

# The INTEL-IRRIS's low-cost sensing approach for optimized irrigation targeting smallholder communities



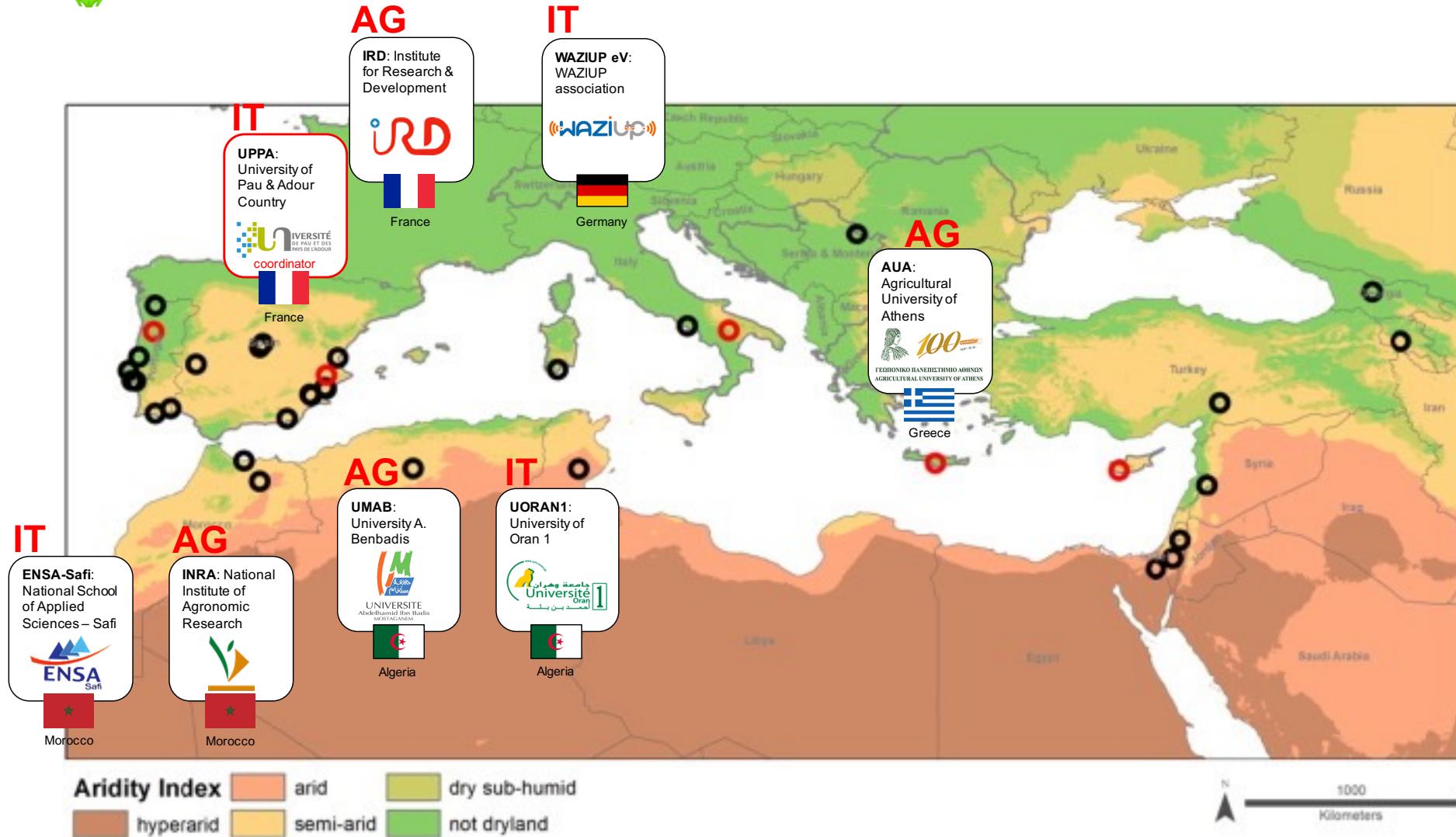
## IPPN – Affordable Phenotyping Workshop Connected stick world tour

June 26<sup>th</sup>, 2023

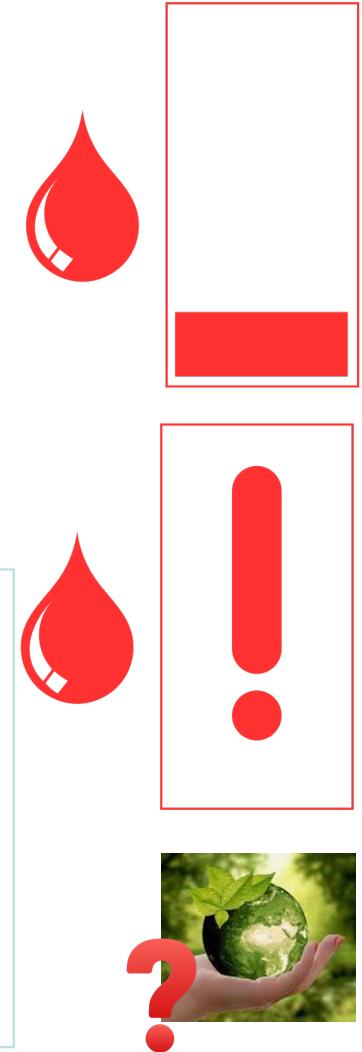
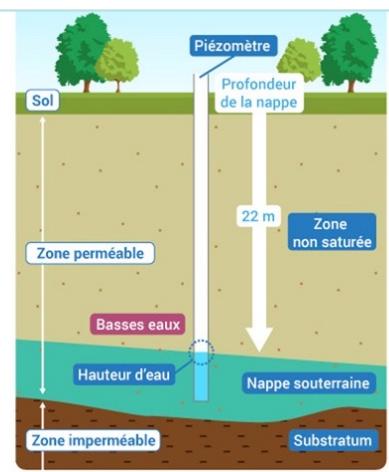
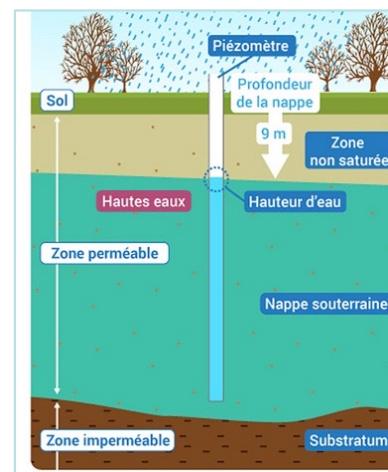
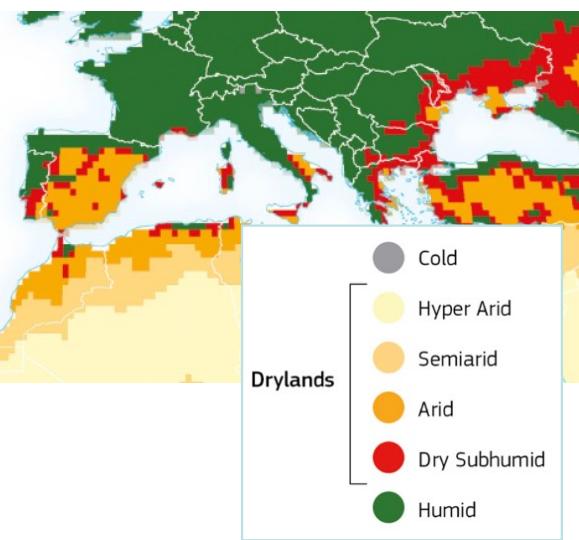
Prof. Congduc Pham  
<http://www.univ-pau.fr/~cpham>  
Université de Pau, France



# Focus on Mediterranean Area



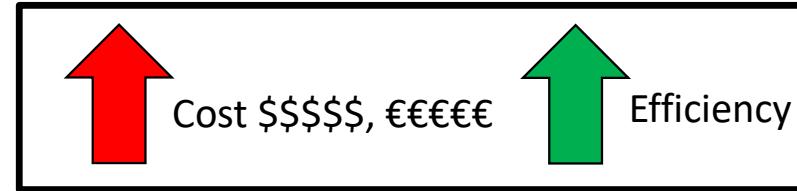
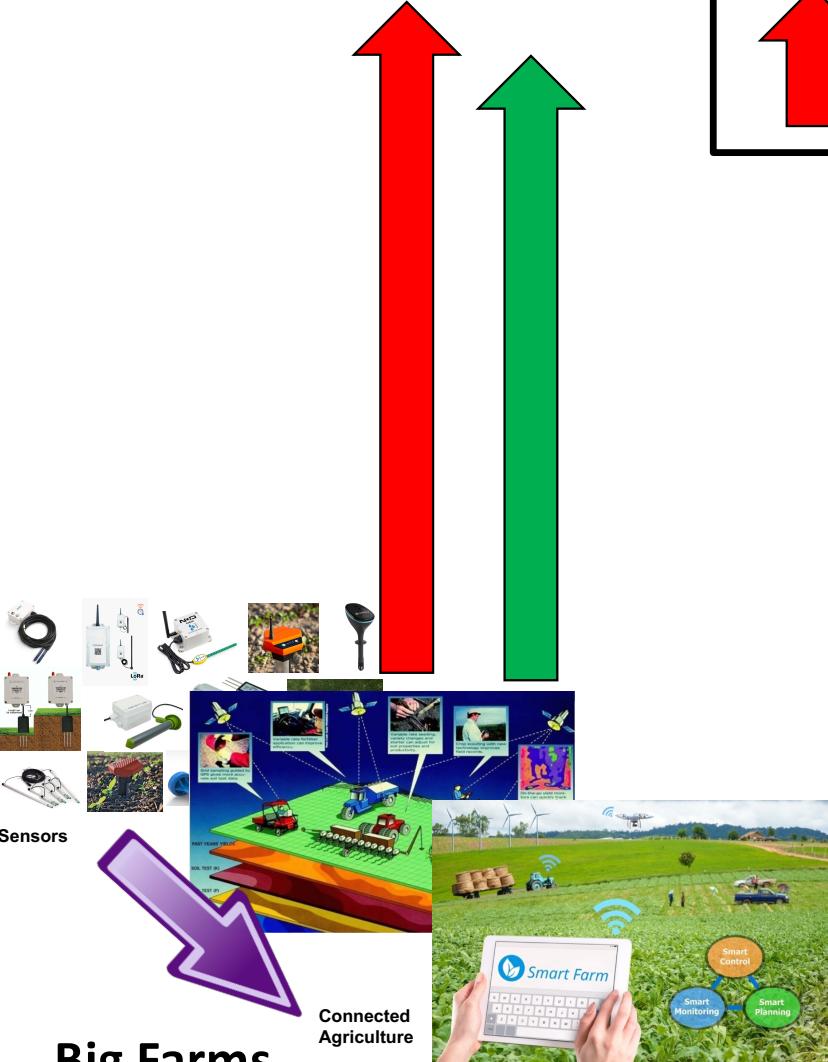
# Water resource is precious!



# Ideal smart agriculture scenario



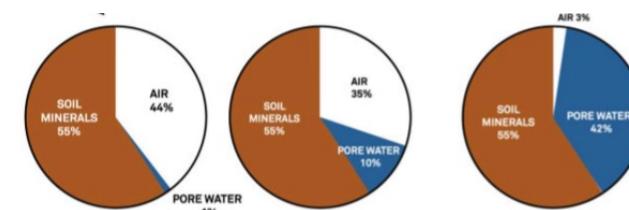
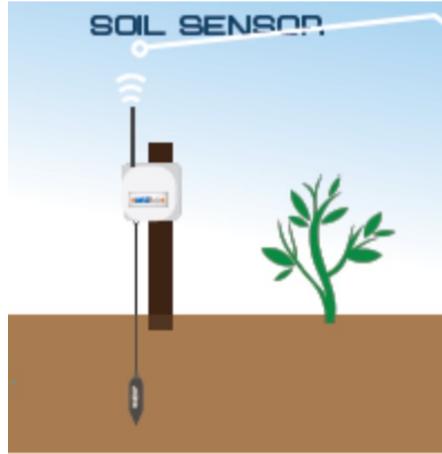
# It is always a tradeoff...



**Small-scale farms,  
Smallholder Farmers**

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

# Irrigation with soil moisture sensing



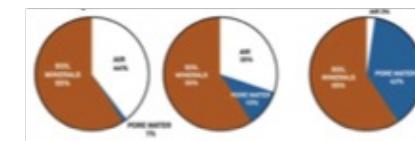
# Not as simple as it seems 😞

**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

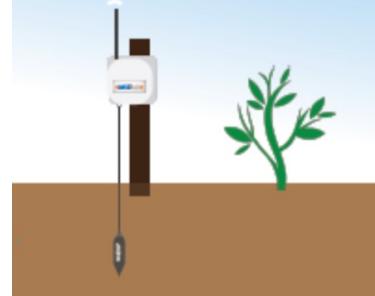
Relationship with other  
agriculture inputs

# INTEL-IRRIS's main objectives

## Low-cost

1

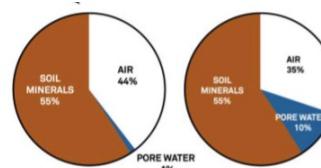
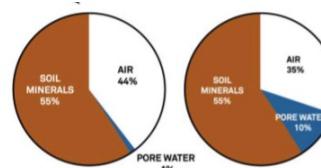
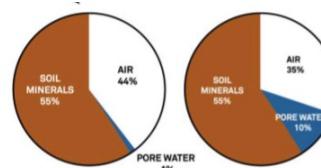
Propose low cost but highly efficient water control systems for irrigation optimization



## Advanced technologies

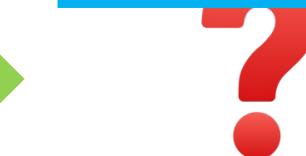
2

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"



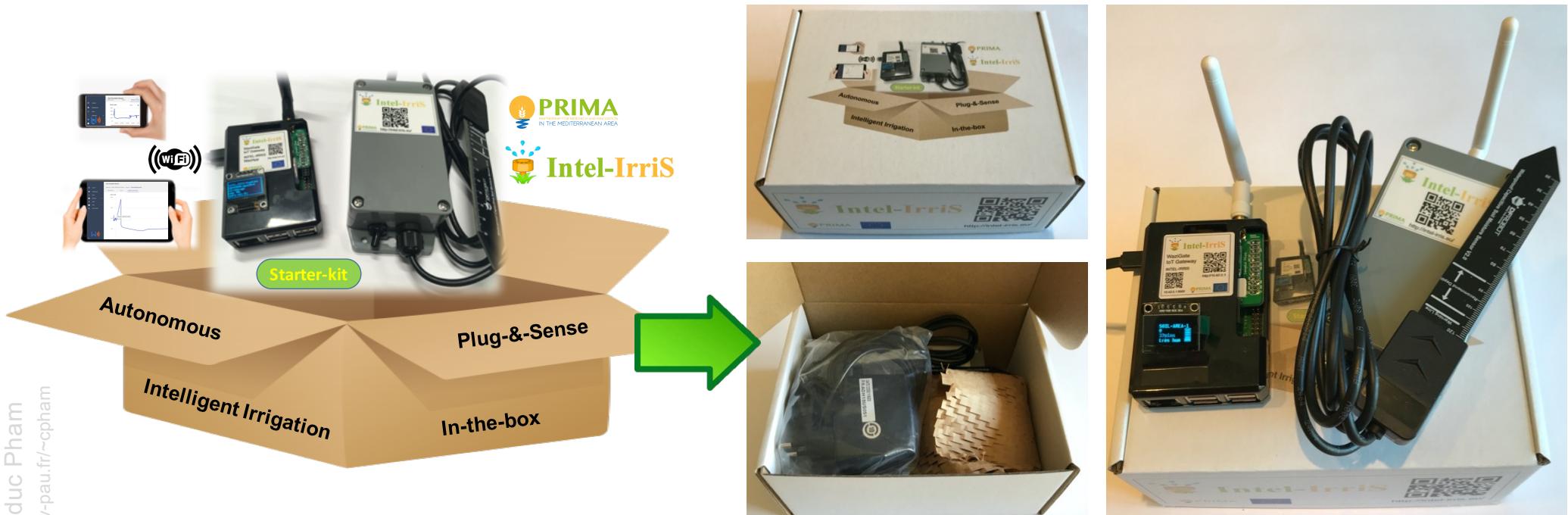
**Small-scale farms,  
Smallholder Farmers**



**NO INTERNET ☹**

# INTEL-IRRIS's starter-kit

○ From idea to reality!



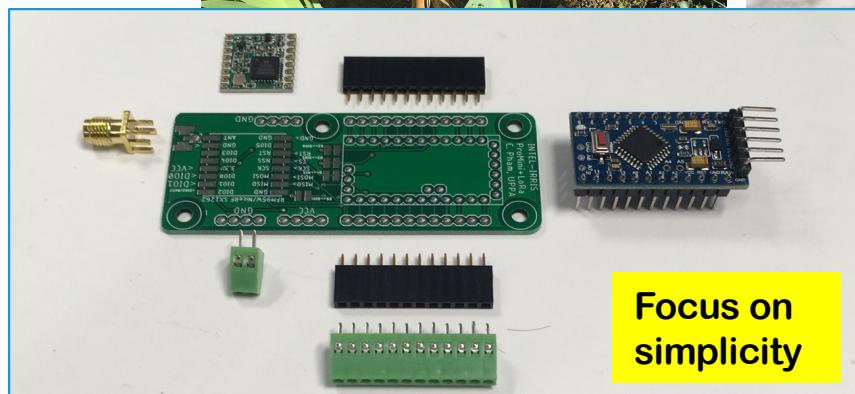
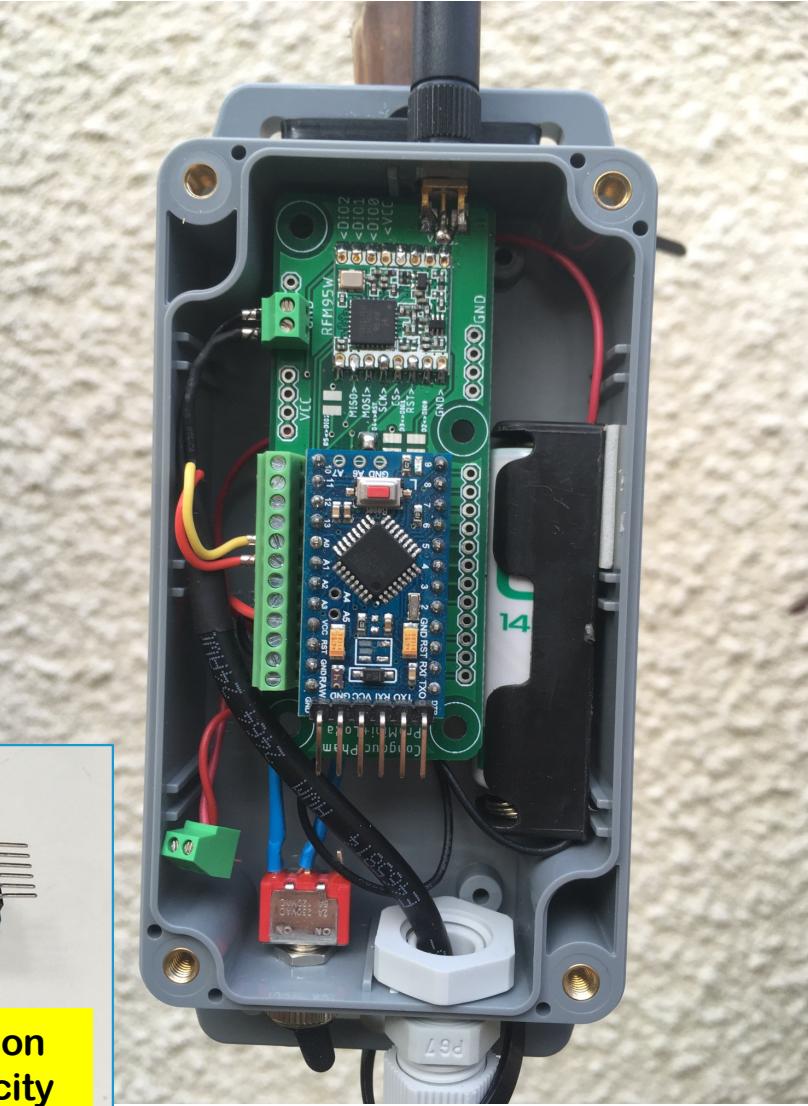
# 2 versions of the soil device



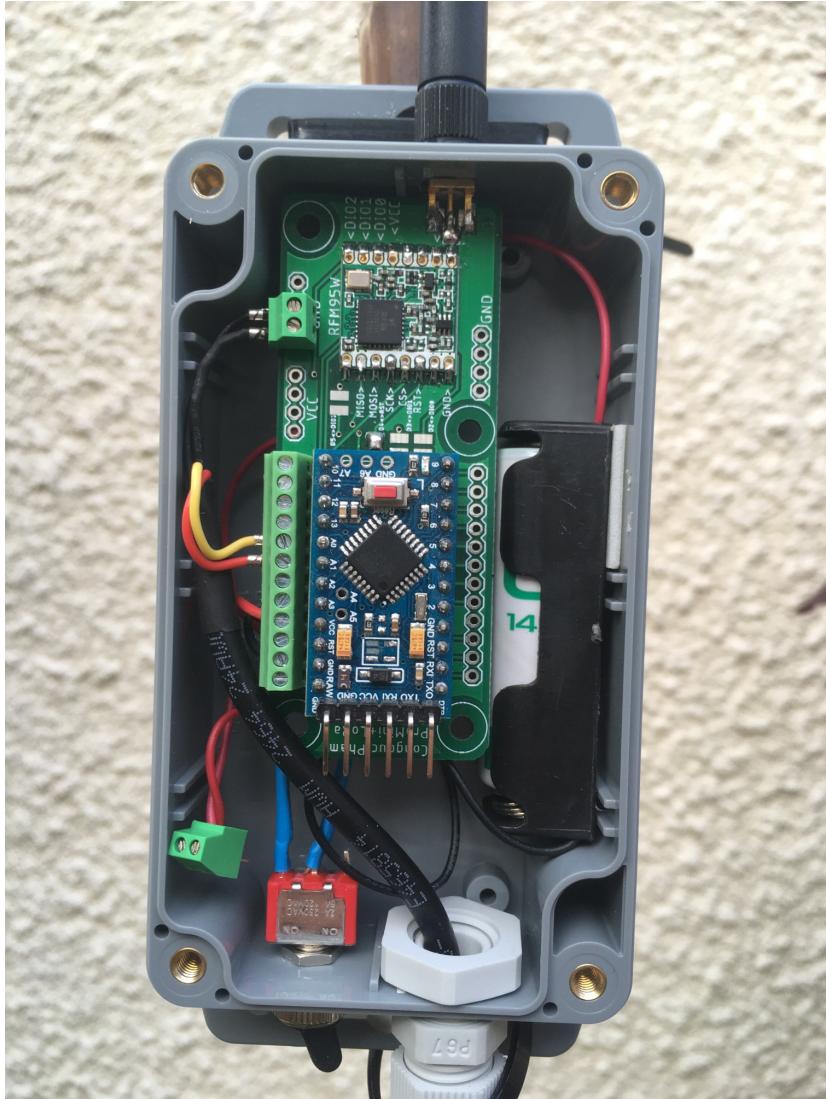
A soil temperature sensor can be added

Especially for tensiometer

# INTEL-IRRIS "connected stick"



# Connected stick? Connected to what?



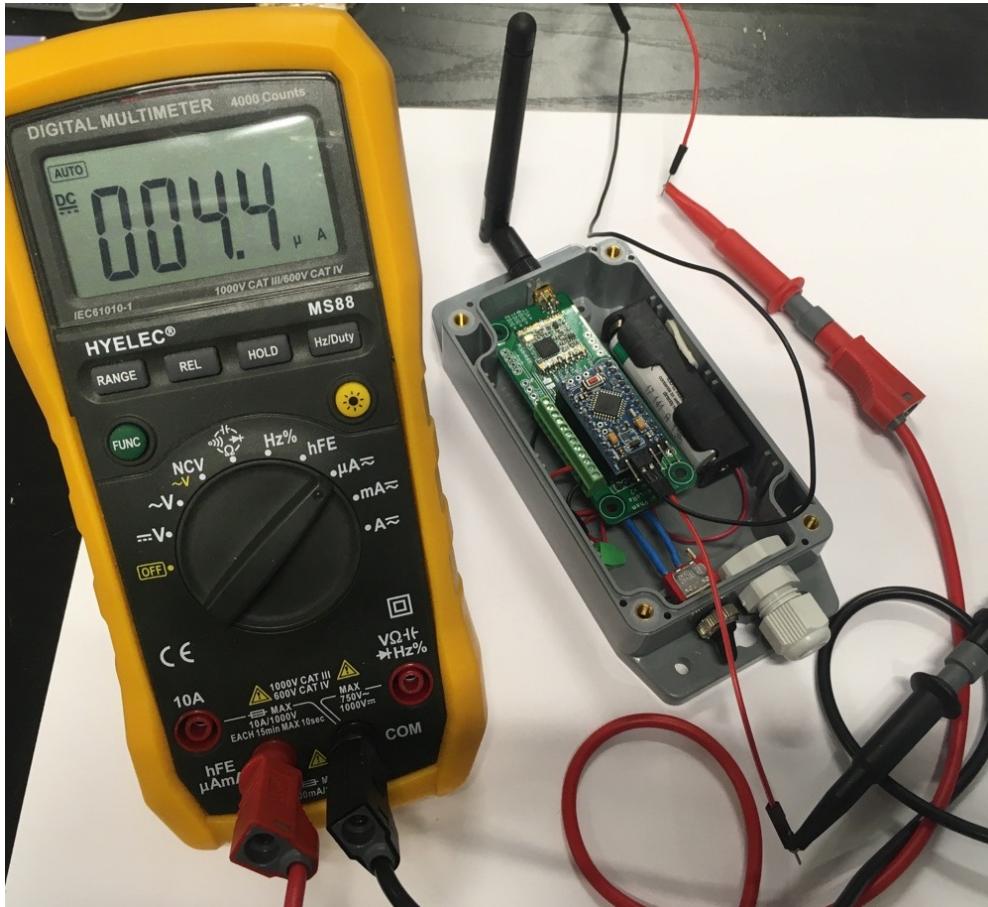
LoRa  
LoRaWAN®

Low-Power  
Long-Range  
LPWAN



NO INTERNET 14

# Power consumption in deep sleep

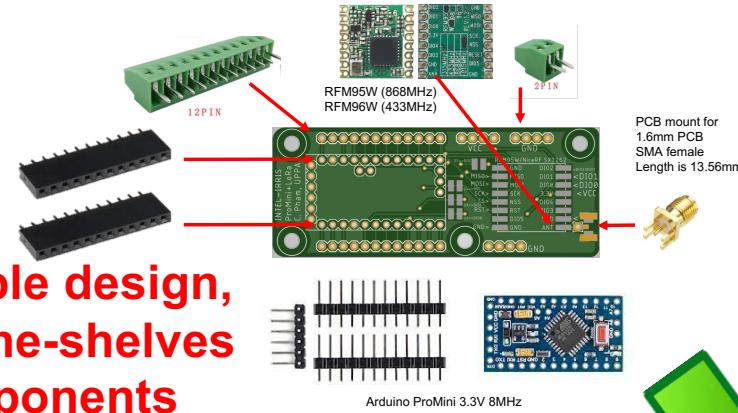


Measured below 5 $\mu$ A in deep sleep, between 2 active periods with transmissions

Expected autonomy with 1 transmission / hour is over 2 years with either 2 AA batteries or 1 AA 3.6V Lithium battery

# Key to low-cost design

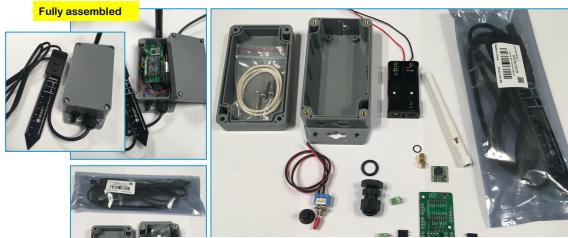
Simple design,  
off-the-shelves  
components



Easy integration



Low-cost approach



Generic platform,  
easy adaptation



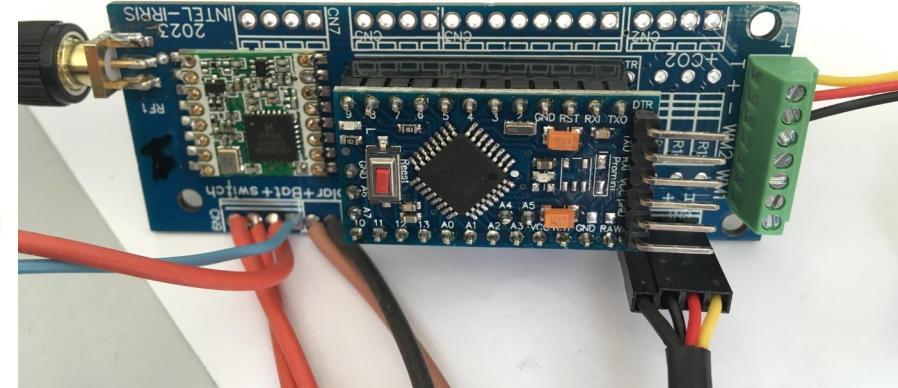
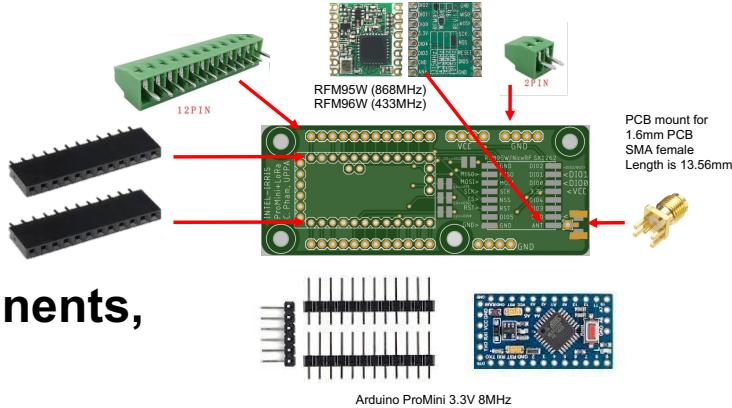
Technology transfer,  
Capacity building



# Low-cost design space

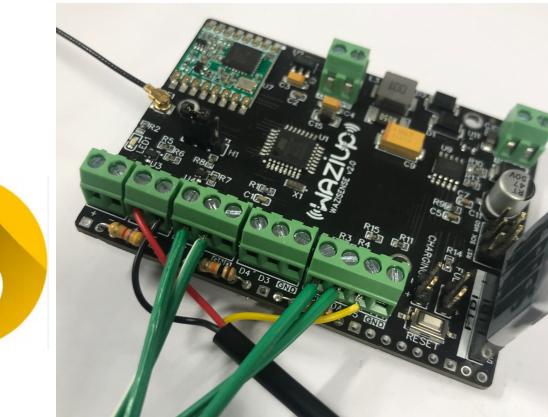
1

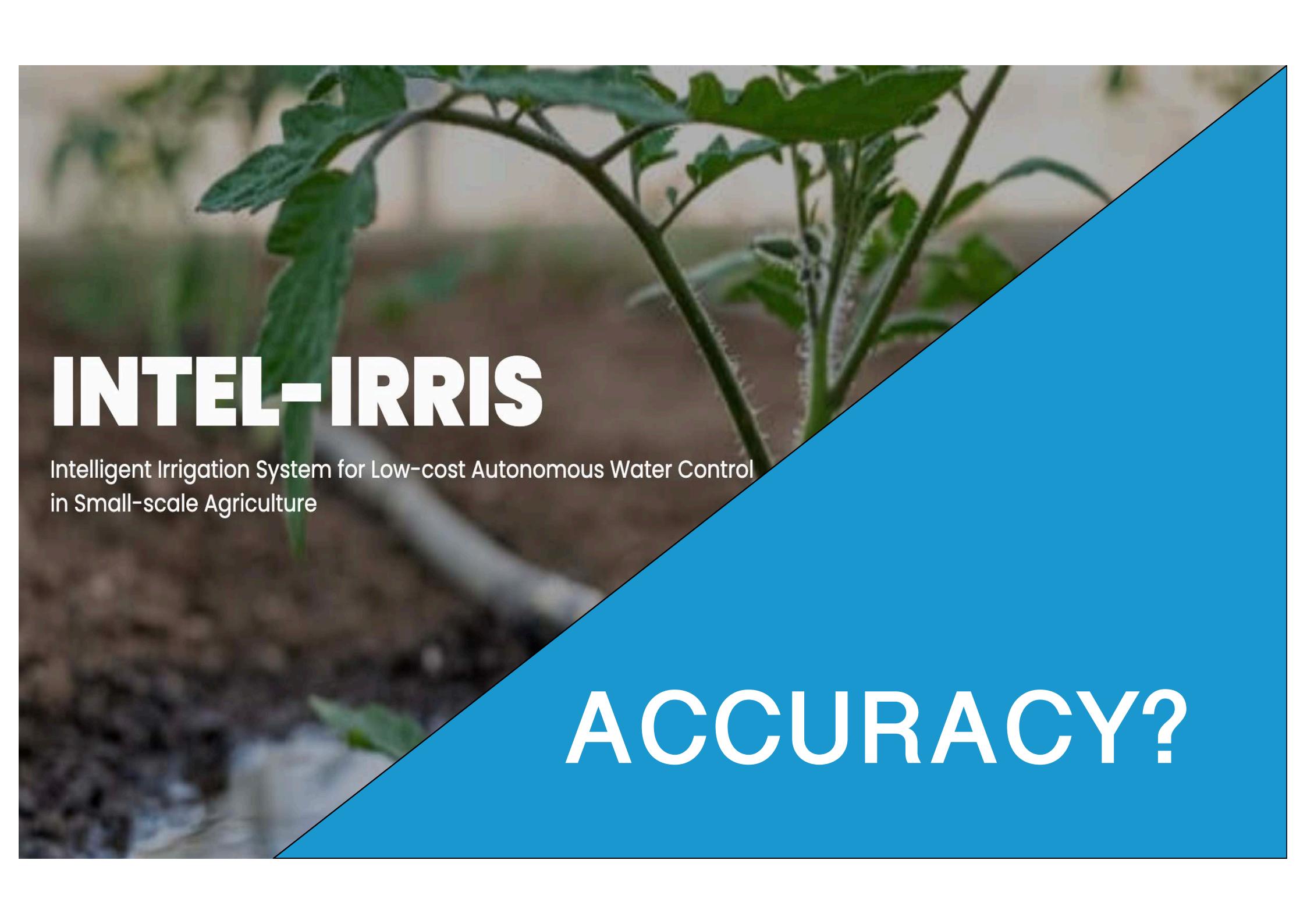
Simple design, off-the-shelves components, 100% DIY



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.

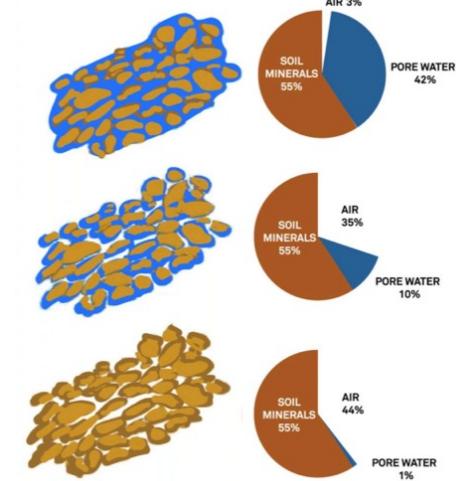
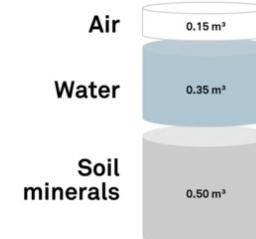
# INTEL-IRRIS

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

# ACCURACY?

# Capacitive sensor

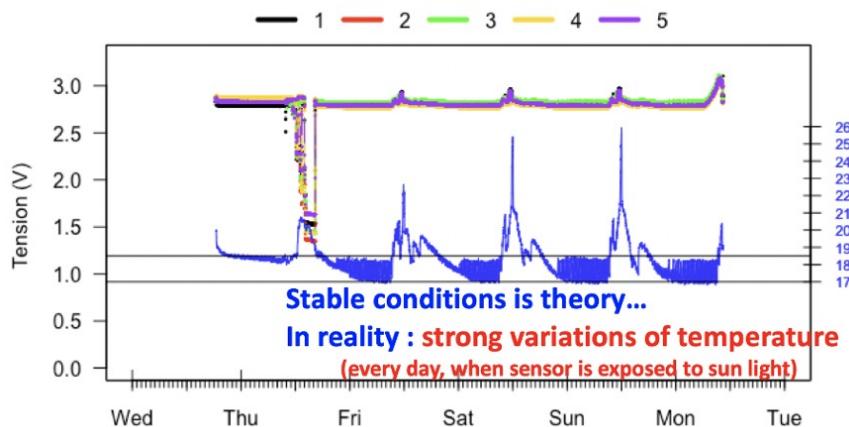
- Capacitive soil moisture sensors usually measure volumetric water content
- Soil density & soil texture are important parameters



From METER group



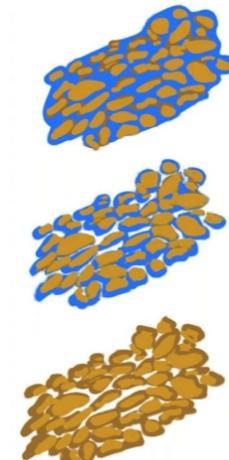
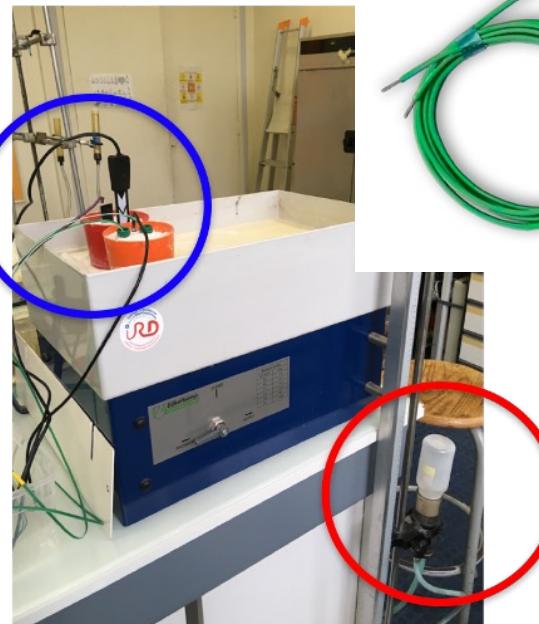
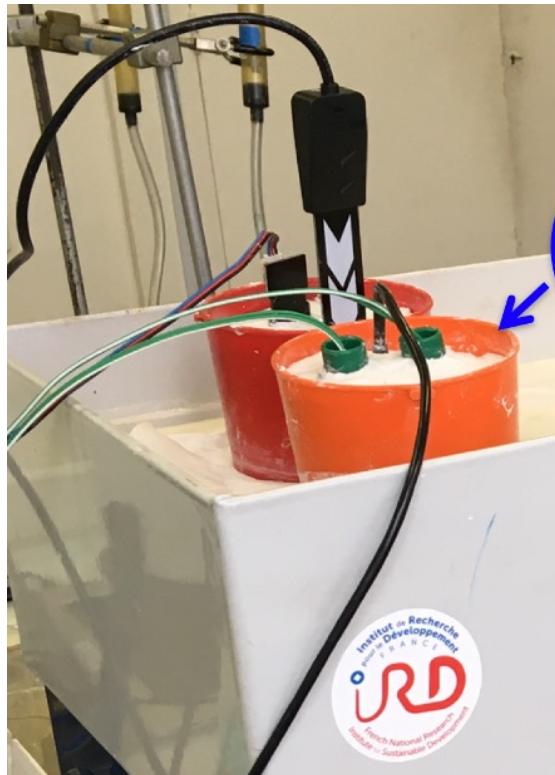
5 sensors are placed in a sand tank at constant water content



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

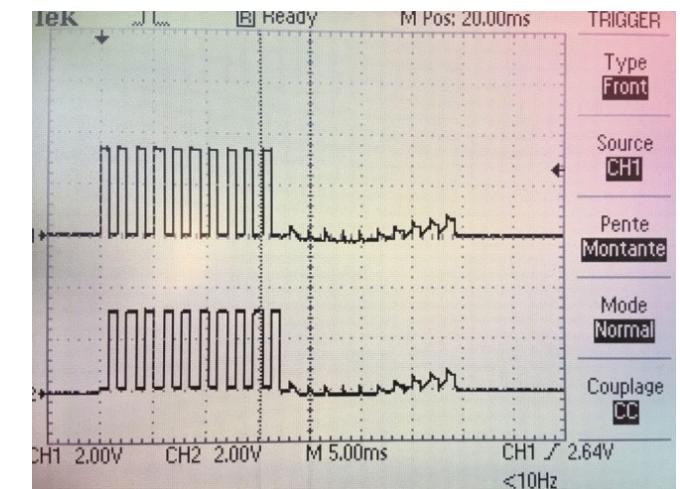
# Water tension sensor

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



comparison

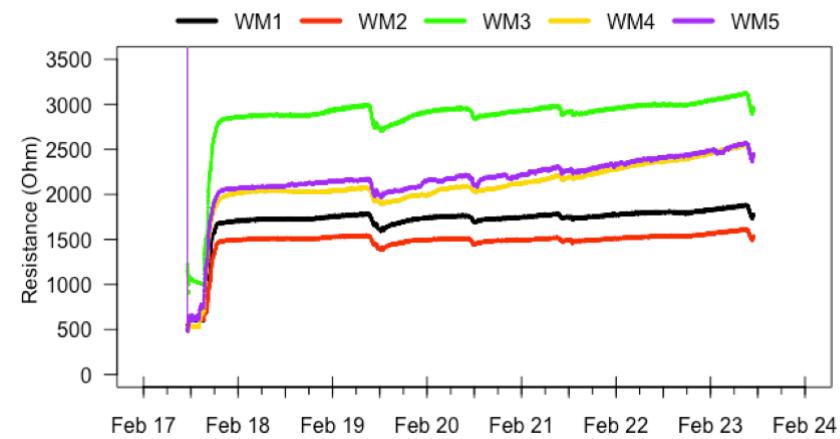
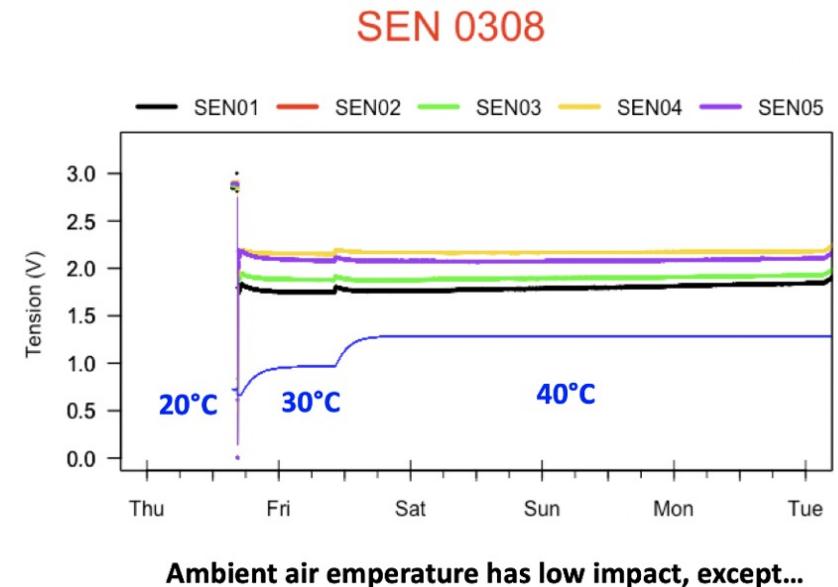
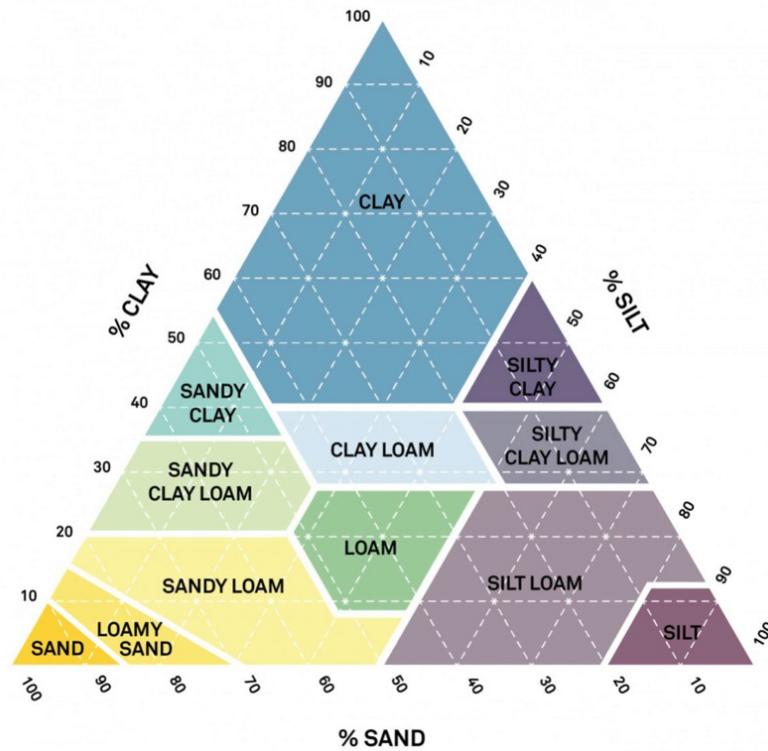
From METER group

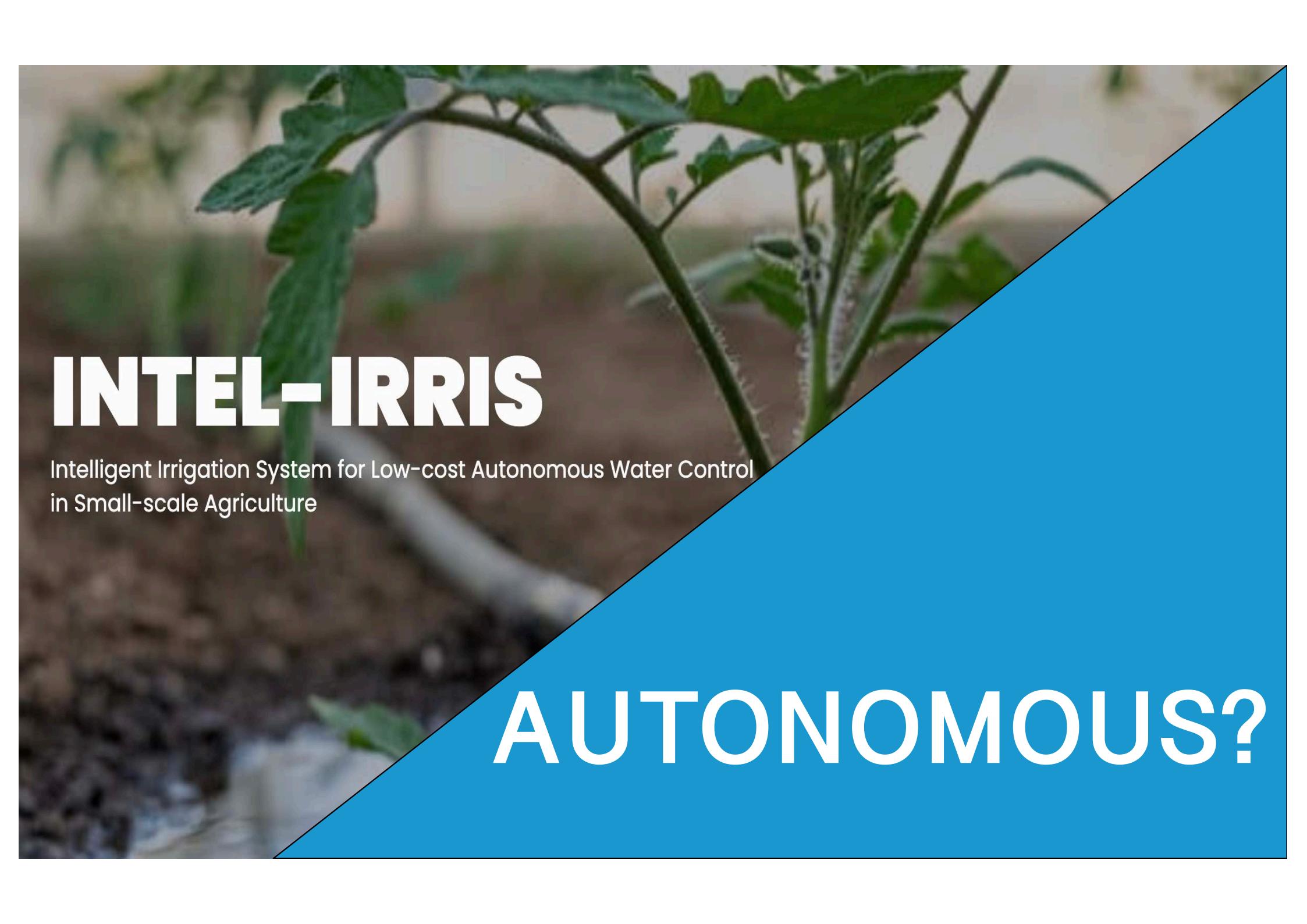


IRD in conducting extensive tests on the stability & suitability of microcontroller-based usage of the Watermark water tension sensor

# Calibration

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



A close-up photograph of a green plant with serrated leaves growing in dark brown soil. The plant has several thin stems and small leaves. The background is slightly blurred.

# INTEL-IRRIS

Intelligent Irrigation System for Low-cost Autonomous Water Control  
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# AUTONOMOUS?

# Towards Plug-&-Sense



# Gateway: collect sensor data

WAZIGATE GATEWAY

FULL EDGE-COMPUTING  
 (NO INTERNET)

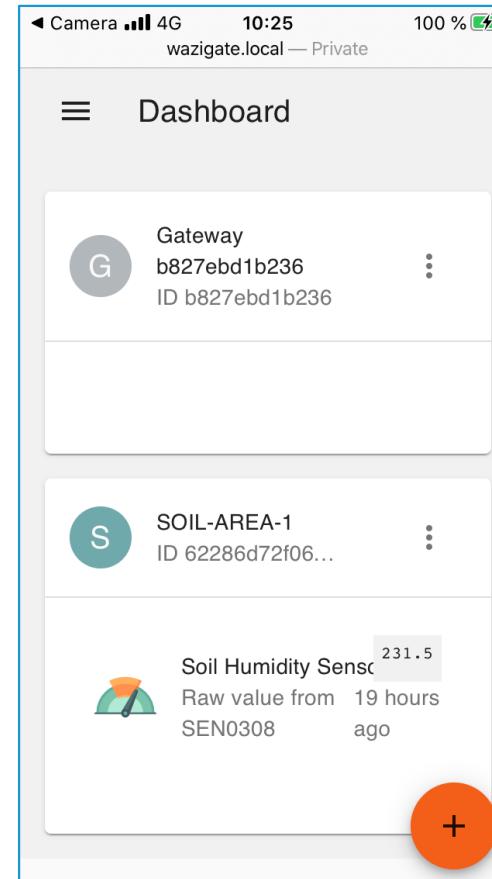
ALL DATA PROCESSING  
 CAN BE DONE LOCALLY



1 GATEWAY HANDLES  
 SEVERAL DEVICES

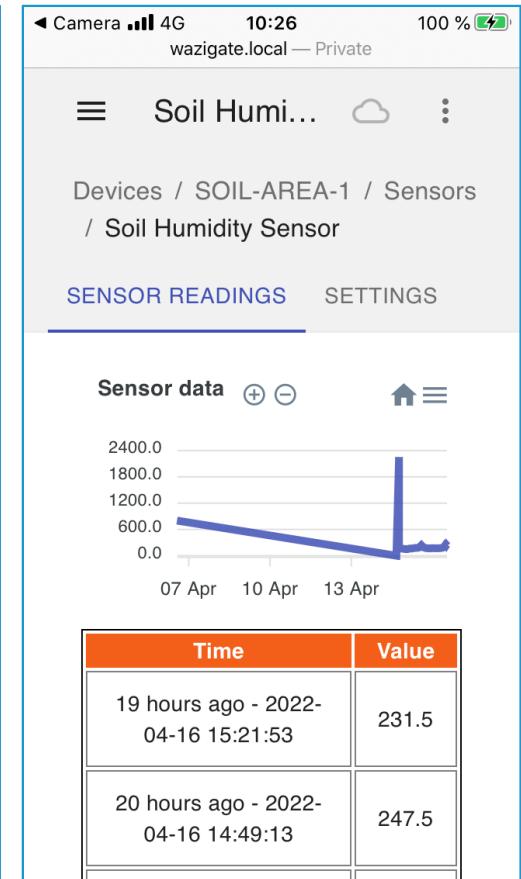
< 50€

EMBEDDED WEB INTERFACE



Dashboard

- Gateway b827ebd1b236 ID b827ebd1b236
- SOIL-AREA-1 ID 62286d72f06...
- Soil Humidity Sensor 231.5 Raw value from 19 hours SEN0308 ago



Soil Humi...

Devices / SOIL-AREA-1 / Sensors / Soil Humidity Sensor

SENSOR READINGS SETTINGS

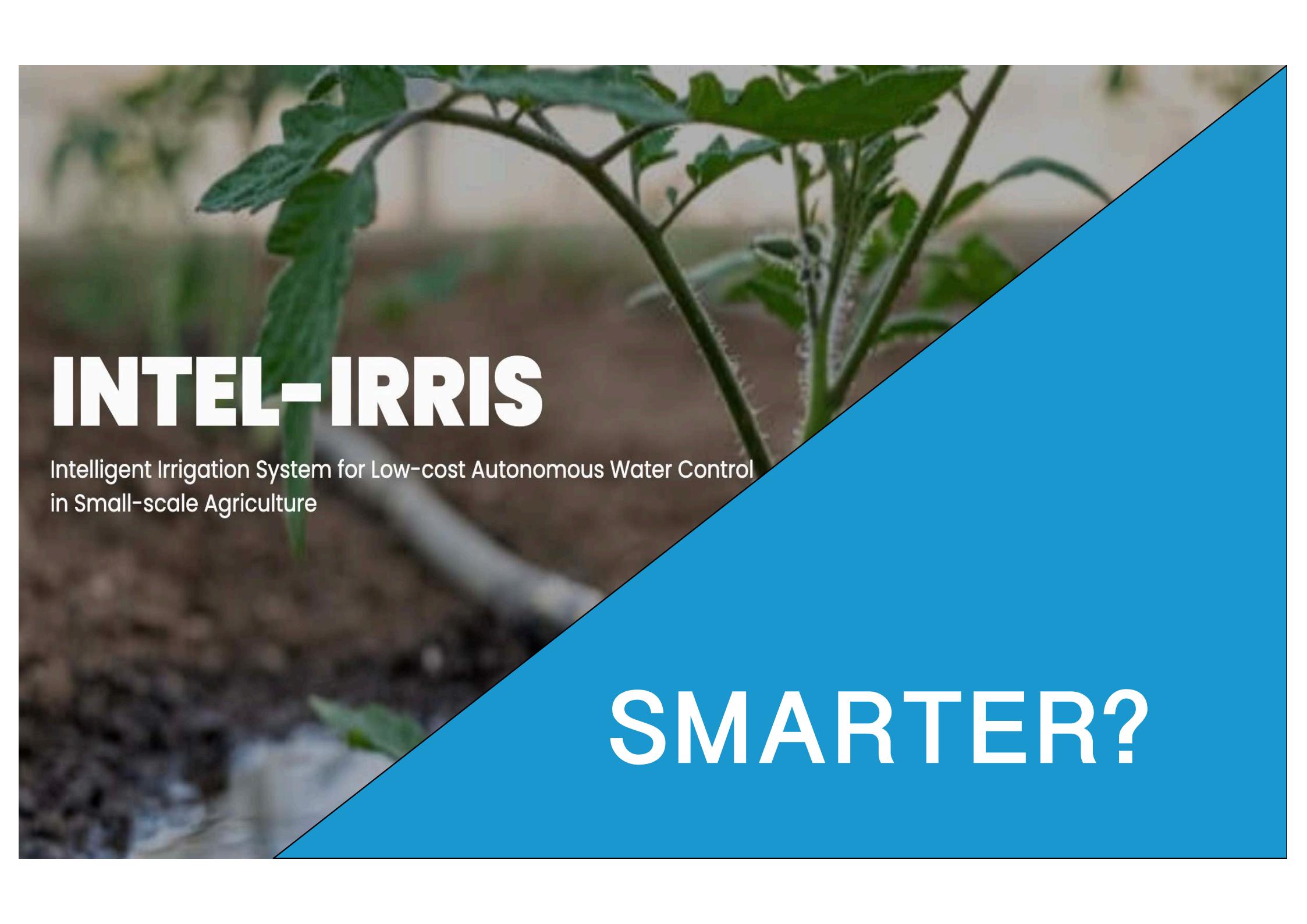
Sensor data

Time	Value
19 hours ago - 2022-04-16 15:21:53	231.5
20 hours ago - 2022-04-16 14:49:13	247.5

EASILY ACCESSED FROM A SMARTPHONE

# Piloting farms, visits, deployment,...



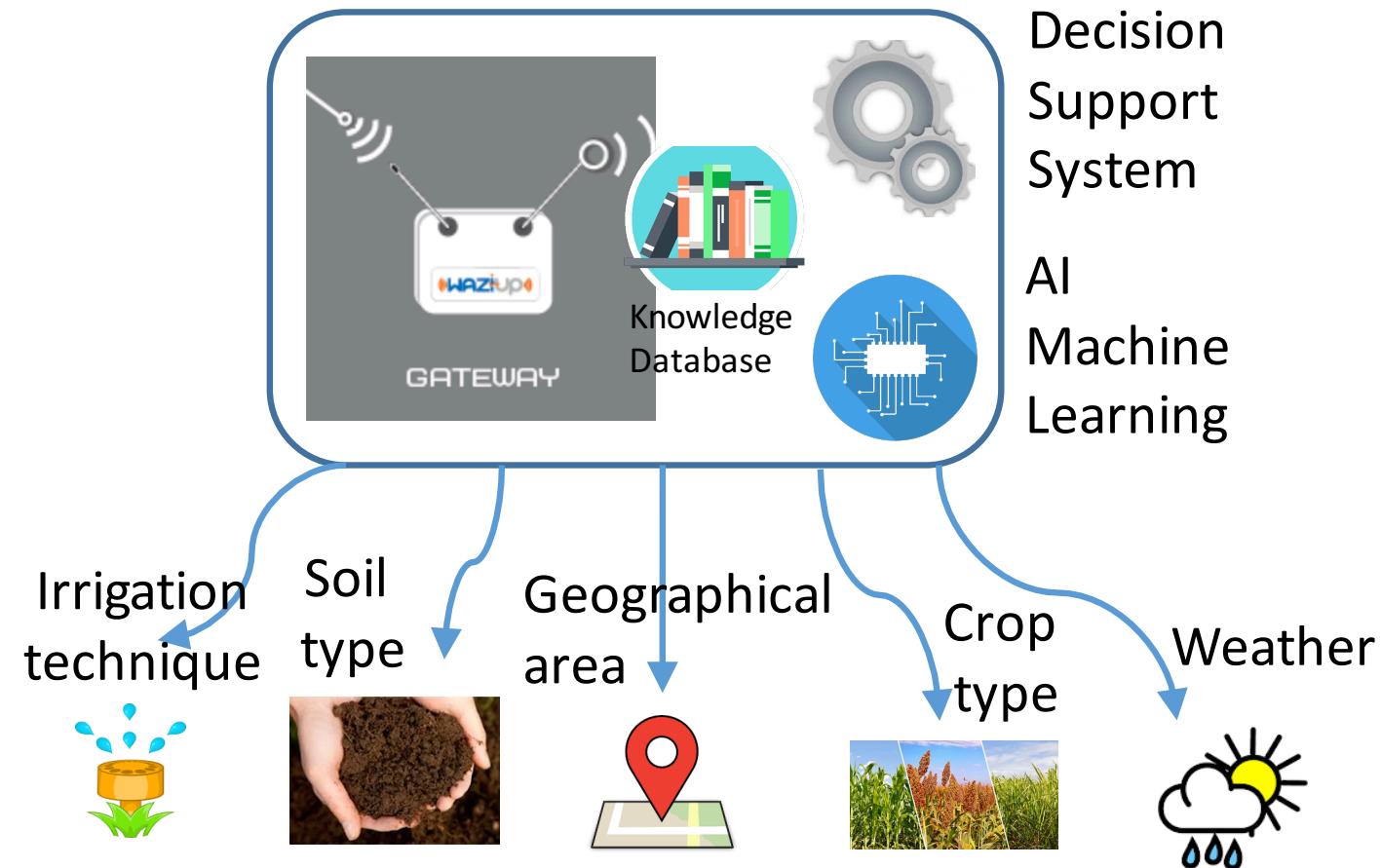
A close-up photograph of a green plant with several leaves and a thin stem. In the background, a white, ribbed irrigation tube or pipe is visible, suggesting a smart irrigation system. The image has a shallow depth of field, focusing on the plant in the foreground.

# INTEL-IRRIS

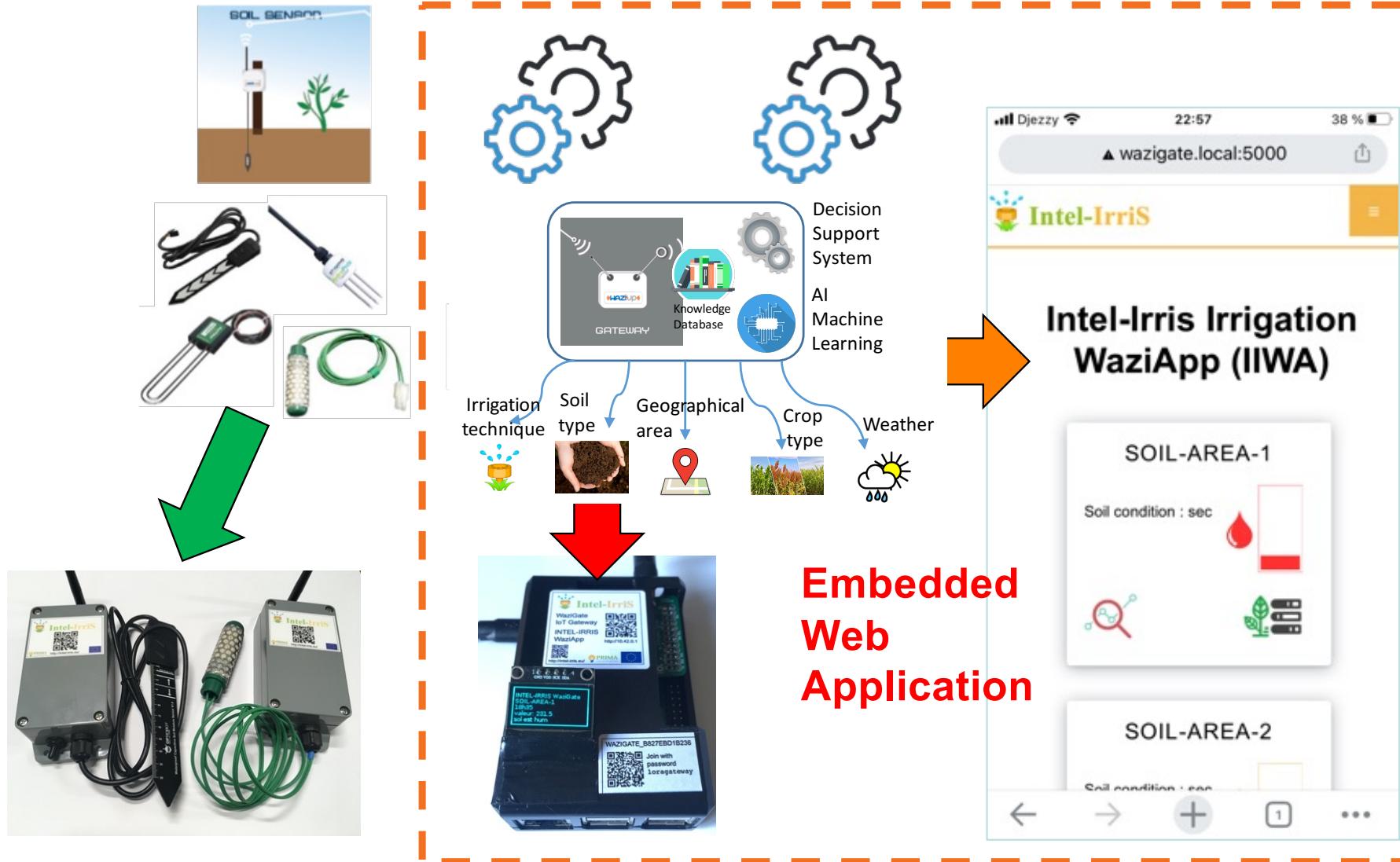
Intelligent Irrigation System for Low-cost Autonomous Water Control  
in Small-scale Agriculture

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

- Submerison
- 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

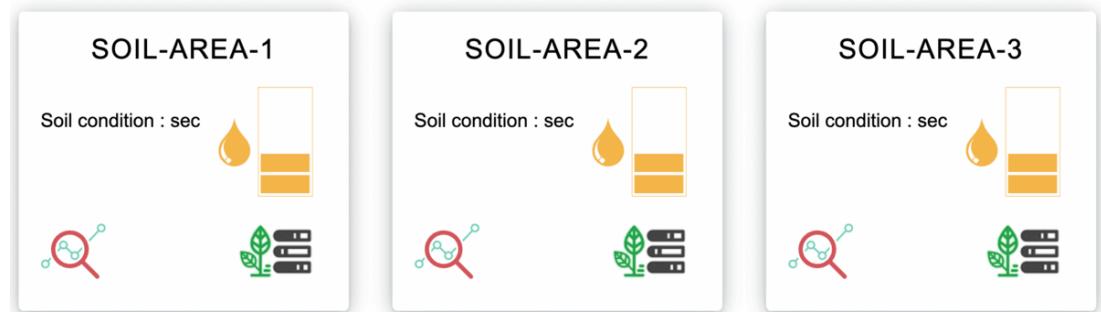
### Weekly evaporation (in mm) value in mm

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

Save configuration

# First IIWA demo at Mostaganem event

- March 7th, 2023
- Real-time demo of soil sensor + IIWA



<https://intel-irris.eu/presentation-of-intel-irris-starter-kit-for-smallholder-farmers-in-mostaganem-algerie>

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

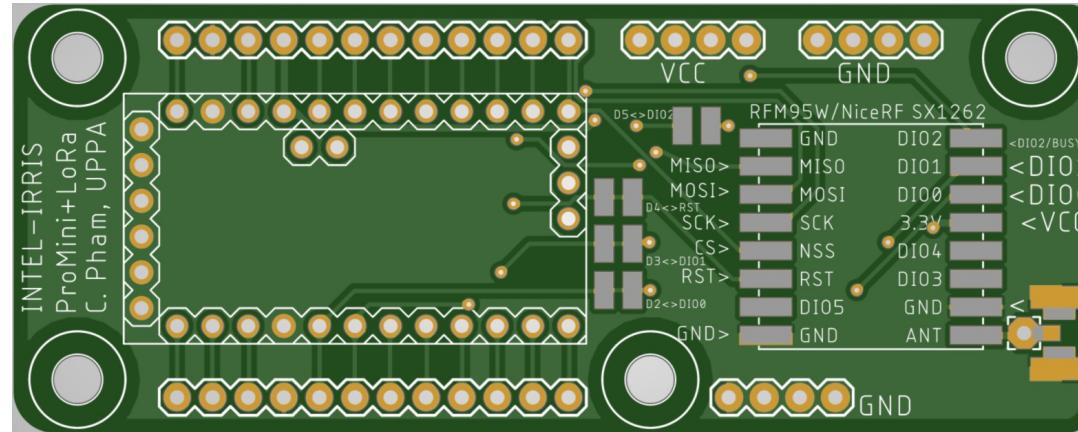
# INTEL-IRRIS

Intelligent Irrigation System for Low-cost Autonomous Water Control  
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WHAT'S  
NEXT?

# Full LoRaWAN support

- Integration of the RAK3172 LoRaWAN radio module
- Advertised 1.69uA in sleep mode
- Expected consumption in sleep mode below 7uA



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

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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 | IRD | IRDOR | INRA  
 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



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

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



Institut de Recherche  
 pour le Développement  
 FRANCE

christian.hartmann@ird.fr  
 jean-francois.printanier@ird.fr



Irrigation : concepts et état des lieux



Présenté par : Dr. BOUAZZAMA Bassou  
 Chercheur et Ingénieur en Génie Rural  
 Bassou.bouazzama@ira.ma



Irrigation :  
 concepts et état  
 des lieux



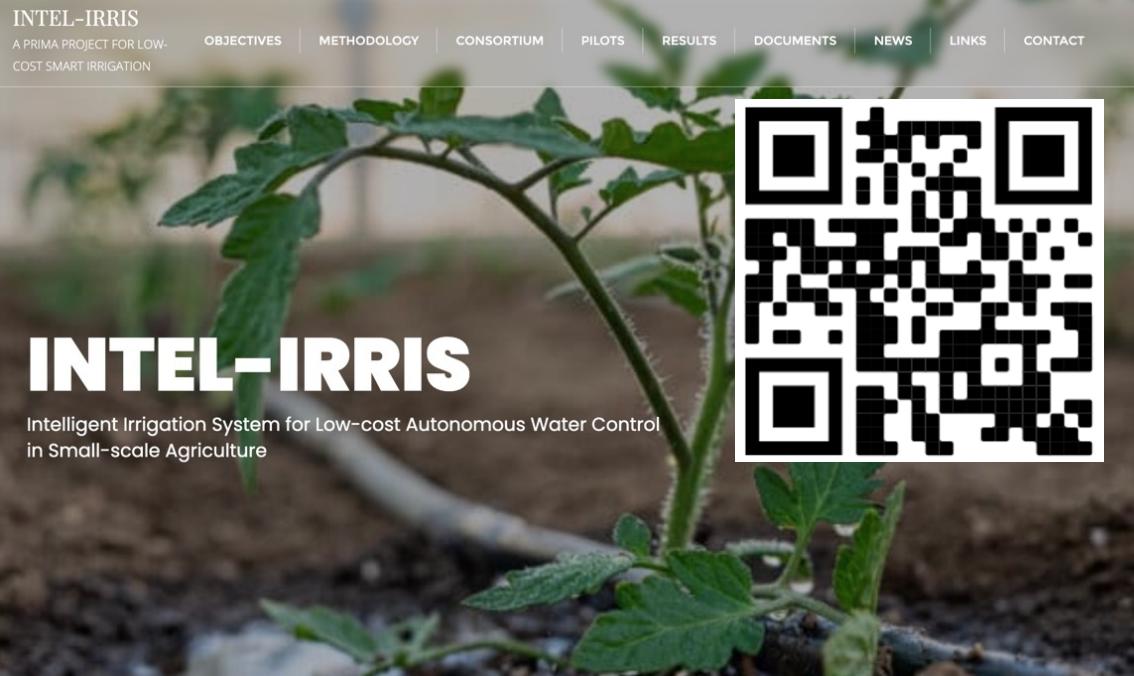
L'eau dans le sol et les  
 contraintes de l'irrigation

Pr BENKELIFA Mohammed (UMAB)



# More information

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



The website header includes the project name "INTEL-IRRIS" and a subtitle "A PRIMA PROJECT FOR LOW-COST SMART IRRIGATION". Below the header is a large image of a young tomato plant with a QR code overlaid. The website navigation menu at the top includes links for OBJECTIVES, METHODOLOGY, CONSORTIUM, PILOTS, RESULTS, DOCUMENTS, NEWS, LINKS, and CONTACT.

**Project Partners:**

- AUA:** Agricultural University of Athens (Greece)
- ENSA-Safi:** National School of Applied Sciences – Safi (Morocco)
- INRA:** National Institute of Agronomic Research (Morocco)
- IRD:** Institute for Research & Development (France)
- UMAB:** University A. Benbadis (Algeria)
- UORAN1:** University of Oran 1 (Algeria)
- UPPA:** University of Pau & Adour Country (France)
- WAZIUP eV:** WAZIUP association (Germany)

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



Intel\_Irris  
@Intel\_IrriS

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

