

# INTEL-IRRIS's approach & methodology for low-cost sensing in irrigation optimization for smallholders



**INDICATIC AIP & IICA – Workshop on  
*Agricultura Inteligente***  
**June 7<sup>th</sup>, 2023**

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<http://www.univ-pau.fr/~cpham>  
Université de Pau, France



# Smart/Intelligent Agriculture

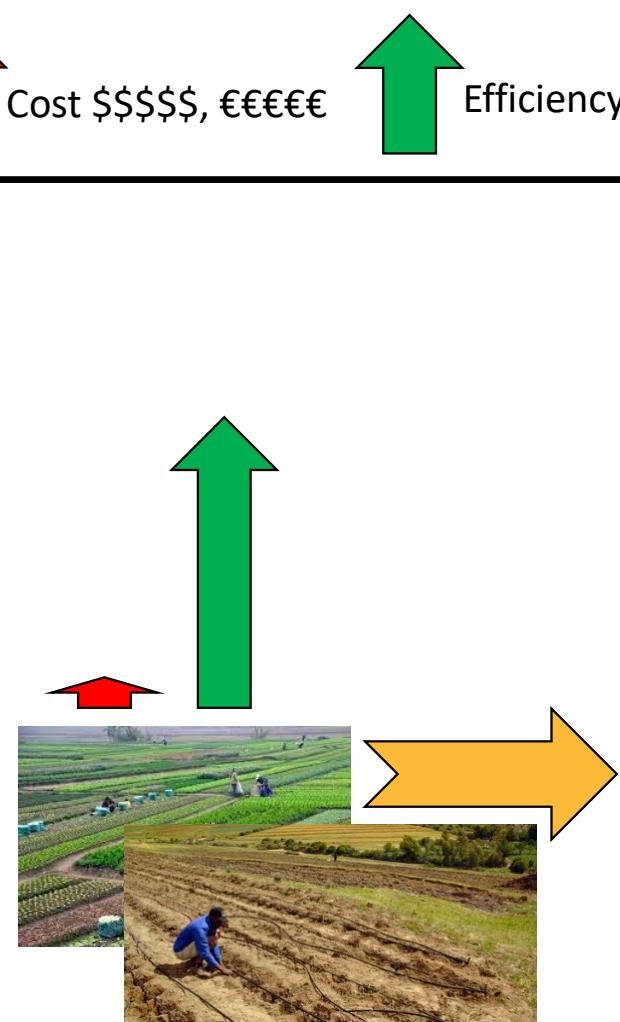
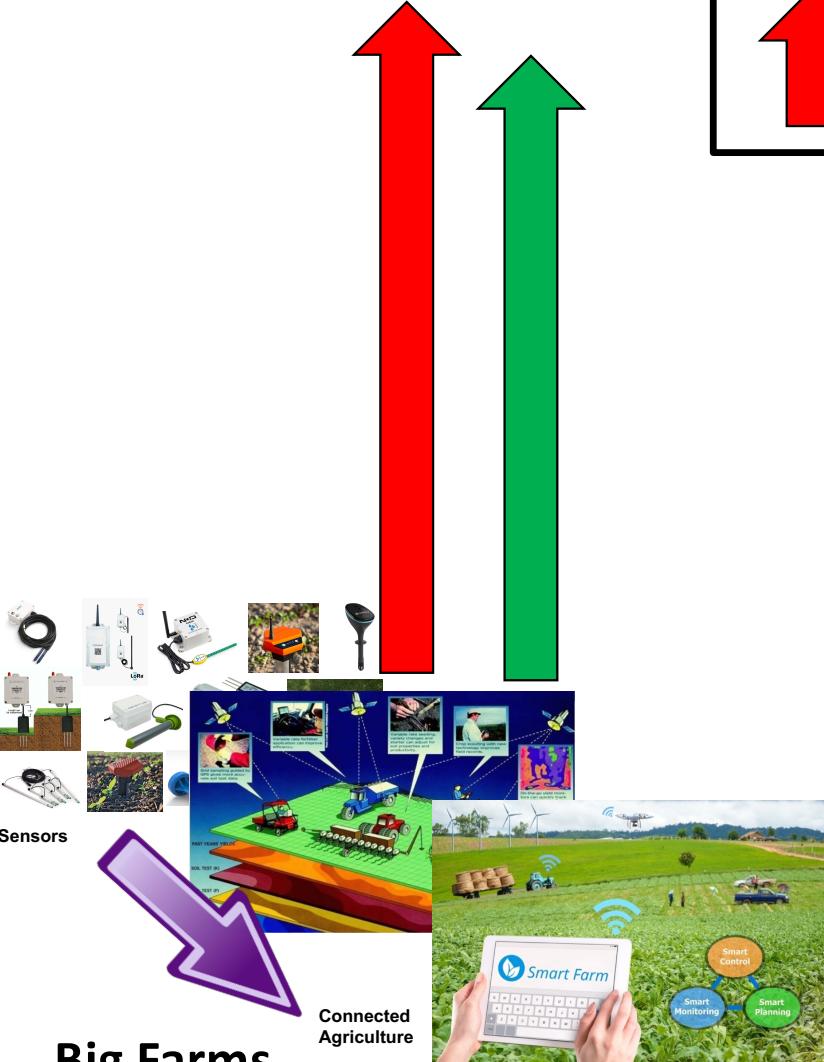
- **increasing productivity & incomes, enhancing resilience** of livelihoods & ecosystems and **optimizing usage of resources**
- **leverage advanced technology** for tracking, monitoring, automating and analyzing agricultural operations & processes
- to make agriculture a **more predictable and efficient process**

**Cloud and Big Data**  
**Sensor Technologies**  
**Mobile Technologies**  
**Internet of Thing**  
**Remote Data Analysis**  
**Drones & Satellites**  
**Artificial Intelligence**

# Ideal smart agriculture scenario



# It is always a tradeoff...

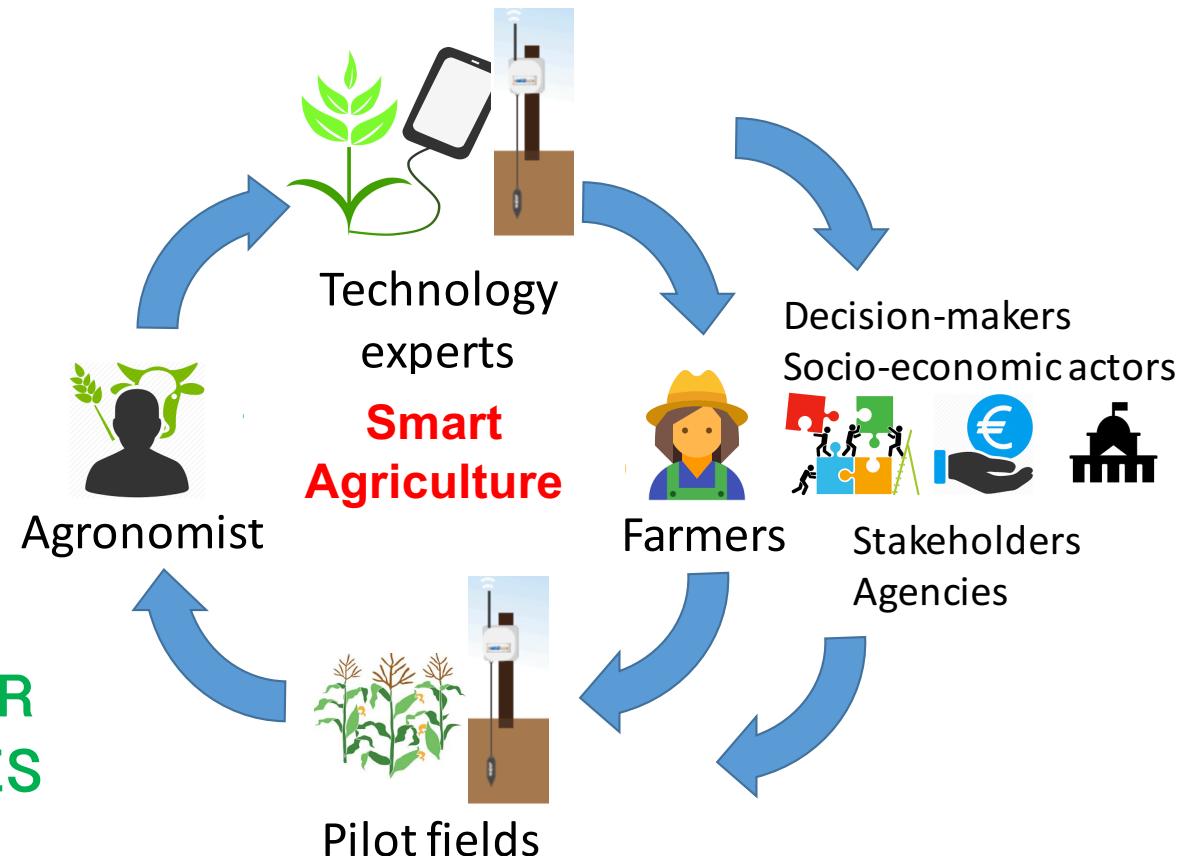


**Small-scale farms,  
Smallholder Farmers**

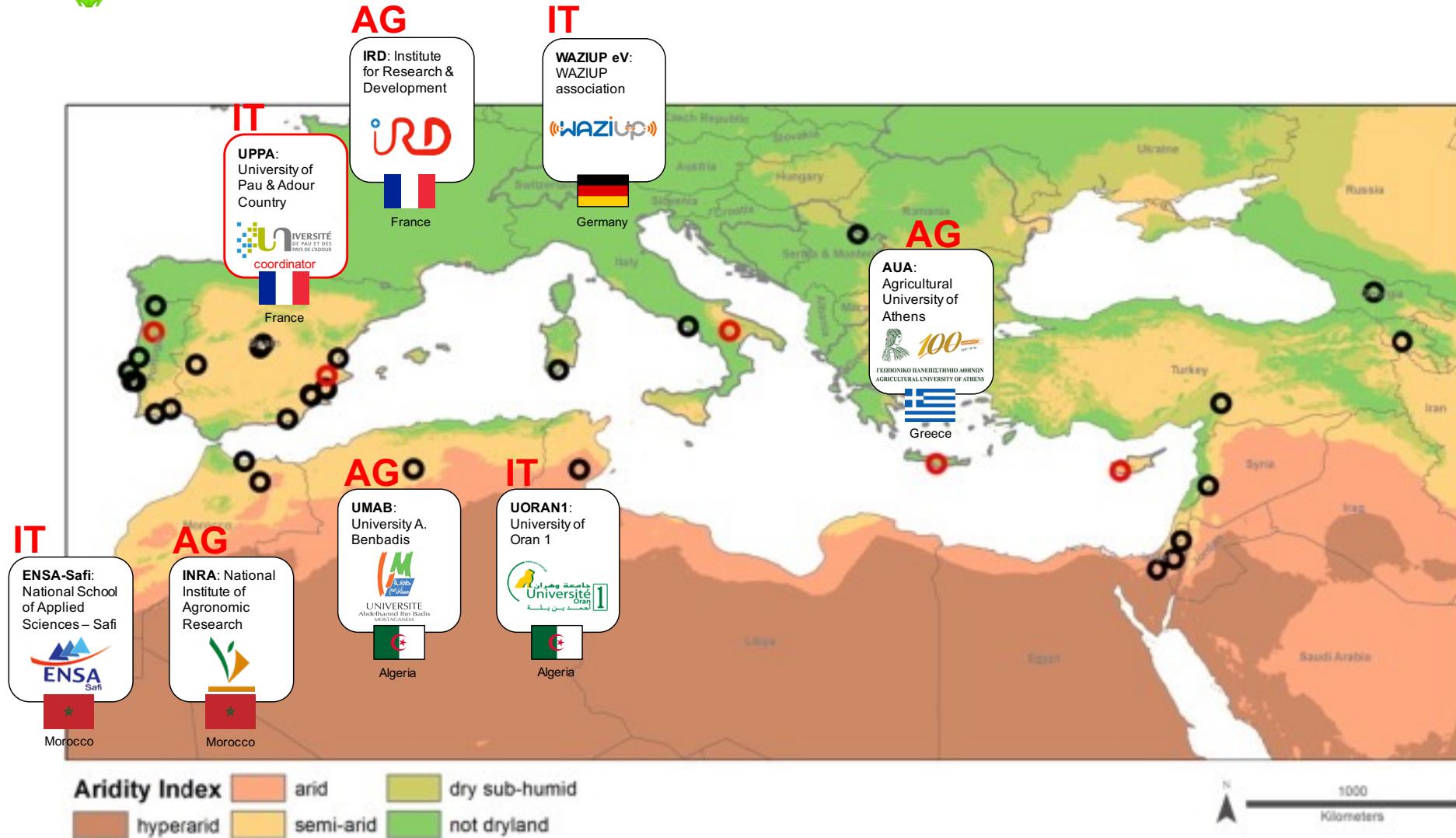
**What can  
research &  
innovation  
bring to smart  
agriculture?**

# Research & Innovation?

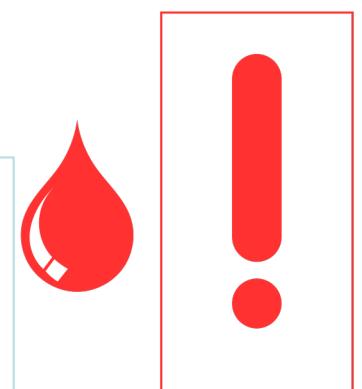
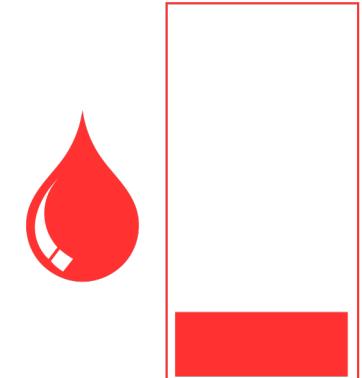
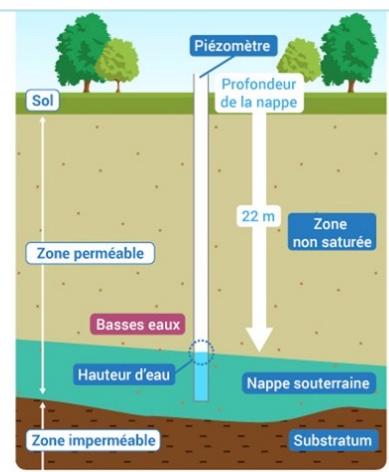
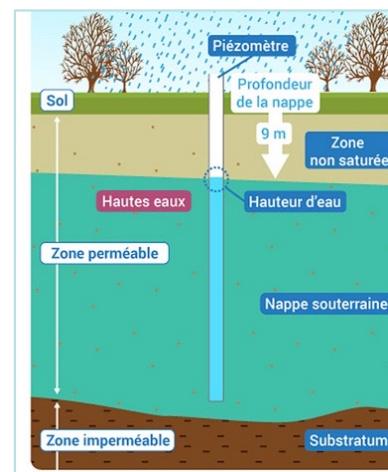
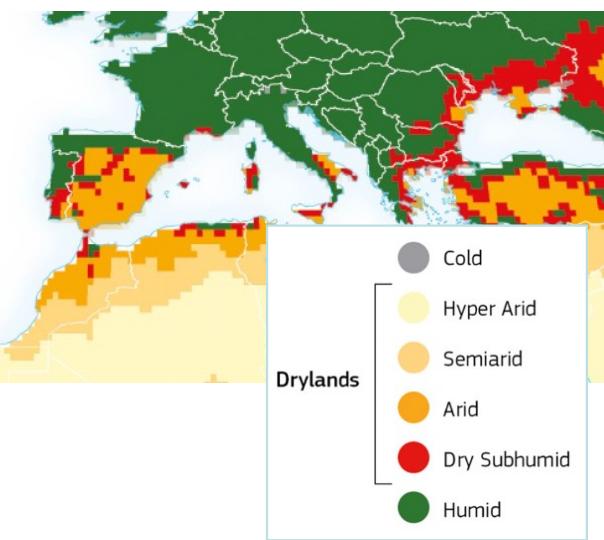
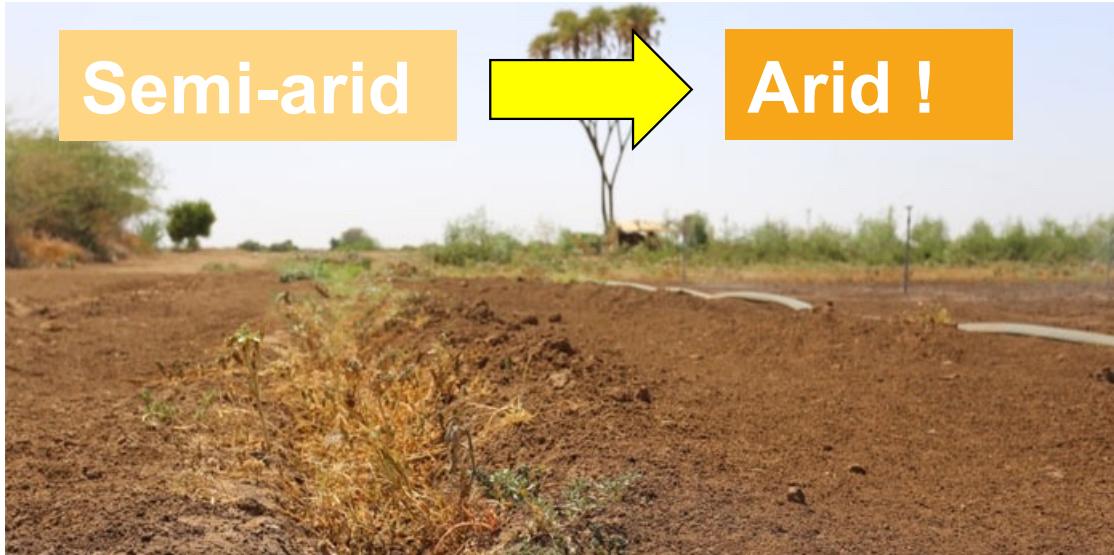
- NEED FOR TRANSDISCIPLINARY RESEARCH & INNOVATION
- MULTI-ACTOR APPROACH
- ADAPTED TO LOCAL CONTEXT AND NEEDS
- BE INCLUSIVE FOR ALL COMMUNITIES



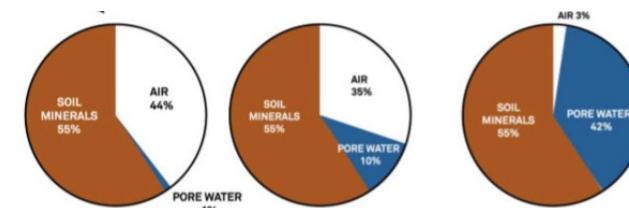
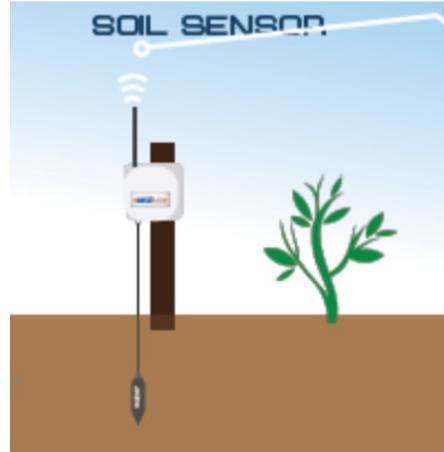
# Focus on Mediterranean Area



# Water resource is precious!



# Irrigation with soil moisture sensing



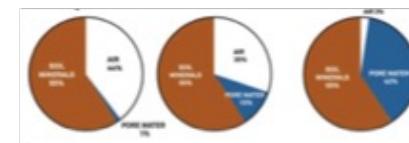
# Not as simple as it seems 😞

**Sense**



Volumetric Water Content,  
Water Potential, Water  
Tension,....

TDR, FDR, capacitance,  
resistance, ....



Soil characteristics: bulk  
density, soil salinity, soil  
texture & soil type

Evapotranspiration, soil-  
plant-atmosphere  
continuum,....



Irrigation type: drip,  
furrow, sprinkler,...

Plant/Crop varieties

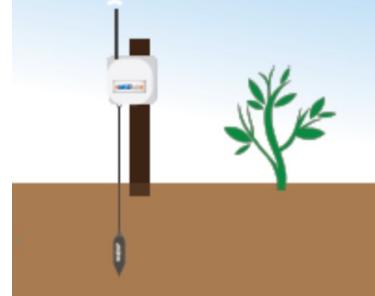
Relationship with other  
agriculture inputs

# INTEL-IRRIS's main objectives

## Low-cost

1

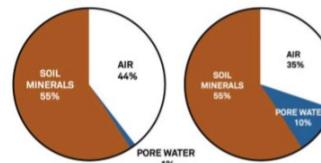
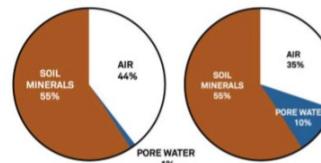
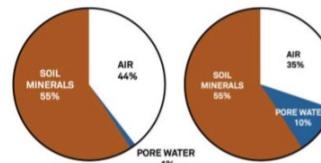
Propose low cost but highly efficient water control systems for irrigation optimization



## Advanced technologies

2

Use cutting-edge technologies to propose highly innovative systems yet simple to deploy and adapted to smallholders



3

Seamless integration into existing irrigation system and/or local customs and practices



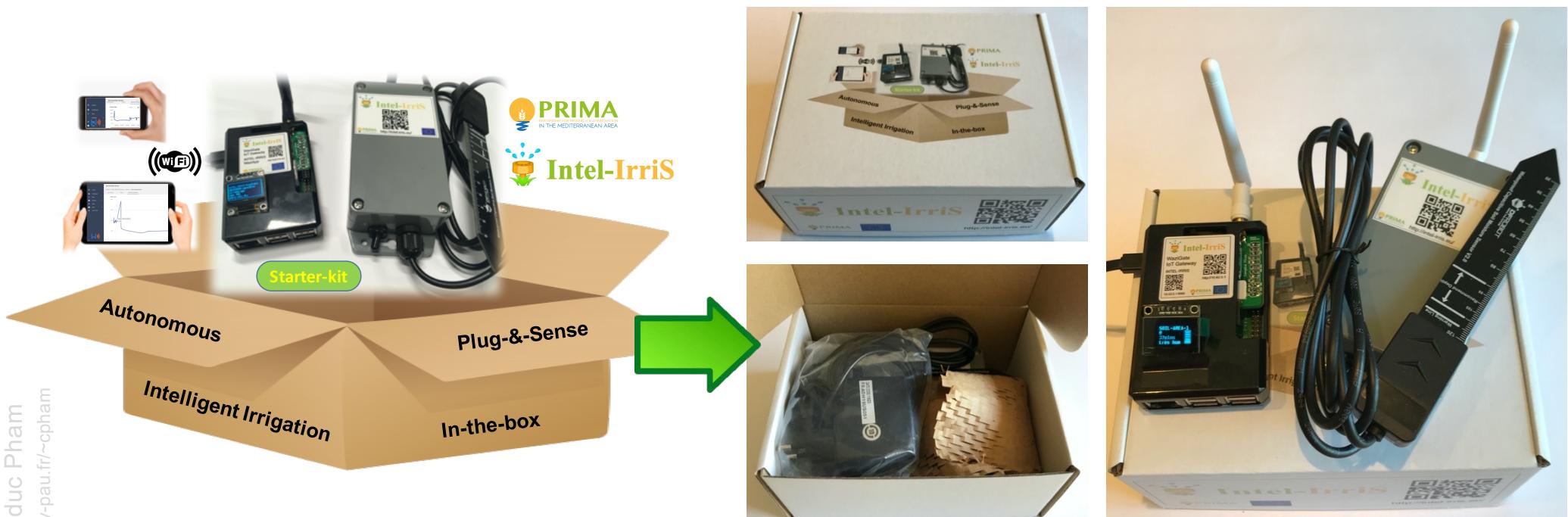
# INTEL-IRRIS's starter-kit

- At the beginning: **an idea...**
- Very simple, "Intelligent Irrigation in-the-box", "plug-&-sense"



# INTEL-IRRIS's starter-kit

○ From idea to reality!



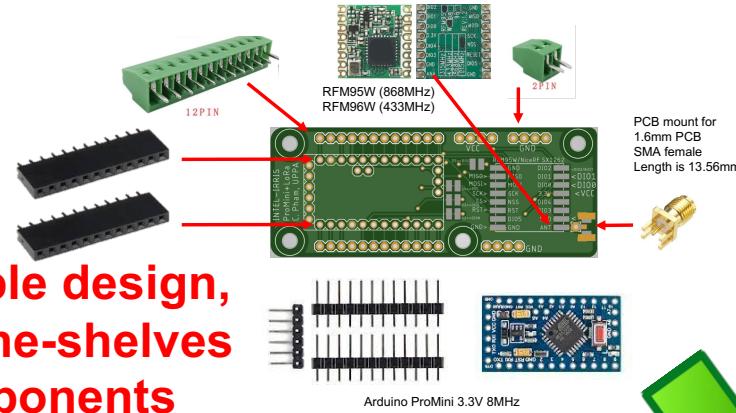
# 2 versions of the soil device



A soil temperature sensor can be added

# Key to low-cost design

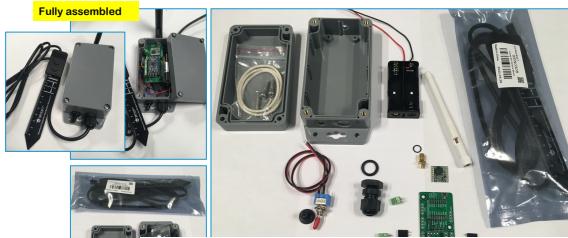
Simple design,  
off-the-shelves  
components



Easy  
integration



Low-cost  
approach



Generic  
platform,  
easy  
adaptation



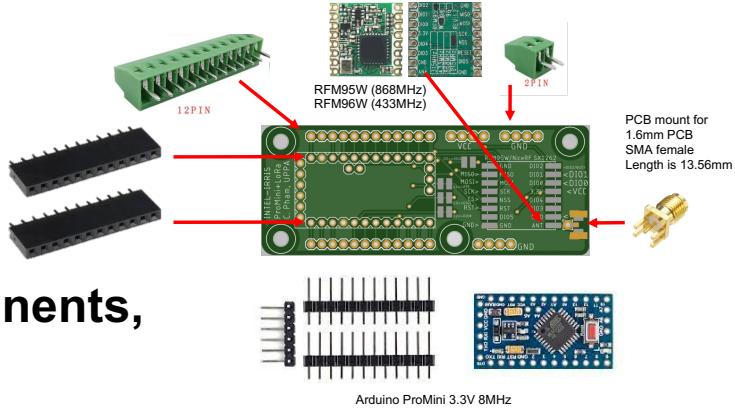
Technology transfer,  
Capacity building



# Low-cost design space

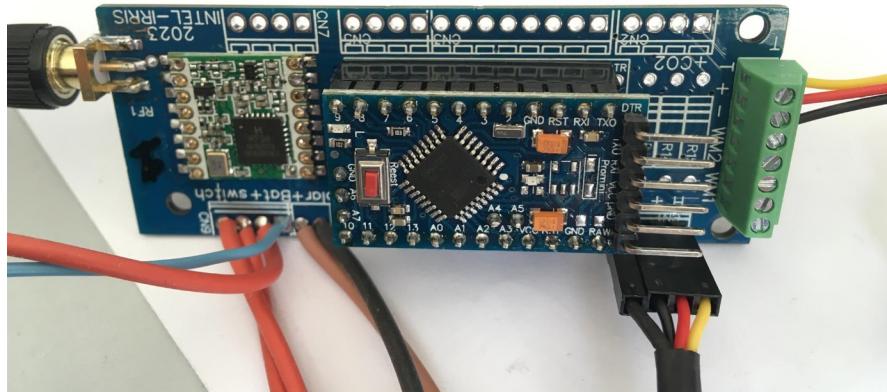
1

Simple design, off-the-shelves components, 100% DIY



Simple design, off-the-shelves components, low-cost support for solar panel, some components already soldered, mixed-DIY

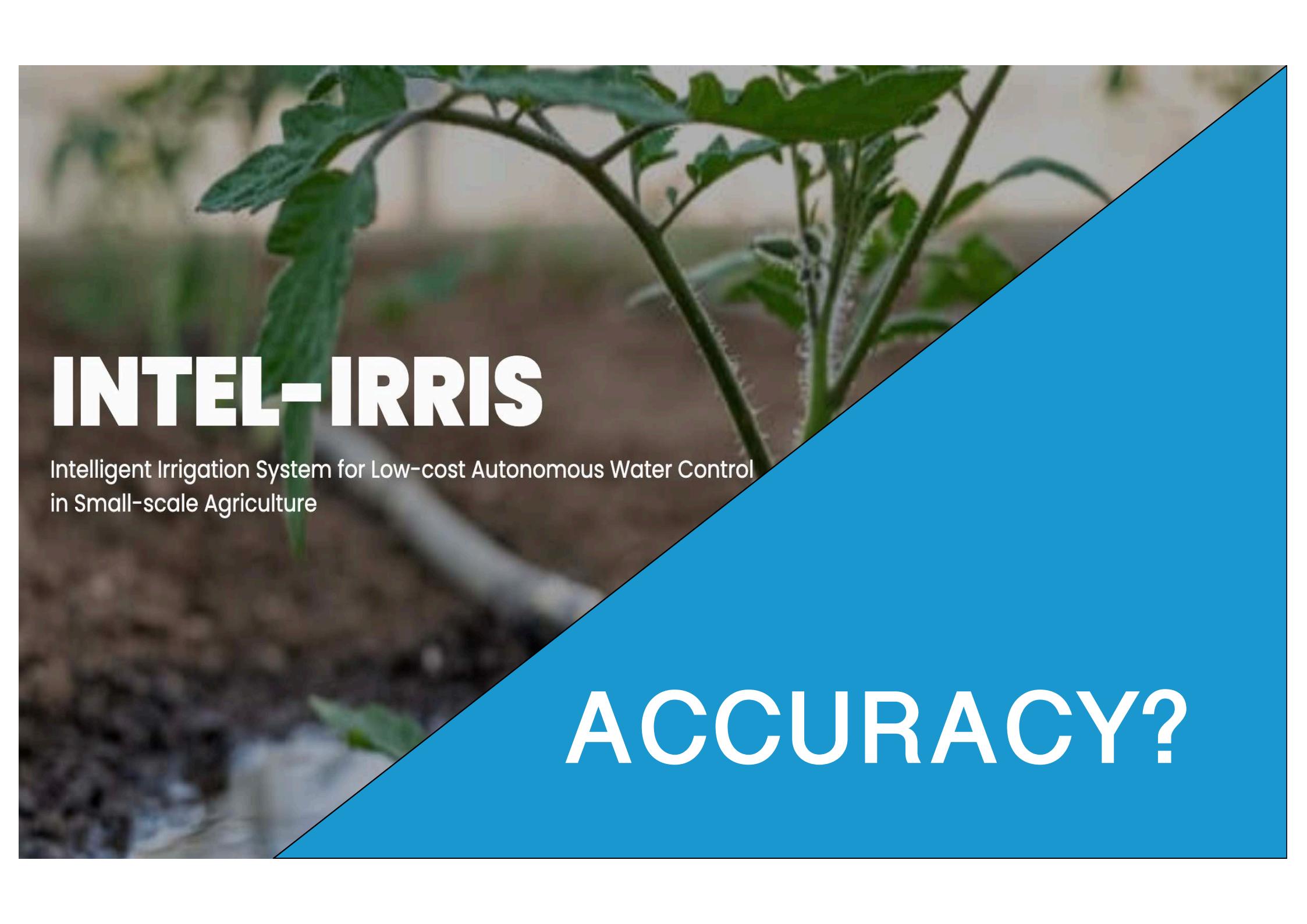
2



3

Integrated design, off-the-shelves components, full support for solar panel, all components already soldered



A close-up photograph of a young green plant with several leaves and a thin stem, growing out of dark brown soil. The background is slightly blurred.

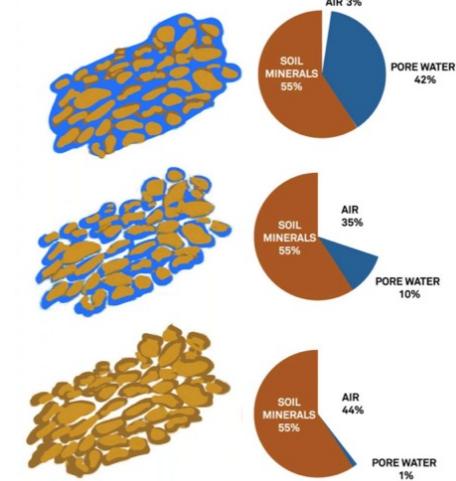
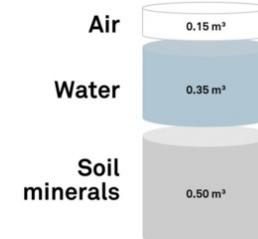
# INTEL-IRRIS

Intelligent Irrigation System for Low-cost Autonomous Water Control  
in Small-scale Agriculture

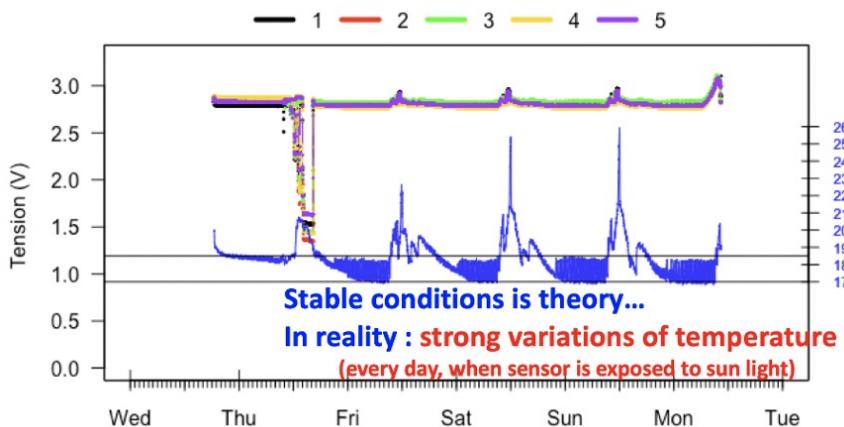
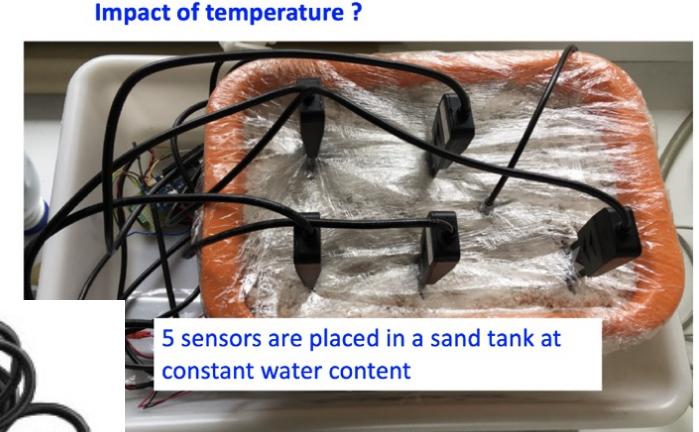
# ACCURACY?

# Capacitive sensor

- Capacitive soil moisture sensors usually measure volumetric water content
- Soil density & soil texture are important parameters



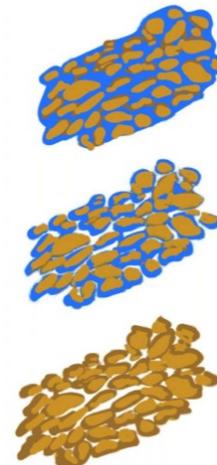
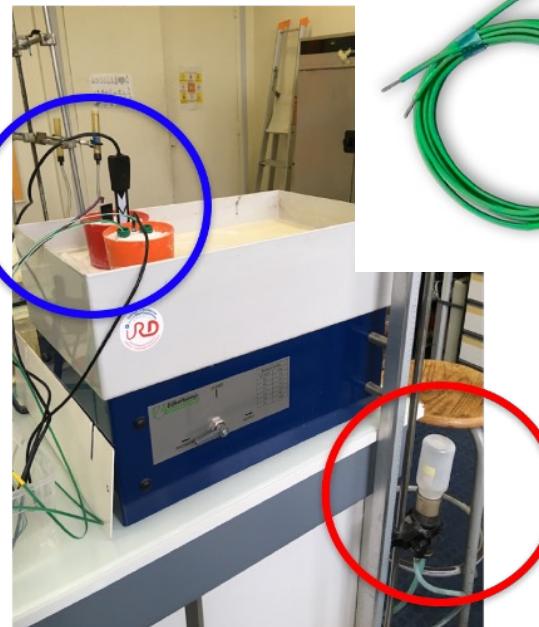
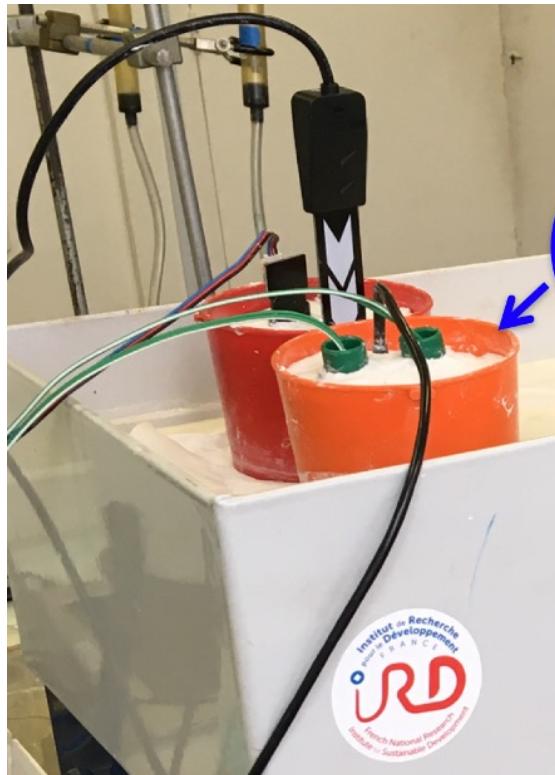
From METER group



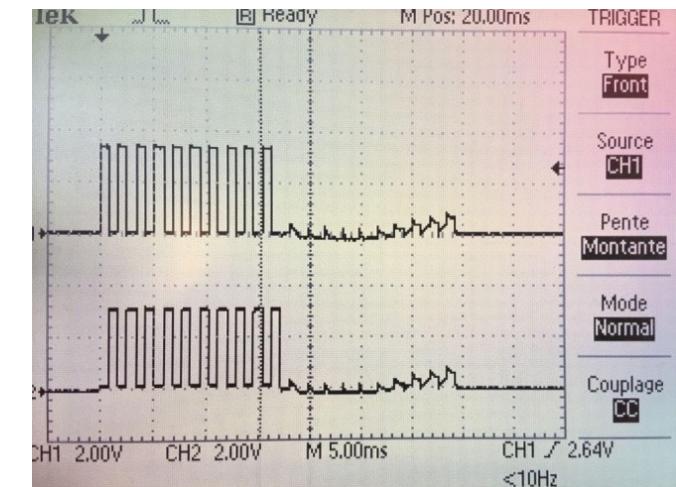
IRD in conducting extentise test on the accucary and the stability of the low-cost SEN0308 capacitive sensor

# Water tension sensor

- Water tension sensor measures the amount of force required to extract water from soil's pores



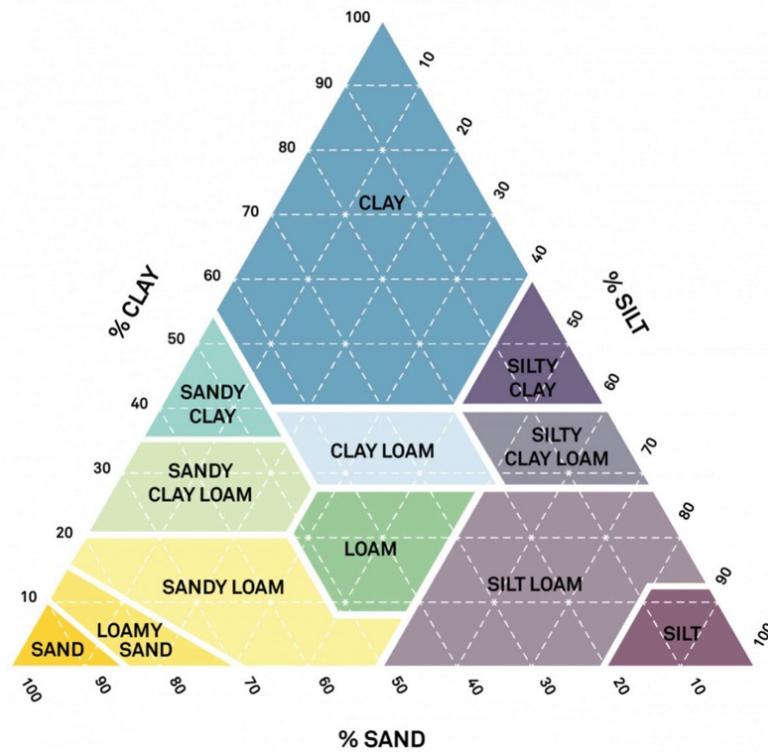
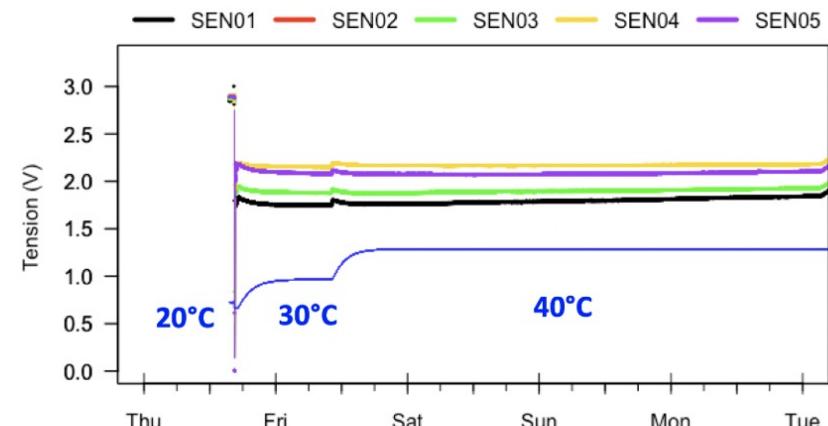
From METER group



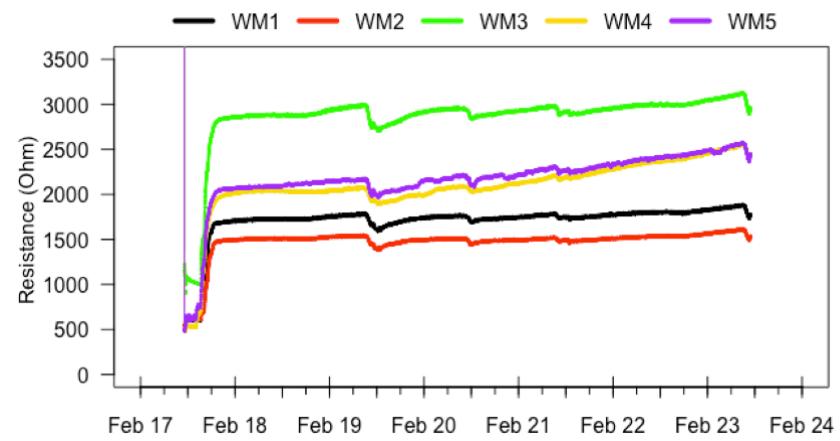
IRD in conducting extensive tests on the stability & suitability of microcontroller-based usage of the Watermark water tension sensor

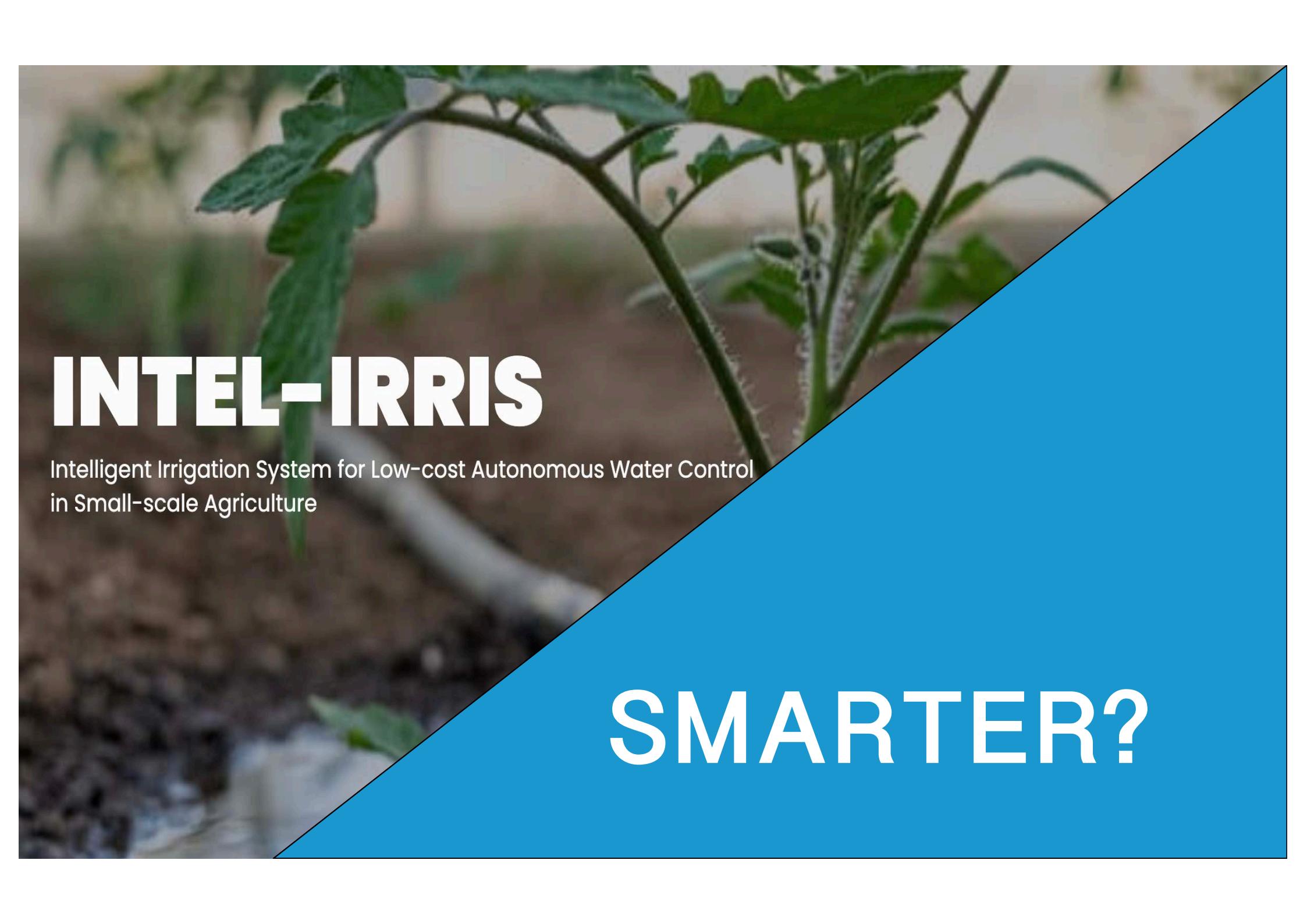
# Calibration

- Soil-specific calibration
- Impact of external "noise"


**SEN 0308**


Ambient air temperature has low impact, except...



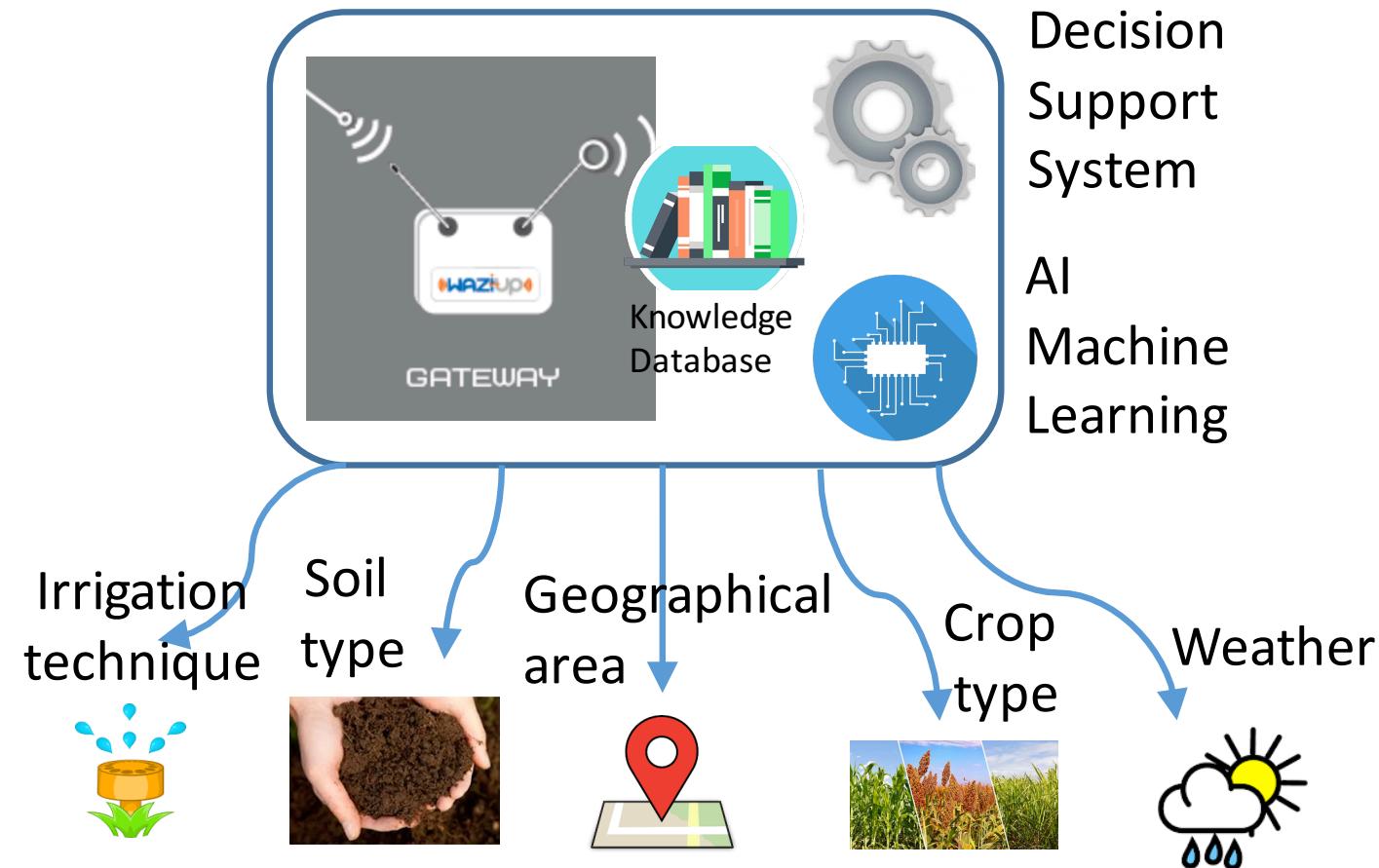
A close-up photograph of a green plant, likely a tomato or similar leafy vegetable, growing in soil. A white, flexible irrigation tube is visible, connected to the plant's stem, suggesting a smart irrigation system. The background is slightly blurred.

# INTEL-IRRIS

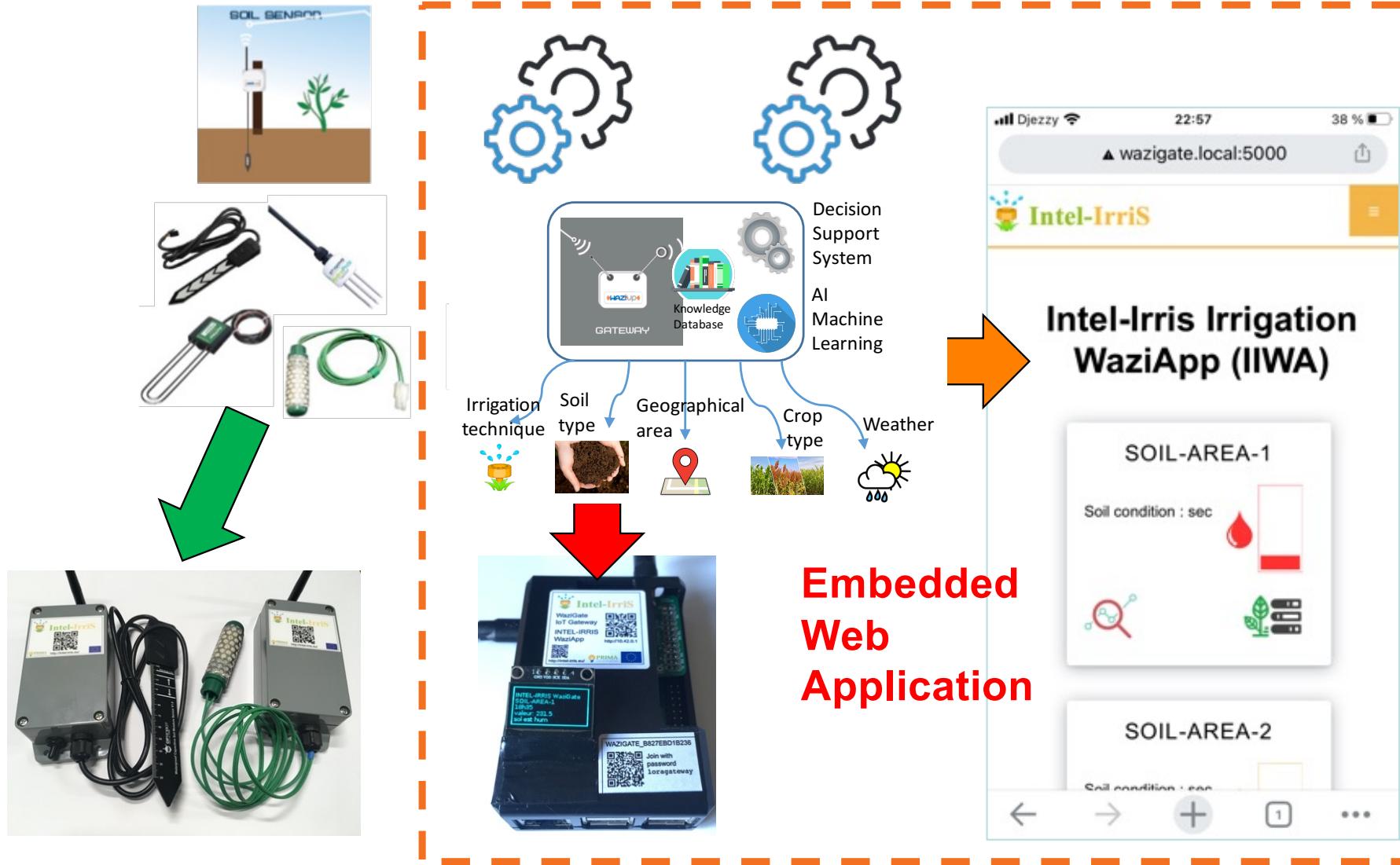
Intelligent Irrigation System for Low-cost Autonomous Water Control  
in Small-scale Agriculture

SMARTER?

# Added value: embedded intelligence!



# INTEL-IRRIS: add intelligence



# Advanced parameters

Basic

More parameters will be integrated in IIWA during the project

## Moisture sensor parameters

### Sensor Type

- Capacitive
- Tensiometer (cbar)
- Tensiometer (raw)

## Soil parameters

## Plant parameters

## Moisture sensor parameters

## Soil parameters

### Soil Type

Silty

### Soil Irrigation Type

- Submersion
- Furrow
- Sprinkler
- Drip
- Subirrigation

## Moisture sensor parameters

## Plant parameters

### Plant type

Tomatoes

### Planting Date

01/04/2023

## Moisture sensor parameters

## Weather parameters

### Region

Semi-Arid

Save configuration

Advanced

## Moisture sensor parameters

### Sensor age

0

### Maximum sensor value

800

### Minimum sensor value

0

## Soil parameters

## Moisture sensor parameters

## Soil parameters

### Soil Salinity

empty or -1 for disabled

### Soil Bulk Density

empty or -1 for disabled

### Soil Field Capacity

empty or -1 for disabled

## Moisture sensor parameters

## Plant parameters

### Plant category

Vegetable

### Plant Variety

feiza tomatoes

## Moisture sensor parameters

## Weather parameters

### Weekly evaporation (in mm) value in mm

### Weekly pluviometry (in mm) value in mm

Save configuration

# Not only the cost barrier...



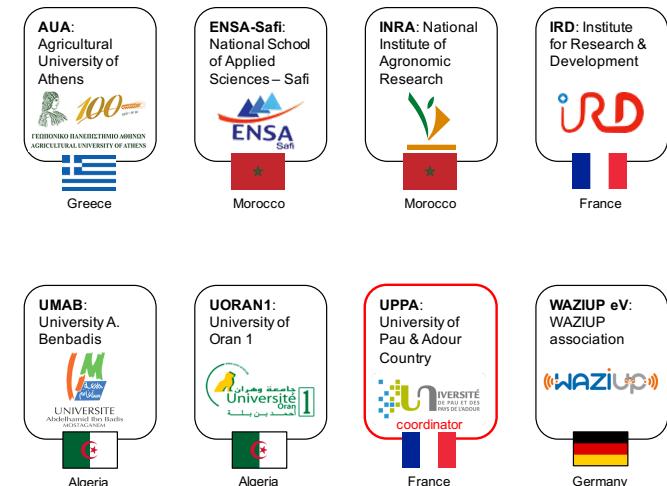
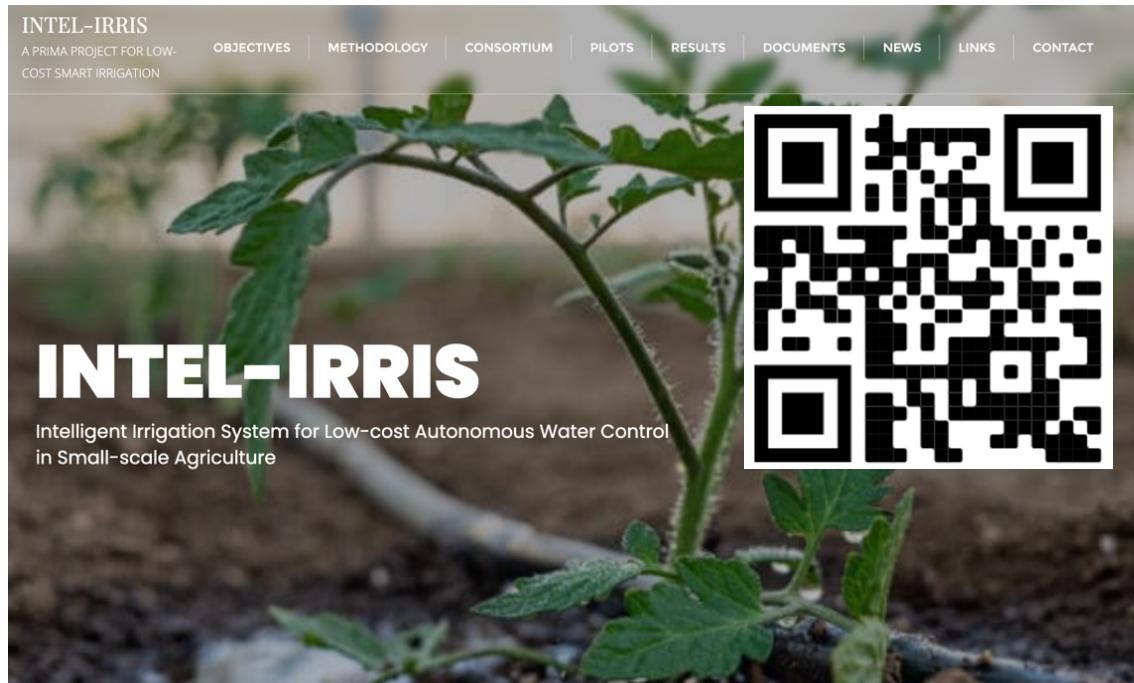
**High acceptability  
of technologies,  
even complex ones**



**Very low acceptability  
of technologies  
because too complex!**

# More information

- Web site: <https://intel-irris.eu>



- Twitter: [https://twitter.com/Intel\\_IrriS](https://twitter.com/Intel_IrriS)



**Intel\_Irris**  
@Intel\_IrriS

A close-up photograph of a young green plant with large, serrated leaves growing in dark brown soil. The plant has a central stem with several branches and leaves. The background is slightly blurred.

# INTEL-IRRIS

Intelligent Irrigation System for Low-cost Autonomous Water Control  
in Small-scale Agriculture

WHAT'S  
NEXT?

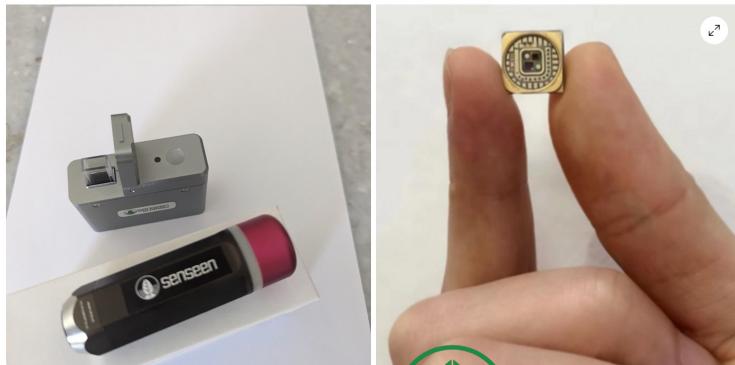
# Smart Agriculture as a whole

- Integration of multiple technologies solutions
  - Remote sensing, satellite data, knowledge base, ...
  - Artificial Intelligence for vertical application silos: rice, viticulture, ...
  - Advanced sensing system, spectrometer, hyperspectral, ...
  - ...
- **BUT**, to ensure wide dissemination, these technologies **MUST**
  - be open, be simple, be inclusive for smallholders
  - be accessible at lower cost
  - take into account weak connectivity areas
  - avoid vendor lock-ins
  - ensure interoperability of software & data
  - ...

# Some examples

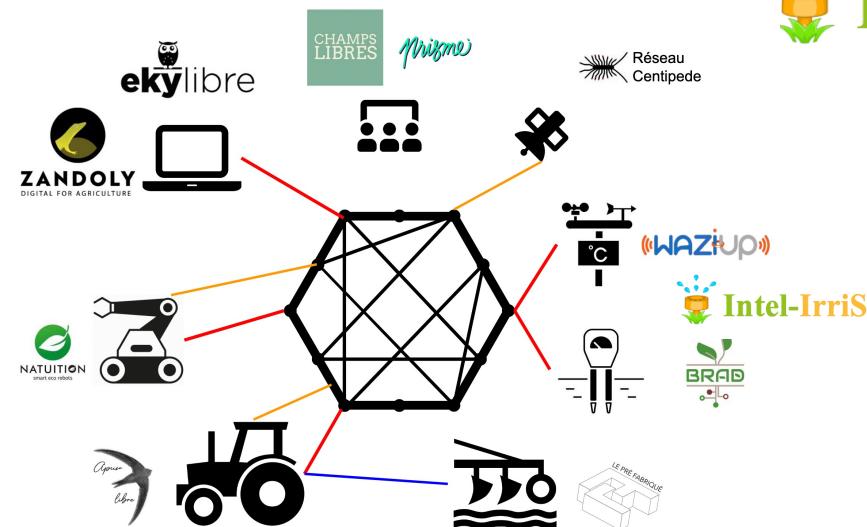


## Portable spectrometers



**SENSEEN**  
 Scanners for the planet

Diagram from ekylibre, draft project proposal

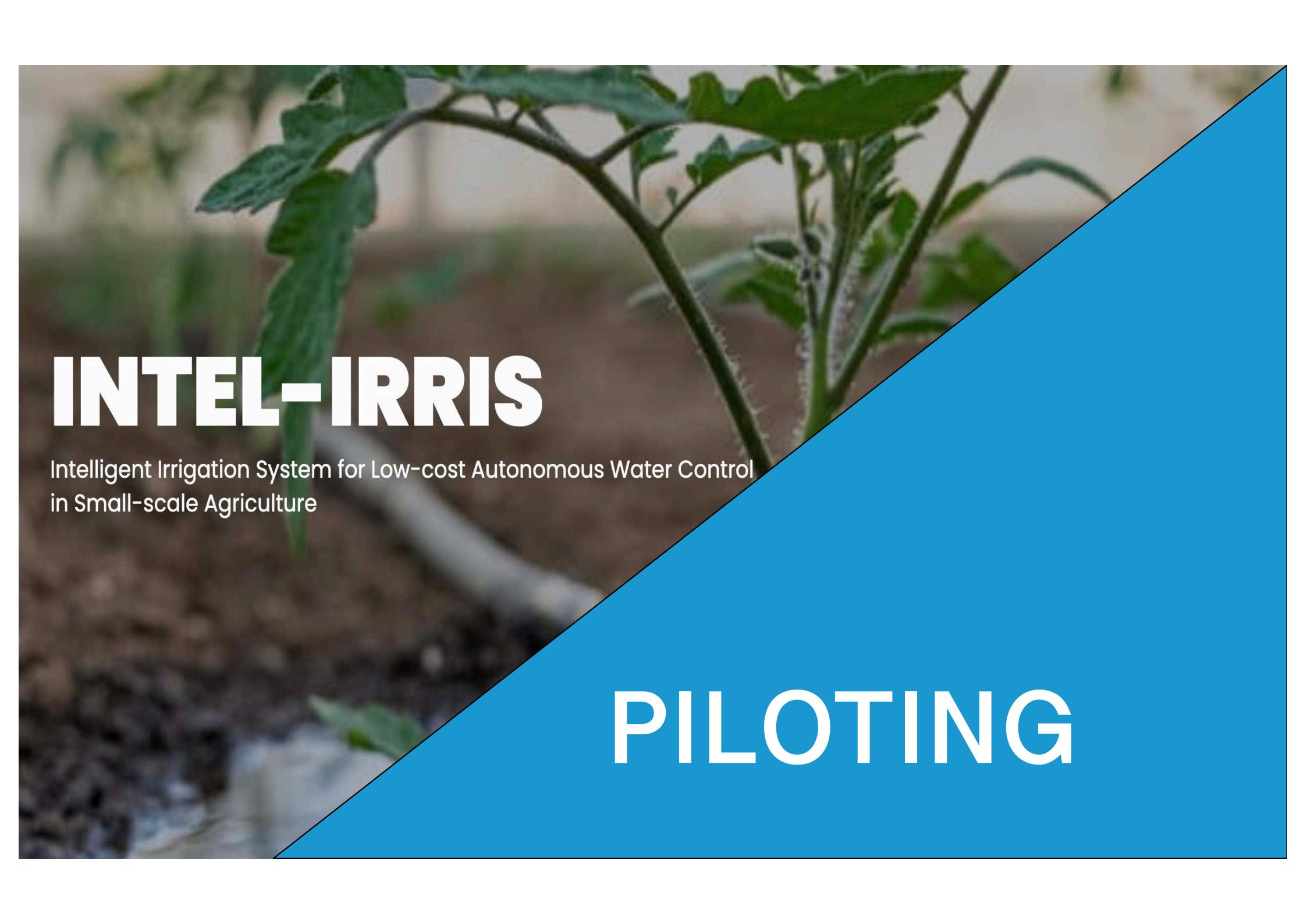


## Towards full interoperable agri software & systems



# Intelligent Irrigation System for Low-cost Autonomous Water Control in Small-scale Agriculture





# INTEL-IRRIS

Intelligent Irrigation System for Low-cost Autonomous Water Control  
in Small-scale Agriculture

## PILOTING

# Piloting farms, visits, deployment,...



A close-up photograph of a young green plant with several leaves and a thin stem, growing in dark brown soil. The background is slightly blurred.

# INTEL-IRRIS

Intelligent Irrigation System for Low-cost Autonomous Water Control  
in Small-scale Agriculture

# CAPACITY BUILDING

# Tutorial materials

INTELLIGENT IRRIGATION SYSTEM  
 FOR LOW-COST AUTONOMOUS  
 WATER CONTROL  
 IN SMALL-SCALE AGRICULTURE



Building the Intel-Irris LoRa IoT platform  
 Part 1: soil sensor device



INTELLIGENT IRRIGATION SYSTEM  
 FOR LOW-COST AUTONOMOUS  
 WATER CONTROL  
 IN SMALL-SCALE AGRICULTURE



Building the Intel-Irris LoRa IoT platform  
 Part 2: edge-enabled gateway (WaziGate)



**Intel-Irris**

للمعهد الوطني للبحث الزراعي  
 INRAE | INSTITUT NATIONAL DE LA RECHERCHE AGRONOMIQUE  
 Institut National de la Recherche Agronomique

Technologies de capteurs de mesure de l'humidité du sol pour le pilotage de l'irrigation:

Principe de fonctionnement, Calibrations et Performances

El Aissaoui Abdellah (Ing. PhD)  
 Institut National de La Recherche Agronomique  
 Centre Régional de La Recherche Agronomique de Settat  
 Laboratoire des Agroéquipements et Energie

30 Mars 2022

Dr. Christian Hartmann  
 M. Jean-François Printanier  
 M. Mamadou Gueye  
 M. Lotfi Smaili

INTELLIGENT IRRIGATION SYSTEM  
 FOR LOW-COST AUTONOMOUS  
 WATER CONTROL  
 IN SMALL-SCALE AGRICULTURE



Building the Intel-Irris IoT platform  
 Annex-1: ordering PCBs



INTELLIGENT IRRIGATION SYSTEM  
 FOR LOW-COST AUTONOMOUS  
 WATER CONTROL  
 IN SMALL-SCALE AGRICULTURE



Building the Intel-Irris LoRa IoT platform  
 Part 3: the INTEL-IRRIS starter-kit



LES CAPTEURS FAIBLE COÛT POUR  
 MESURER L'EAU DANS LE SOL:  
 CONTRAINTES, LIMITATIONS ET  
 PERSPECTIVES



Intelligent Irrigation System for Low-cost Autonomous Water Control in Small-scale Agriculture

INTEL-IRRIS – PRIMA 52 2020 – PROJECT ID 1568



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Centre Régional de la Recherche  
 Agronomique de Tadla

Unité de Recherche : Système  
 de Production en irrigué

Irrigation : concepts et état des lieux



Présenté par : Dr. BOUAZZAMA Bassou  
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Webinaire (1<sup>ère</sup> édition)  
 Irrigation : concepts et état des lieux



L'eau dans le sol et les  
 contraintes de l'irrigation

Pr BENKELIFA Mohammed (UMAB)

