FLEXIBLE AND PRECISE IRRIGATION PLATFORM TO IMPROVE FARM-SCALE WATER PRODUCTIVITY

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Current challenges in management of water for agriculture: matching science and practice on farm level
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Agriculture keeps advancing, adapting new technology to meet the needs of an increasingly global economy.

Caring for the land, while ensuring that it continues to produce food and energy satisfying the high EU lifestyle standards, requires informed decisions (KBM).

Like all business owners, Farmers want to operate at the top of their capacity, but they also want to be good stewards of the land. So they are eager for learning strategies to reduce negative impacts while maintaining optimum yields.

Water is a significant challenge in the complex industry of agriculture. Access to it is one issue. Keeping it clean is another.
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THREE STEPS APPROACH

1- Acting on a vision
2- Building upon local assets
3- Preparing new solutions

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THE EU BLUEPRINT: INCREASING WATER PRODUCTIVITY

SAVING WATER

a) BETTER GOVERNANCE AND MANAGEMENT
b) INFRASTRUCTURE MAINTENANCE
c) TECHNOLOGICAL INNOVATION
d) DEFICIT IRRIGATION STRATEGIES
e) DECREASE SOIL EVAPORATION
f) PRECISE IRRIGATION SCHEDULING
g) REDUCE RUNOFF (AND PERCOLATION)
h) HOLISTIC APPROACH TO INPUTS
i) WATER REUSE
j) CROPPING SYSTEM IMPROVEMENT
k) CROP ROTATION
l) TRADE AND CONSUMERS RESPONSABILITY

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Precision Irrigation involves the 'differential irrigation' treatment of field variation as opposed to the 'uniform irrigation' treatment that underlies traditional irrigation management.

Since 1996 PI is considered part of the broad concept of Prescription Farming (Rawlins, 1996).

Prescription Farming utilize real-time information regarding the processes that might be limiting production on a spatial scale in the field.

Modern Precision Irrigation (PI) criteria involves Site-Specific Irrigation (SSI) application.
Precision Irrigation (PI):

Precise Irrigation is able to significantly reduce agricultural water uses.

Precise Irrigation is deemed the best solution to minimize adverse environmental impacts.

“Precise irrigation” is frequently mentioned in regulations and laws as the front line of modern irrigation methods.
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EXPECTATIONS

• WATER SAVINGS OF ABOUT 20%;
• HIGHER WATER PRODUCTIVITY
• HIGHER ECONOMIC WATER PRODUCTIVITY;
• HIGHER YIELD (quantity and/or quality).

• MINIMIZE ADVERSE ENVIRONMENTAL IMPACTS
• IMPROVE WATER GOVERNANCE THROUGH BETTER MANAGEMENT OF THE RESOURCE BASE;
• LOWER CARBON AND WATER FOOTPRINT

• ENERGY SAVINGS OF ABOUT 20%
• ENERGY PEAK-LOAD AND COSTS REDUCTION (Automated PI with Time-of-Use (TOU) Rate Control and Automated Demand Response (AutoDR)
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EXPECTATIONS

Precision irrigation will potentially alter on-farm decision-making, and simultaneously achieve the multiple objectives of enhancing input use efficiency, reducing environmental impacts, and increasing farm profits and product quality.

(Smith and Baille, 2009)
Precision Irrigation (PI):
A recent bibliometric analysis indicates that there is NO ONE research/technical publication dealing with the JOINT MANAGEMENT of the identified main PI components:

SENSORS + SITE-SPECIFIC IRR + WEATHER FORECAST + IRR. SCHEDULING + IRR STRATEGY + IRR. TECHNOLOGY
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BARRIERS TO PI IMPLEMENTATION

- Uncertainty about future availability of water: 3%
- Risk of reduced yield or poor crop quality: 8%
- Physical field/crop condition limit system: 5%
- Will not be farming this operation long enough to justify improvements: 8%
- Cannot finance improvements: 7%
- Improvements will not reduce costs enough to cover installation cost: 21%
- Investigating improvements not a priority: 41%
- Other: 7%

Jose Payero and Ahmad Khalilian
Clemson University, South Carolina
InfoAg, 16-18 July, 2013, Springfield, IL

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Precise irrigation bottlenecks

- Cost savings and Yield increase are actually unsteady.
- Changes in soil particle size distribution not always involve noticeable change in soil water holding capacity.
- Soil fertility, N fertilisation, and Added Organic Matter have higher impact on precise agriculture than water management.
- Soil permeability, waterlogging, soil compaction, salinity, water quality, root growth dynamics can overcome precise irrigation effectiveness.
- Farmers lack suitable support for precise irrigation.
- All too often, agriculture is reactive to consumer resistance, instead of proactive.
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Management of the available but fragmented knowledge

Building Upon Local Assets
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REMOTE & PROXIMITY SENSING TECHNOLOGIES

Building Upon Local Assets
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Field robots may provide an overview of the crops to determine their necessities using sensory vision or video.

Soil Sensors are in the process of becoming more widely used as they are an arrangement designed as a part of the robot to detect disease.

The new generation of field robots can implement Swarm Technologies operating as interlinked units exchanging information in real time to optimize their efficiency and self-learning capabilities.
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Building Upon Local Assets
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SITE-SPECIFIC IRRIGATION

Soil variability must be substantial:

- 10% water saving where soil AWC varies by 50 mm
- 15% water saving where soil AWC varies by 100 mm
- More than 15% water saving where soil AWC varies by > 100 mm

(Carolyn Hedley)

Similar Irrigation Volume but different Irrigation frequency
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OPTIMIZED IRRIGATION SCHEDULING

Building Upon Local Assets

DAISY
MOHID-LAND
IRRIFRAME
Fertirrigere
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DEFICIT IRRIGATION

Hydraulic signals to control and reduce evapotranspiration

EU Project SAFIR
EU Project W4Cs
EU Project Figaro

Building Upon Local Assets

No signals
Alternate PRD
Chemical signals

A. Battilani, Haifa 07 September 2016
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OPTIMAL IRRIGATION STRATEGY FOR PI APPLICATION

Preparing New Solutions

Water saving Irrigation Strategy Utility Program

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OPTIMAL IRRIGATION SYSTEM FOR PI APPLICATION

Preparing New Solutions

North EU Humid Climate

Mediterranean Sub-Humid to Arid Climate
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OPTIMAL ENERGY MANAGEMENT

Energy comes to about 40% of the total water costs in agriculture

ENERGY CONSUMPTION IN PRESSURIZED IRR. SYSTEMS
Average 0.40 kWh m$^{-3}$ (range 0.15-0.89)

ENERGY COST IN PRESSURIZED IRR. SYSTEMS
Average 0.027 Euro m$^{-3}$

Preparing New Solutions
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KNOWLEDGE BASED IRRIGATION PLATFORMS

Preparing New Solutions

WATER MANAGER

SOLAR PANEL

STORAGE BATTERY

SOLAR PUMP

WIRELESS VALVE

SATELLITE REMOTE SENSING

SUB-FIELD MANAGEMENT ZONE MAPS

PRESSURIZED MICROIRRIGATION

SOIL WATER CONTENT

WIRELESS SENSOR

PRESSURIZED MICROIRRIGATION

MODELS & DSSs

WATER MANAGER CONTROL STATION

ECOLOGY

WATER GOVERNANCE

CROP PROFITABILITY

METEO FORECAST

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PRECISE IRRIGATION MANAGEMENT: AN EXCESSIVE BURDEN FOR FARMERS?
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THE ULTIMATE CHALLENGE

INTEGRATION

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