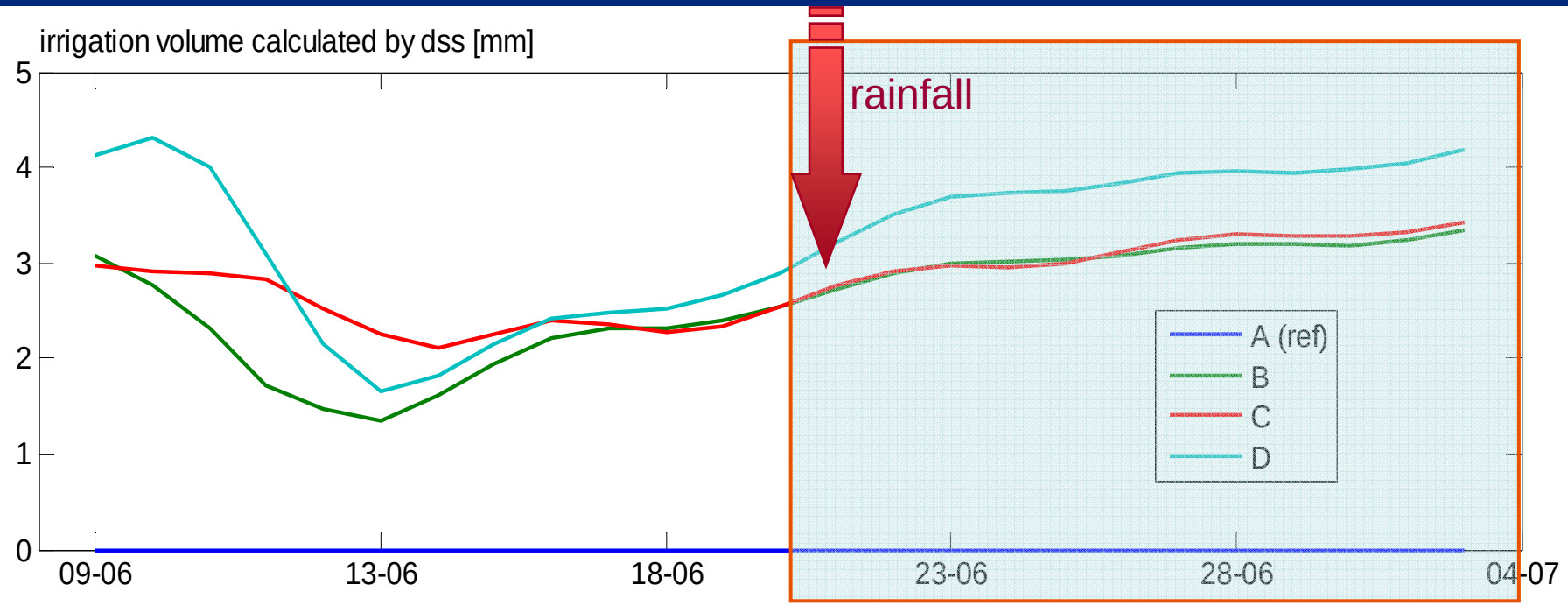
The data exchange platform



EMAIL SENT BY EXPERT SYSTEM

CONFIGURATION FILE FOR NODE: Treatment D FOR CLIENT PRI
EXECUTION DATE/TIME: 29/06/2009 09:57
CROP: LETTUCE
STARTING CONDITION: ROOT ZONE SENSOR
START THRESOLD FOR DATE 30/6/2009: 18.000000
STOP CONDITION: TIME
IRRIGATE FOR DATE 30/6/2009 18:43 minutes
WATER SOURCES
WATER SOURCE FOR DATE 30/6/2009 1
SAFETY CONDITIONS:
IRRIGATE FROM: 14:00 TO 15:00
MINIMUM TIME BETWEEN TWO IRRIGATIONS: 180 min
MAXIMUM TIME BETWEEN TWO IRRIGATIONS: not used
MAXIMUM IRRIGATION TIME: 20 min
MAXIMUM IRRIGATION VOLUME: 10.0 m3

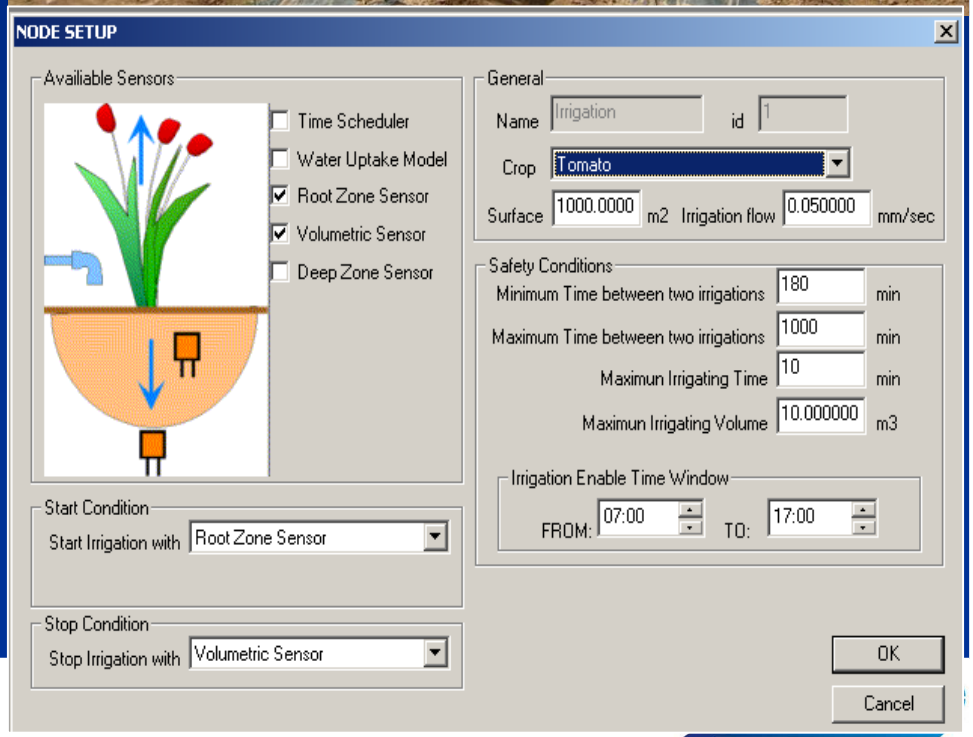
Example



- Irrigation volume is adapted after rainfall
- Water use “of DSS” 38% of farmer’s reference

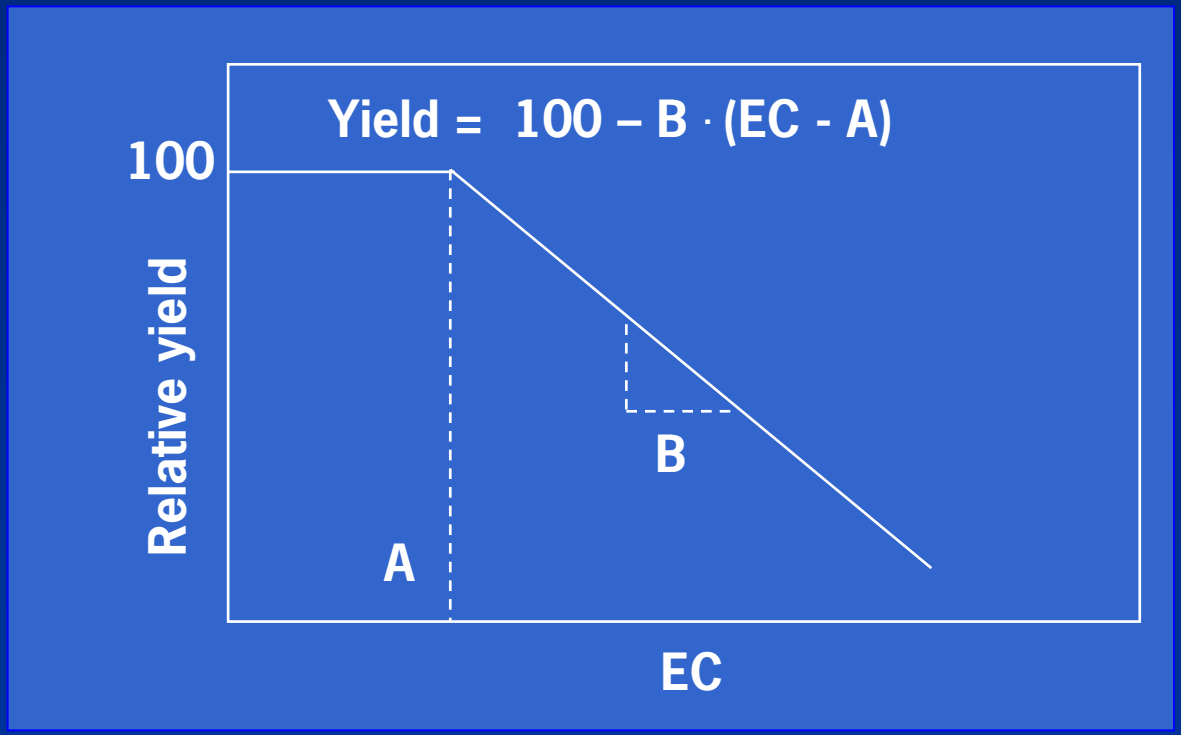
End-user benefits

- Day and long term planning
- Transparent advice
- Set Irrigation Controllers
- Insight in crop history
- Crop Stress management
- Safety (warnings)

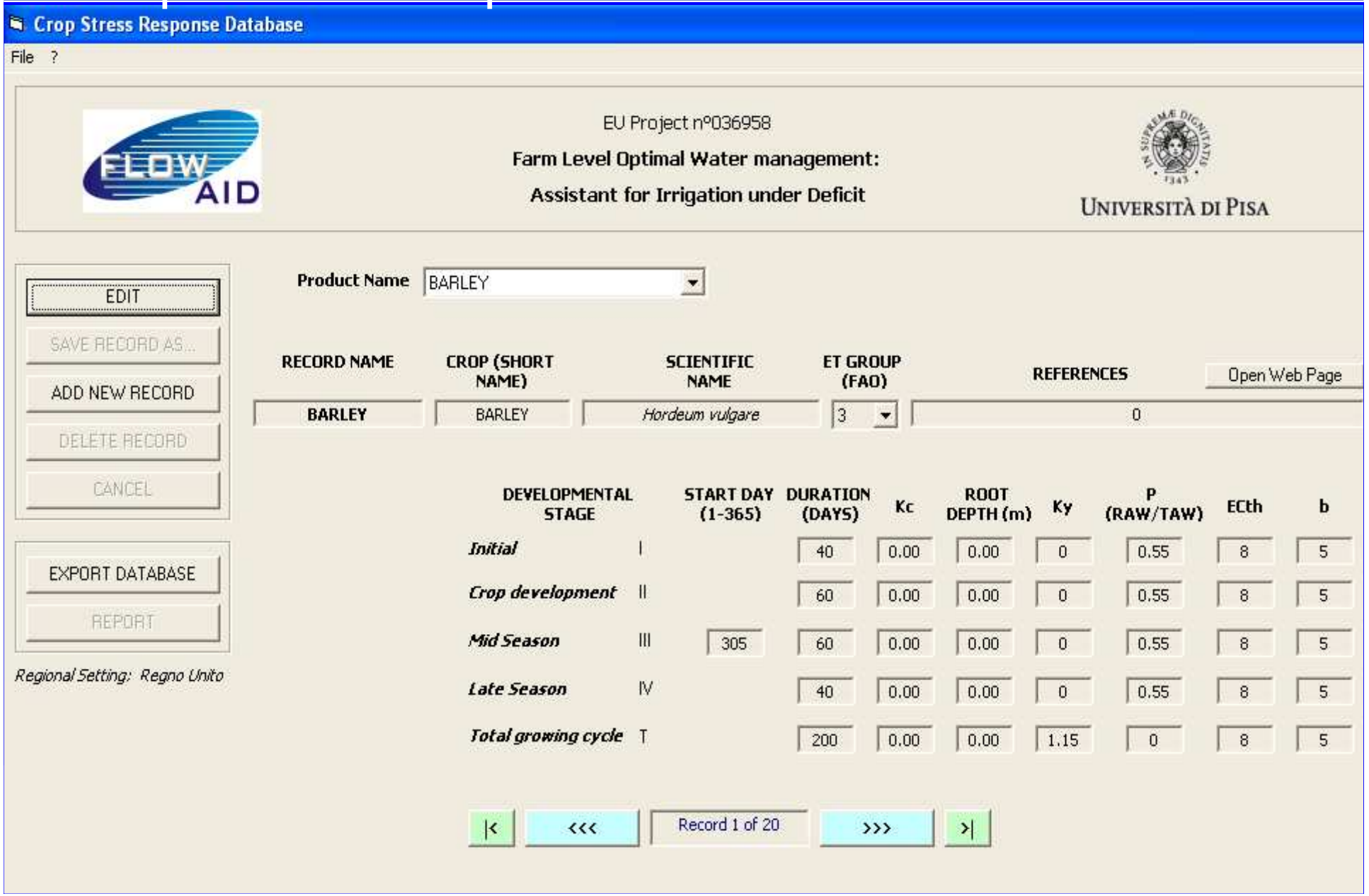


Crop Yield Model for Deficit Irrigation

- Yield to Water Quantity (A: ET-model)
- Yield to Water Quality (B: Salinity model)

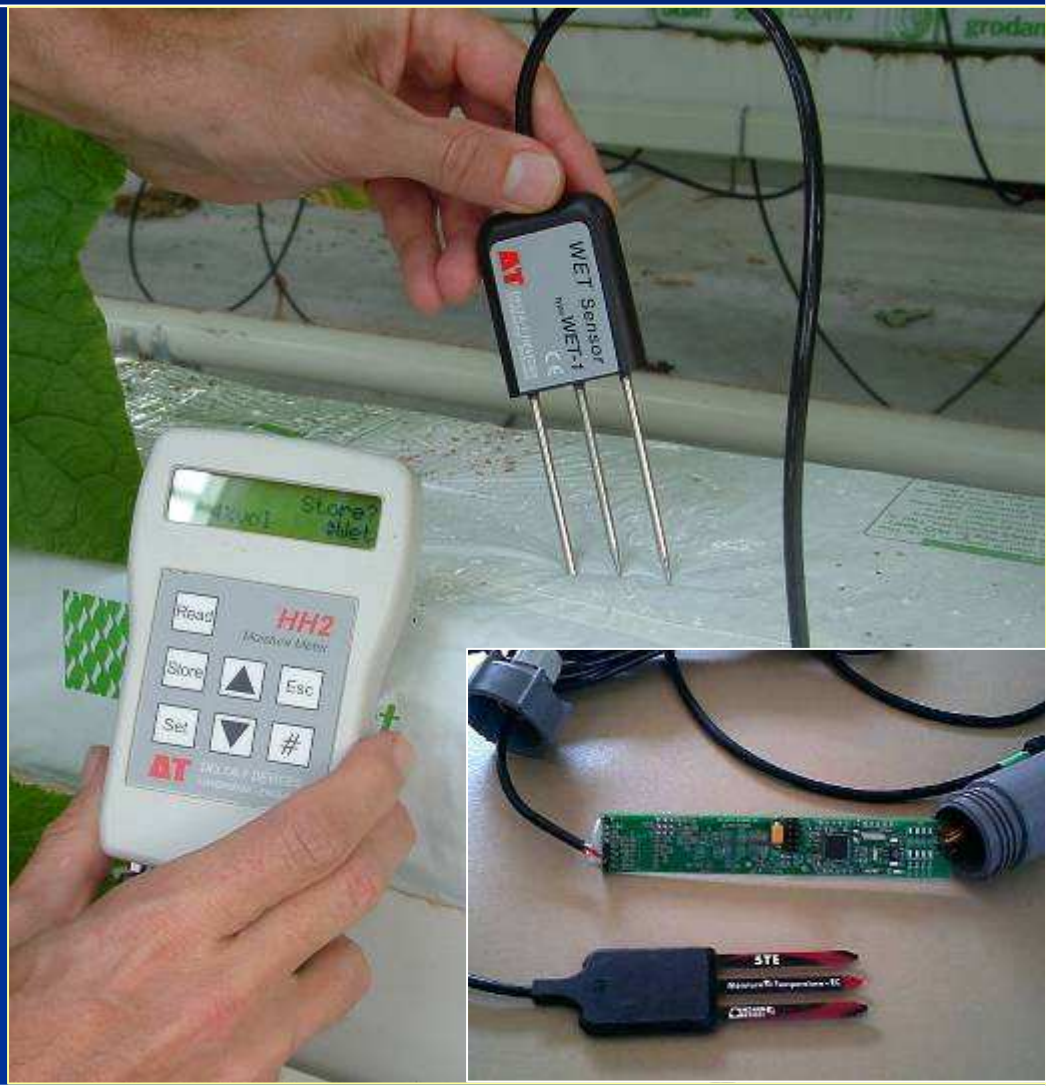


Crop Stress Response Database



Root Zone Sensors

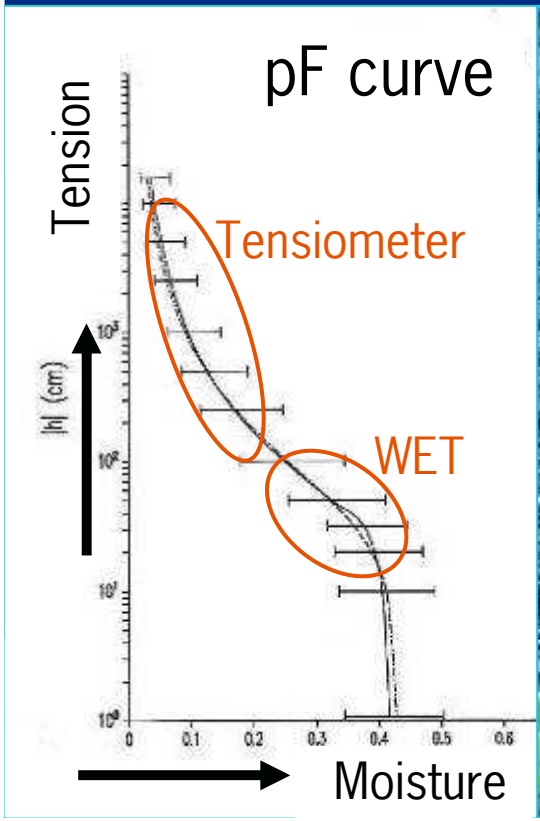
- Water Content
  - Indicates “Available Water”
  - Soil calibrations
  - For medium wet to saturation
- Electrical Conductivity (EC)
  - Total Nutrient Concentration
  - WET-sensor, ECHO-probe
  - Pore Water EC calibration
- Temperature



Electronic Tensiometers: indicate soil suction

- Water filled tensiometer
- Limited range
- Installation and maintenance
- For dry soils

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



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Wireless Sensor Network

- No cabling, easy installation
- Multiple nodes and sensors
- Robustness in field

FLOW AID

A crop planning and farm zoning tool

Availability of resources

Agriculture Policy

Production costs

Climate

Management

What to crop ?

Soil

Social aspects

Marketing

Crops

Decission Suport Systems

CREA

FLOW AID

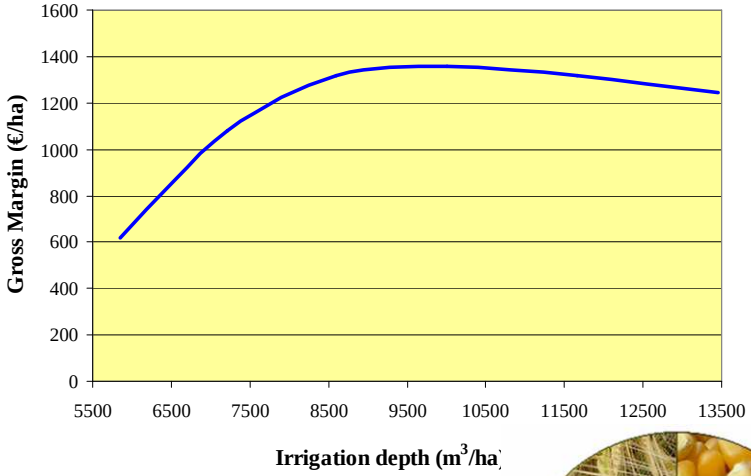
Methodology

Climatic and irrigation data
ETo, CU, EC…

Crops data
Maize, Barley, Sunflower…
Kc, Ky, harvest price…

Yield and GM generator

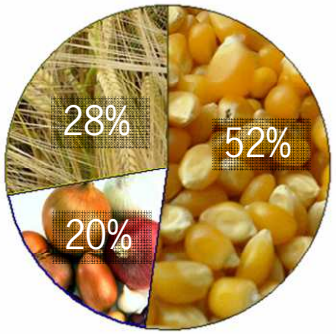
Gross Margin/Gross irrigation



Restrictions
Irrigated area, volume for irrigation, crops

OPTIMIZER

Optimal crops pattern
Risk analysis



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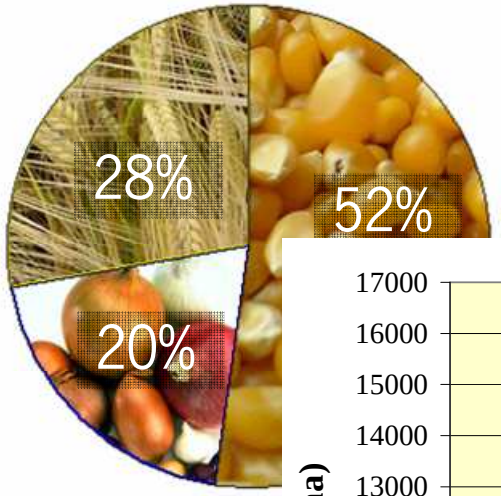
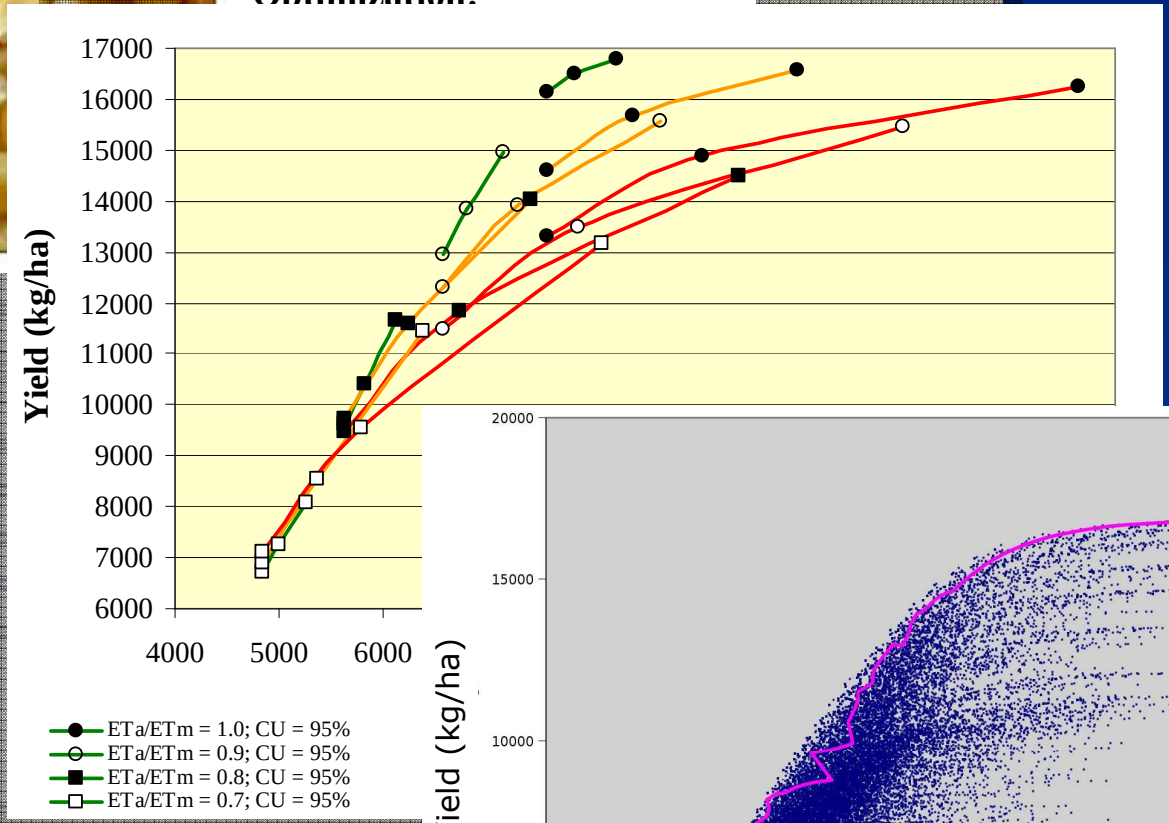
Re

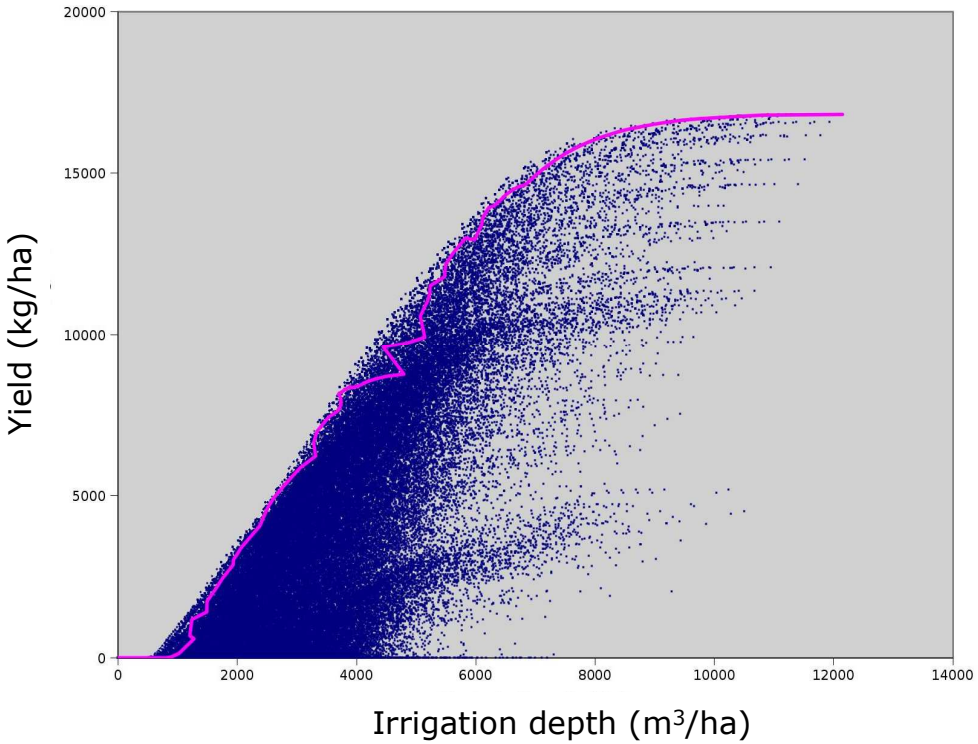


Farm data:
Total area: 100 ha
Vol. Irrigation: 450,000 m³

Optimization:

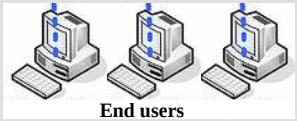
Name: Lebanon
Notes:
ETo paramete
General para
Area (ha)
Optimization method: Eulogio
Crop parameters
Crop: Maize
Maximum area (ha):
Maximum set aside (%):
Maximum irrigation depth (m^3/ha):
Min EC (dS/m):
Notes:
New
Save
Delete
New
Save



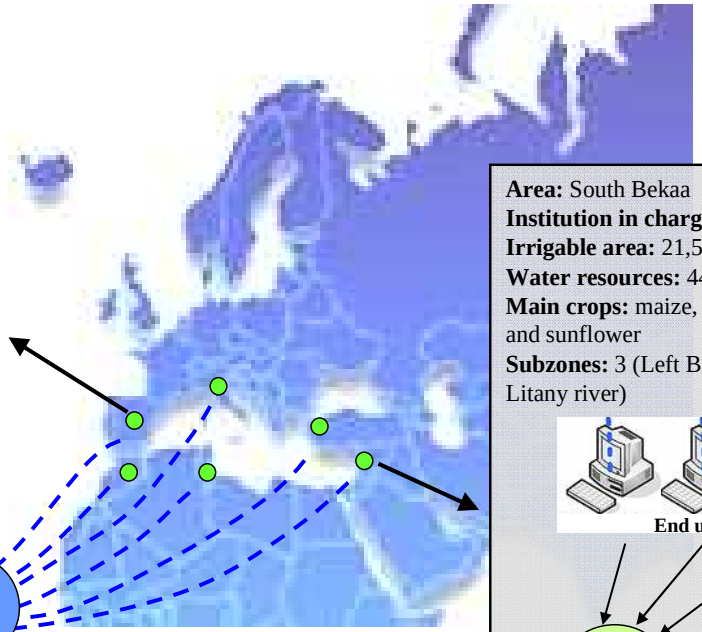


End-user benefits

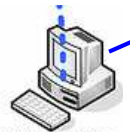
Area: Eastern Mancha aquifer
Institution in charge: SIAR
Irrigable area: 105,000 ha
Water resources: 450 hm^3/year
Main crops: maize, barley, wheat, garlic, onion, potato, sunflower, olive and vine
Subzones: 6 (Albacete, Tarazona, La Gineta, Motilleja, Almansa, Pozo Cañada)



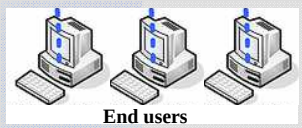
SIAR Simplified model



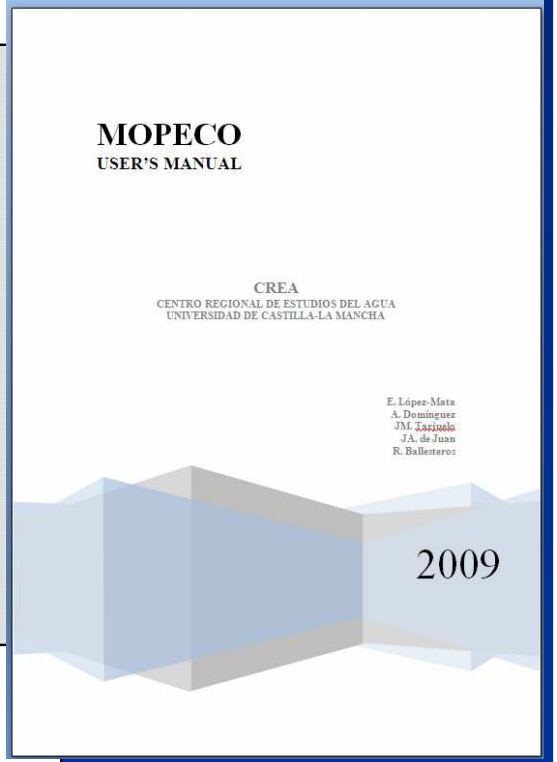
Full model



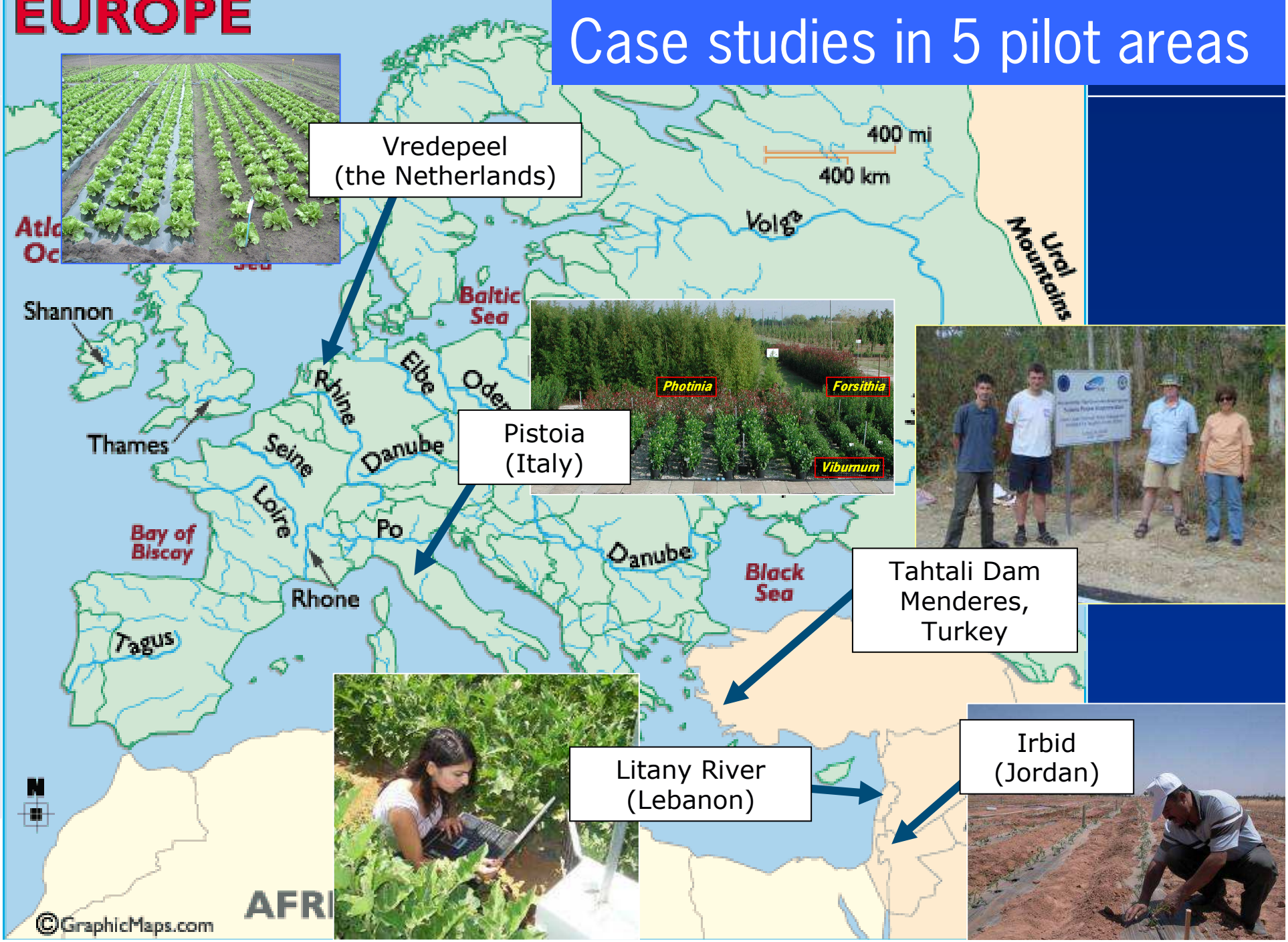
Area: South Bekaa
Institution in charge: LARI
Irrigable area: 21,500 ha
Water resources: 44 hm^3/year
Main crops: maize, soybean, cotton and sunflower
Subzones: 3 (Left Bank, Right Bank, Litany river)



LARI Simplified model



Case studies in 5 pilot areas



Italy

- Pistoia, Tuscany
  - Nursery stock production
  - Farm sizes: 10 - 100 ha
  - Container plants (drip/sprinkler)
  - Many crop types + sizes/plot
  - Need to use saline water
- Objectives
  - Dual water irrigation: Cleaned Waste Water and Fresh Water
  - Prevent Plant Stress

Turkey

- Izmir (Tahtalı Dam)
  - Preservation area
  - Greenhouses (Cucumber)
  - Water from wells
  - No leaching allowed
- Objectives
  - Reduce water use
  - Maintain Marketable Yield
  - Sensor activated control

Jordan

- Irbid, Jordan Valley
  - Fruit and oriental trees, vegetables
  - Limited water resources
  - Poor water management at farm level
  - Low water use efficiency
- Objectives
  - Maximize Water Use Efficiency
  - Soil grown tomatoes
  - Dual water quality irrigation: Treated Waste Water (T) and Fresh Water (F)
  - Sensor Activated Irrigation
  - FULL (F) and DEFICIT irrigation (D)

Lebanon

- South Bekaa Valley, Litany River
  - Tal Amara Research Station
  - Vegetables (potato, eggplant)
  - Water sources:
    - Surface irrigation
    - Sprinkler and drippers
  - Poor water management
- Objectives
  - Deficit irrigation performance
  - Enhance Water Use efficiency
  - Evaluate New Technologies
  - Knowledge transfer to farmers

The Netherlands

- Rain-fed agriculture (horticulture)
  - Soil based cropping
  - Sprinkler overhead irrigation
  - Labour intensive, logistic problems
  - Decision support
  - Plant diseases and pests
- Fertilizers
  - Grains, single dose prior to start
  - Wet periods: leaching of fertilizers
- Economics
  - Low prices
  - Small net income of farmers
- Objectives
  - Prevent nitrate leaching
  - Raise production by using fertgation

FLOW-AID Tools

- Economic optimization model for Farm planning (MOPECO)
  - Maximum gross margin under given constraints for water and economics (harvest price, water costs, salinity)
- Intelligent sensor-activated irrigation and fertigation controllers
  - Flexibility, real-time monitoring and control, safety
- Novel sensor for water potential
  - Easy to use/install, reliable, wide range, robust no maintenance
- Wireless systems
  - Easy to install/use in remote areas
- Database of crop response to salinity and water deficit
  - Useful for DSS-developers, training/teaching, farmer awareness
- Decision support tool (DSS) for irrigation management under constraints
  - Combined information and expertise from various sources, easy to use

Results

- System tested under several constraints
  - Water deficit, water quality, leaching limitation,
- System tested under several settings
  - Semi-arid, mild winter, rain-fed, (non)protected, soil or substrates

- Water Saving (up to 60%) while maintaining crop yield
- Saving of fertilizer (up to 30%)
- Increase in yield (up to 15%)
- Reduction of environmental impact
- Prevent crop damages
- Reduce amount of labour

Technology comes within reach for farmers

- More knowledge available (scientific and practical)
- Availability from suppliers
- Costs are lowering

BUT

- Still room for improvements
- More cost effective tools
- Technology transfer and adoption by farmers
- Improve reliability and safety

Thanks for your attention, and …

… visit us at: www.flow-aid.eu

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GEOMATIONS

ROTHAMSTED RESEARCH

AT
Delta-T Devices

UCLM
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- Questions?

Demonstration

Example using MOPECO on-line

Example using DSS on-line

Further demonstrations during break and afternoon sessions