

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



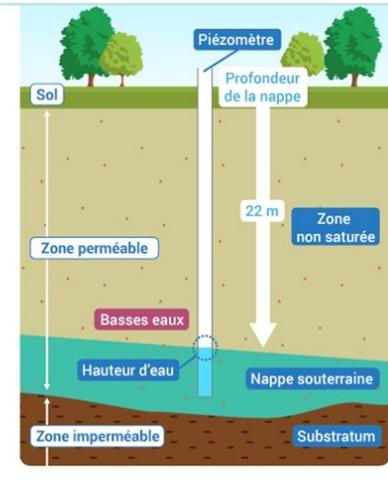
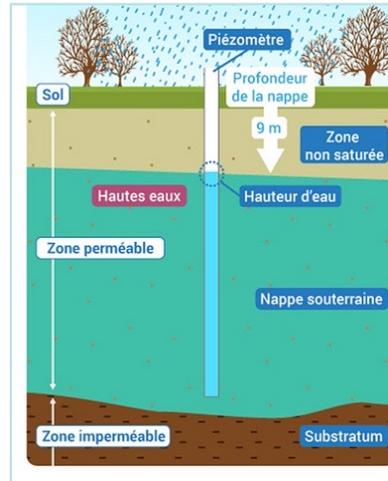
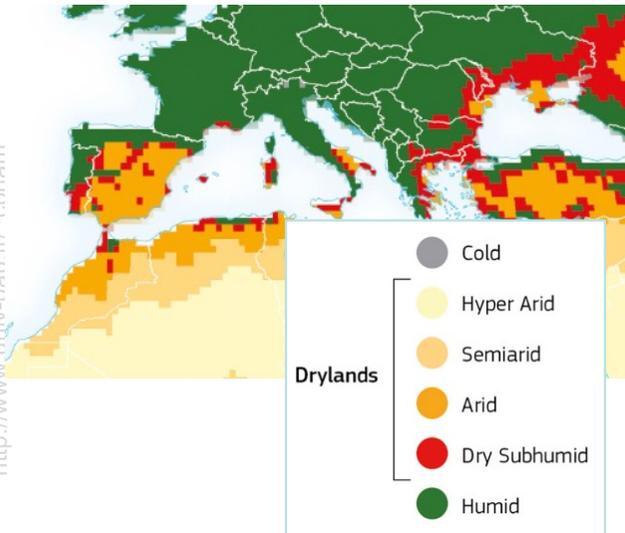
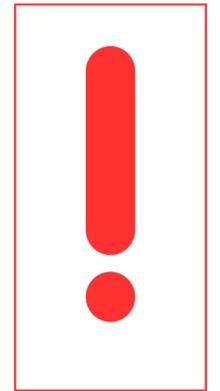
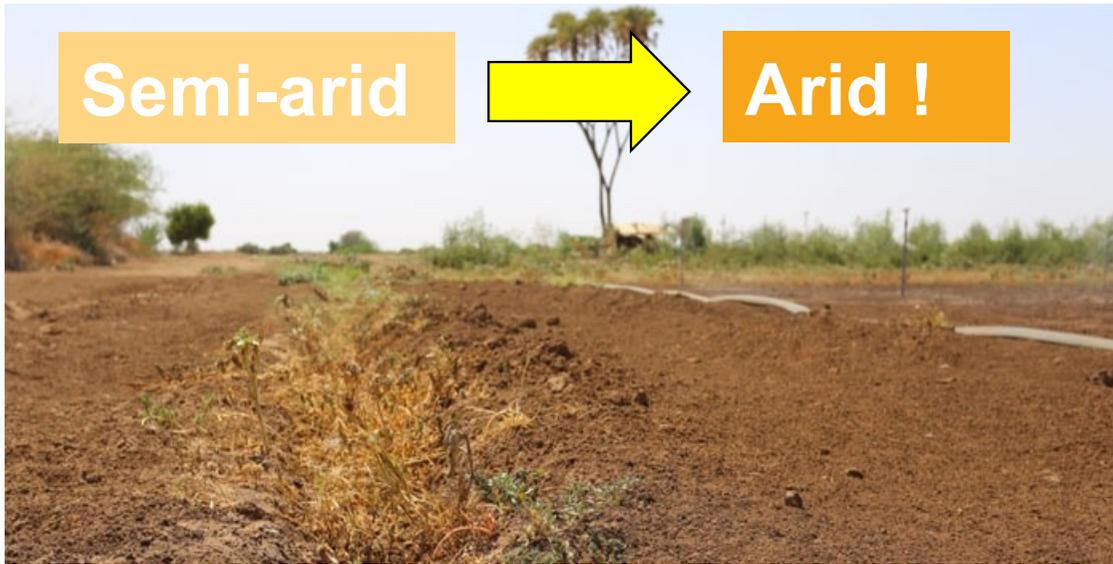
Low-cost sensor design for eco-sustainability in smart agriculture targeting smallholder communities

Green IT 2023 – June 28<sup>th</sup>, 2023

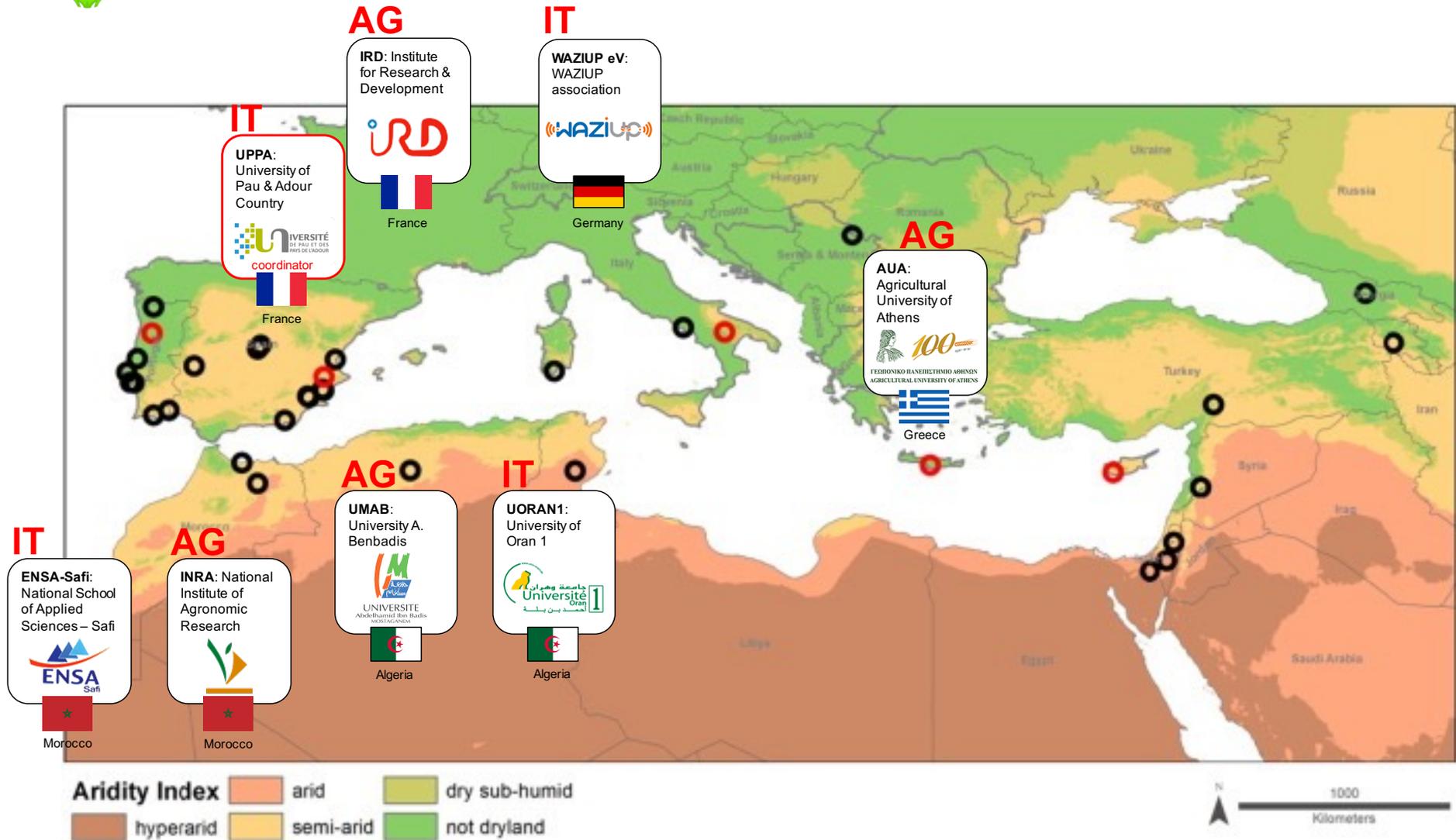
Prof. Congduc Pham  
<http://www.univ-pau.fr/~cpham>  
Université de Pau, France



# Water resource is precious!



# Focus on Mediterranean Area



# 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**

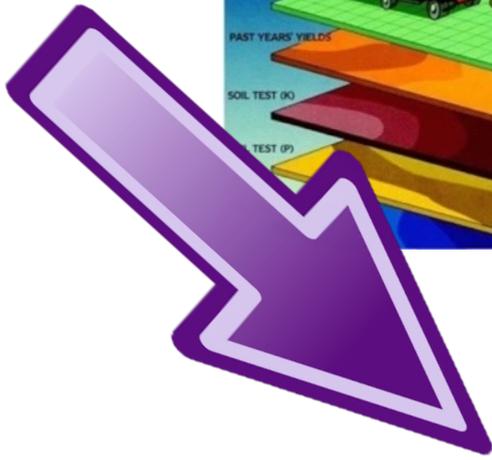
**Drones & Satellites**

**Artificial Intelligence**

# Ideal smart agriculture scenario



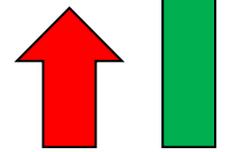
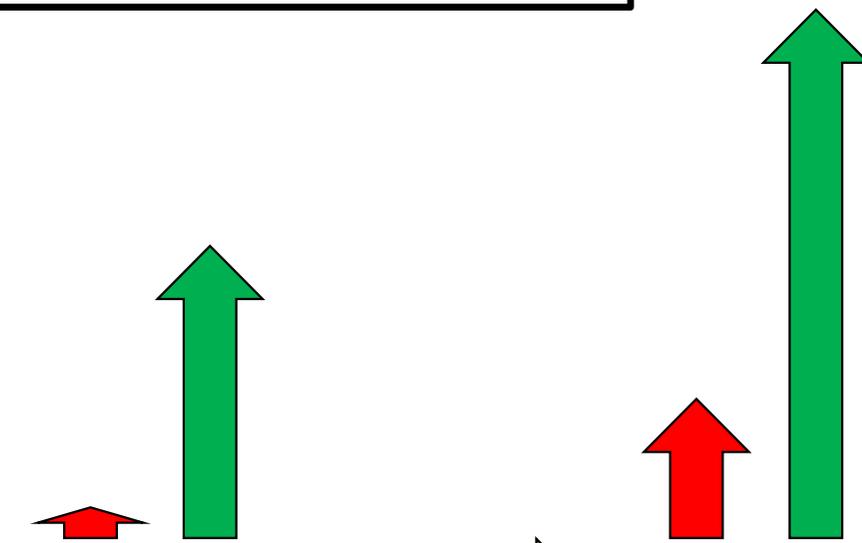
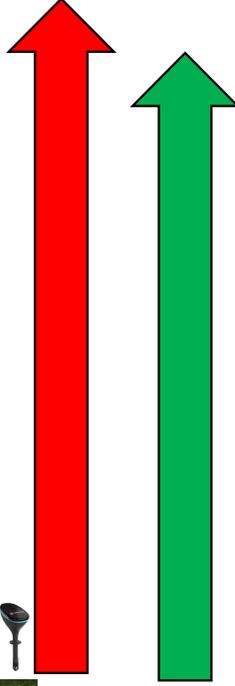
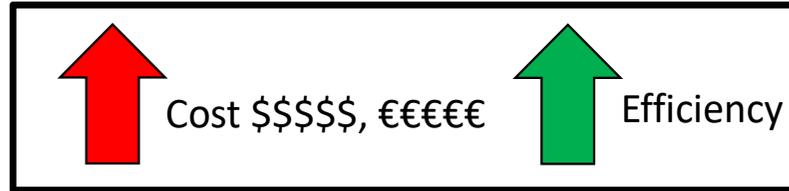
**Sensors**



**Connected Agriculture**



# It is always a tradeoff...



**Big Farms**

Connected Agriculture



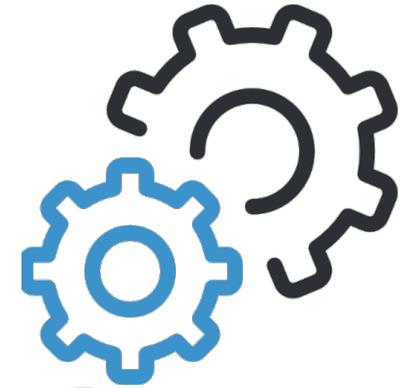
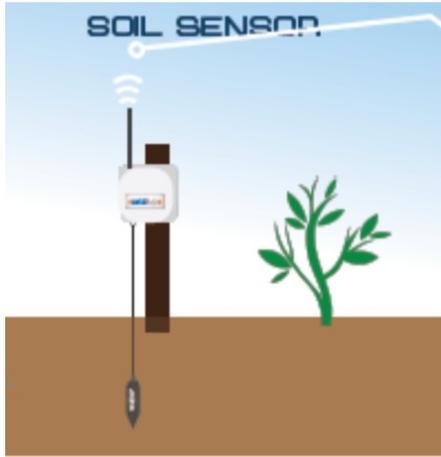
**Small-scale farms,  
 Smallholder Farmers**

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

# Piloting farms, visits, deployment, ... Intel-IrriS

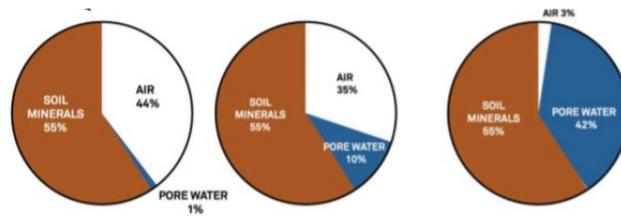


# Irrigation with soil moisture sensing

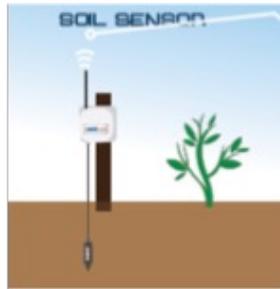


**?** Analyse

**?** Decide



# Not as simple as it seems ☹️



## Sense

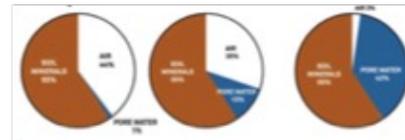


Volumetric Water Content,  
 Water Potential, Water  
 Tension,...

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



? Analyse



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

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



? Decide



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

Plant/Crop varieties

Relationship with other  
 agriculture inputs

# INTEL-IRRIS's main objectives

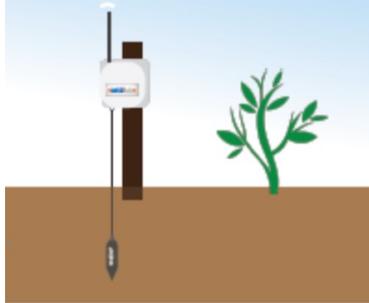
## Low-cost

## Advanced technologies

## Autonomous Plug-&-Sense

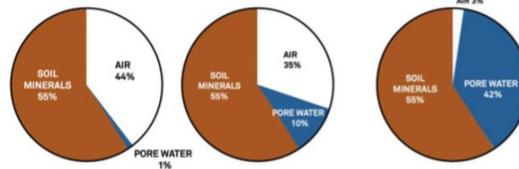
1

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



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



**~ 30€**

**SEN0308  
capacitive sensor**

**~ 60€**

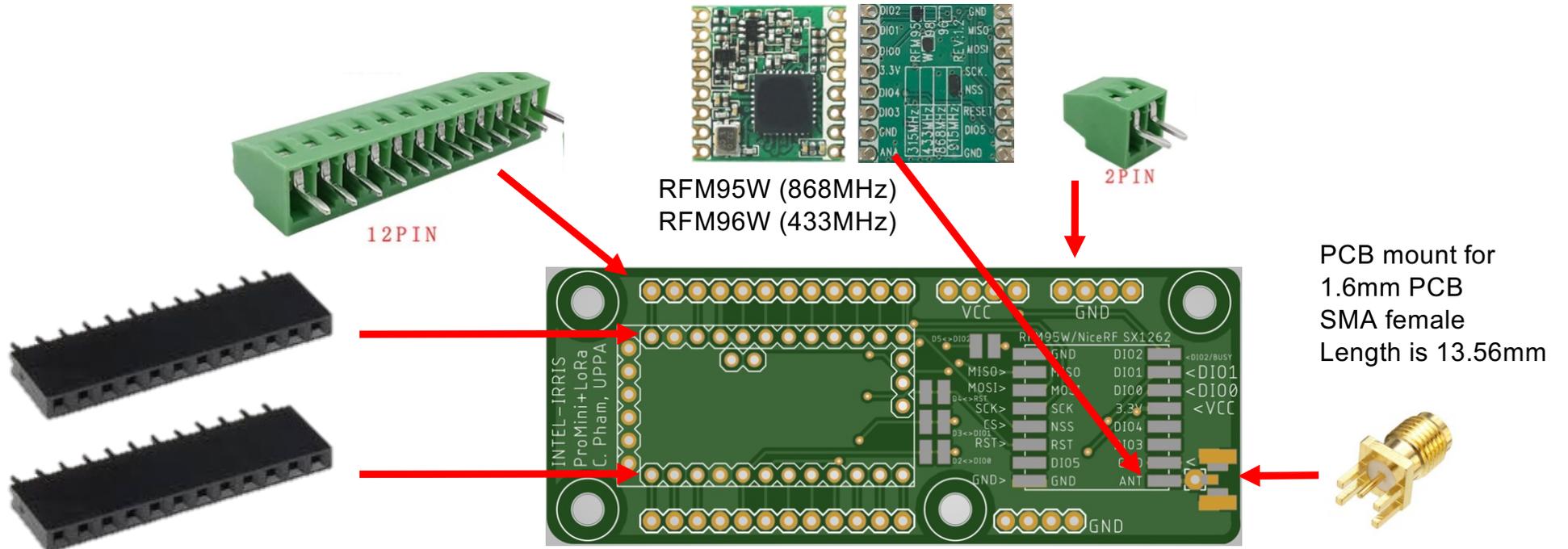
**Watermark WM200  
Water tension sensor**



**A soil temperature  
sensor can be added**

**Especially for  
tensiometer**

# Soil sensor: electronic parts



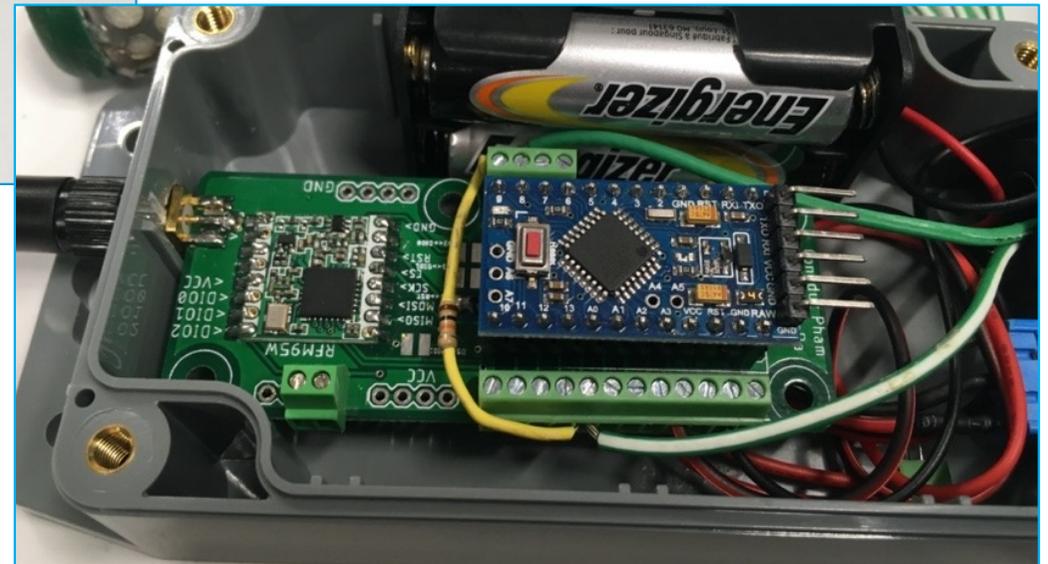
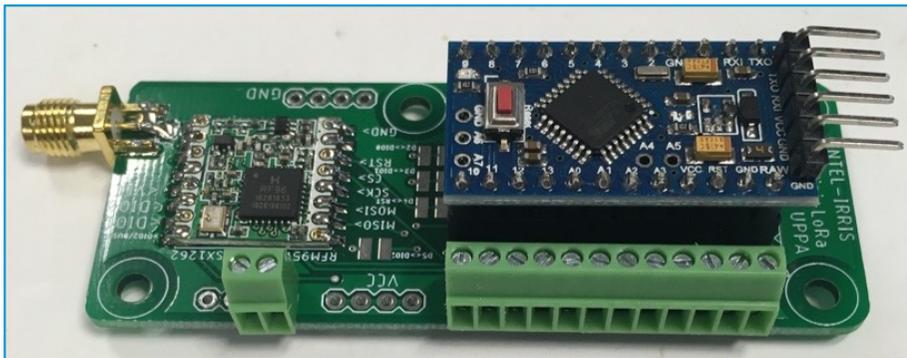
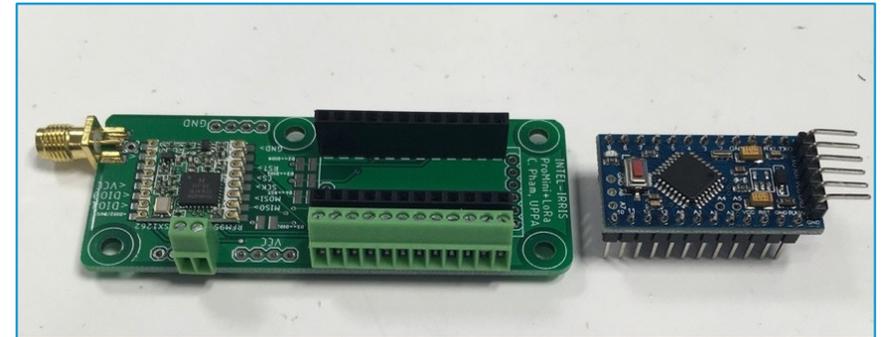
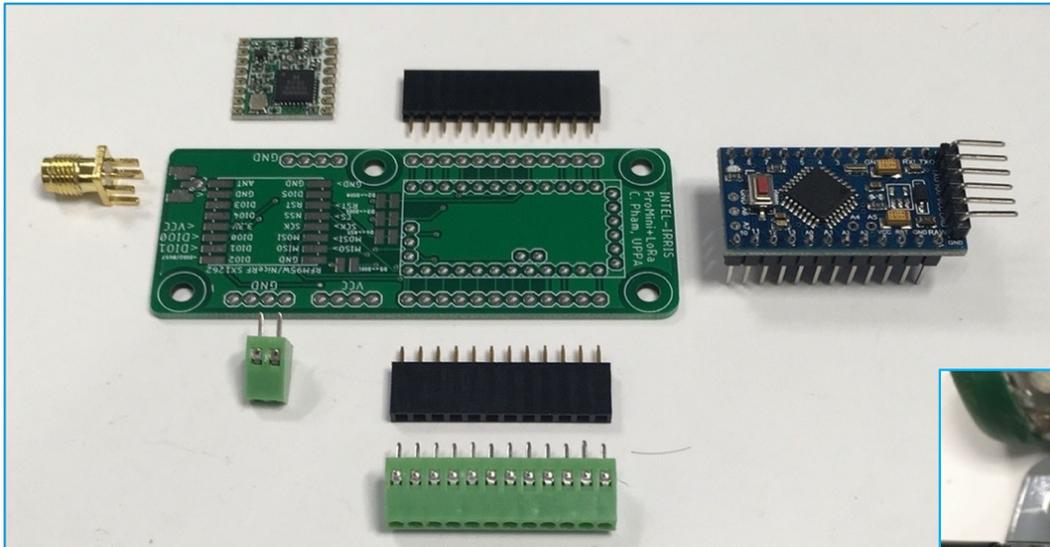
**~ 8€**



Arduino ProMini 3.3V 8MHz

# Simple & Modular design

- Simple integration on PCB of off-the-shelves components

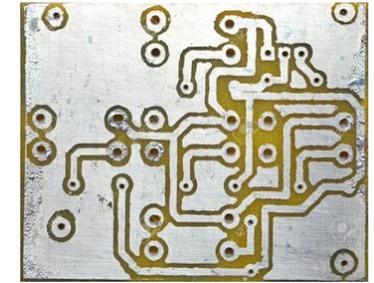


# What is a PCB?

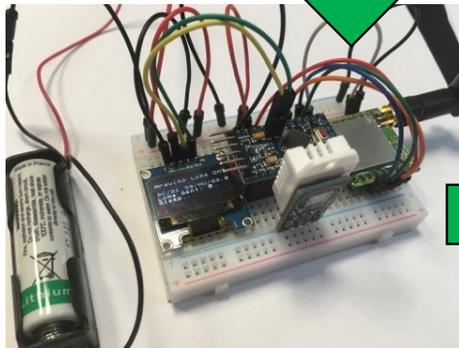
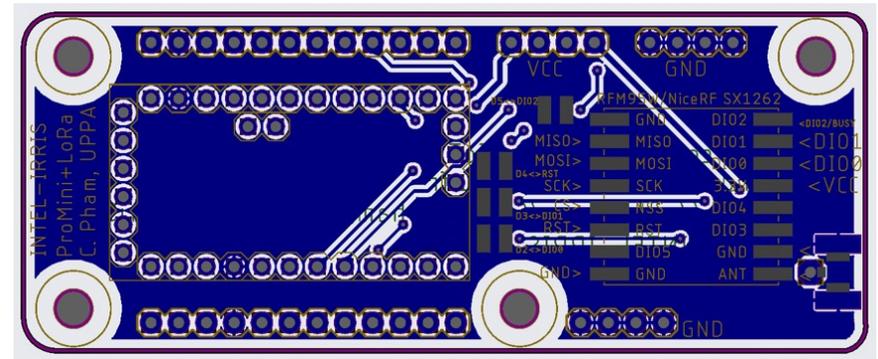
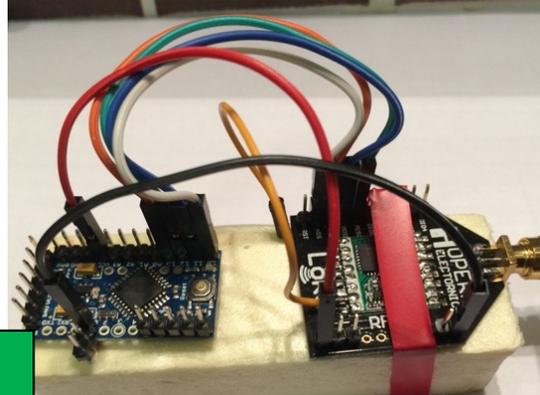
- PCB=Printed Circuit Board
- Copper paths replace Dupont wires



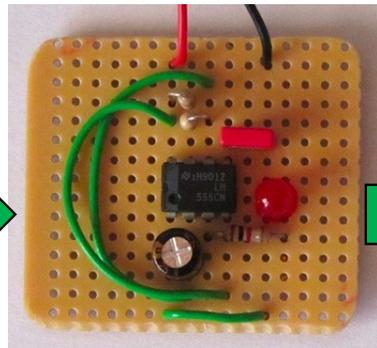
Raw PCB copper board



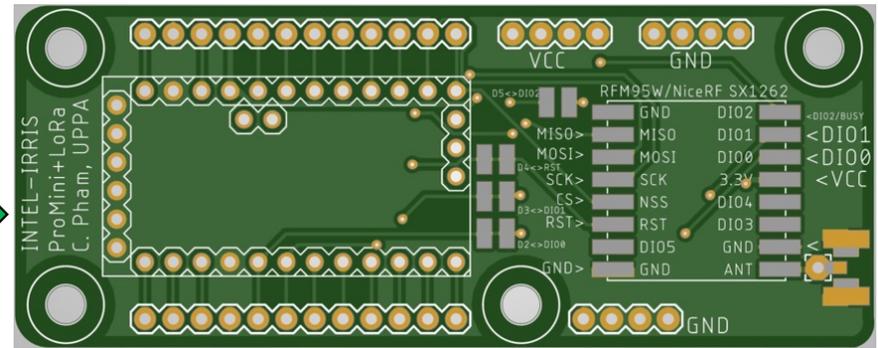
Removing copper to create wire path



Breadboard



Stripboard



# Soil sensor: integration

**~ 12€**

**~ 38€**



**~ 10€**



**~ 2€**



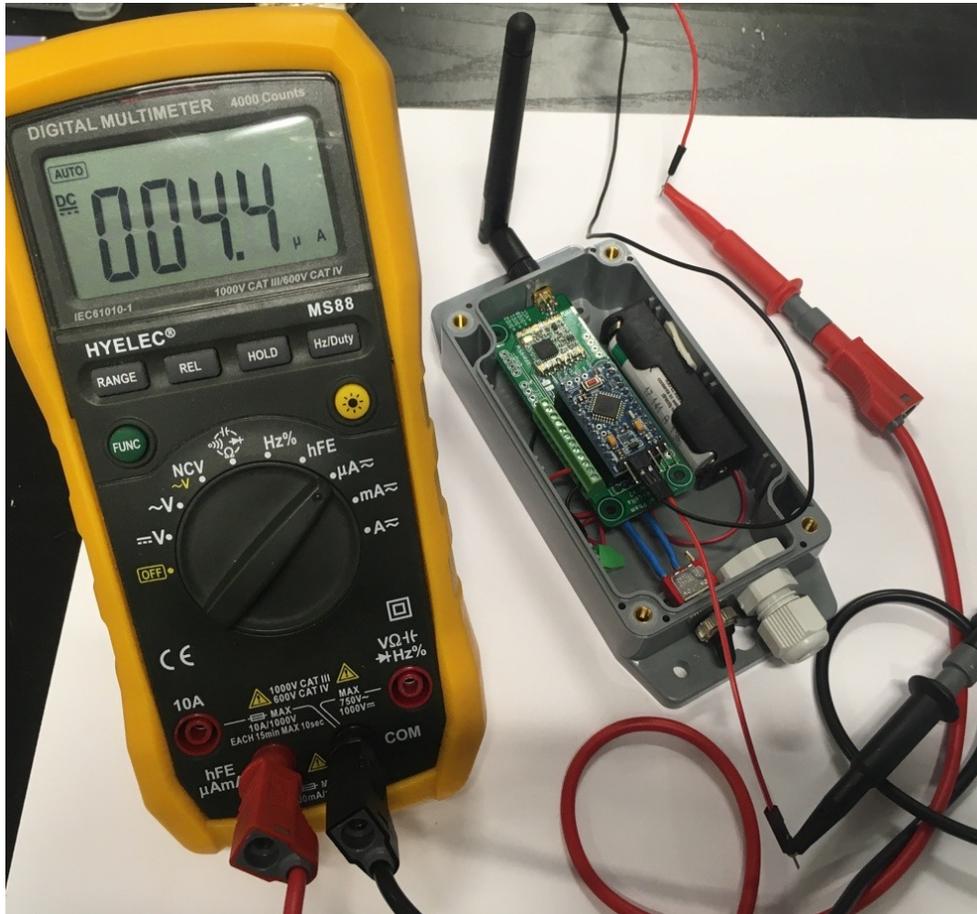


# A generic hardware platform

- ⦿ Low-cost: < 20€
- ⦿ Off-the-shelves components
- ⦿ Easily duplicated
- ⦿ Assembling by local partners
- ⦿ Can connect several sensors
- ⦿ Can be adapted by local partners
- ⦿ Easily maintained
- ⦿ Parts can be replaced



# 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

# 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)



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



Centre Régional de la Recherche Agronomique de Tadia  
Unité de Recherche : Système de Production de Production irriguée

Irrigation : concepts et état des lieux



Présenté par : **Dr. BOUZZAMA Bassou**  
Chercheur et Ingénieur en Génie Rural  
[Bassou.bouzzama@irra.ma](mailto:Bassou.bouzzama@irra.ma)

Webinaire (1<sup>ère</sup> édition)  
**Irrigation : concepts et état des lieux**  
Intel-IrriS

**L'eau dans le sol et les contraintes de l'irrigation**  
Pr BENKHELIFA Mohammed (UMAB)

Build the LoRa IoT microcontroller platform for the PRIMA IN...  
Watch later Share

THAT'S ALL THE BOARD IS READY FOR  
NOW LET'S MOVE IT INTO OUTDOOR ENCLOSURE

Watch on YouTube

Build the outdoor LoRa IoT soil sensor for the PRIMA INTEL-I...  
Watch later Share

CONNECT THE WIRES ACCORDINGLY

Watch on YouTube

Wire the soil humidity sensor and test LoRa transmissions to...  
Watch later Share

NOW LET'S PROGRAM THE BOARD

Watch on YouTube

The INTEL-IRRIS soil sensor device & WaziGate framework f...  
Watch later Share

Watch on YouTube

**Intel-IrriS**  
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 Serrat  
Laboratoire des Agroéquipements et Energie  
30 Mars 2022

**LES CAPTEURS FAIBLE COÛT POUR MESURER L'EAU DANS LE SOL: CONTRAINTES, LIMITATIONS ET PERSPECTIVES**  
PRIMA IN THE MEDITERRANEAN AREA  
Intel-IrriS Intelligent Irrigation System for Low-cost Autonomous Water Control in Small-scale Agriculture  
INTEL-IRRIS - PRIMA 52 2020 - PROJECT ID 1560  
Dr. Christian Hartmann  
M. Jean-François Printanier  
M. Mamadou Gueye  
M. Lotfi Smaili  
Institut de Recherche pour le Développement FRANCE  
[christian.hartmann@ird.fr](mailto:christian.hartmann@ird.fr)  
[jean-francois.printanier@ird.fr](mailto:jean-francois.printanier@ird.fr)

INTEL-IRRIS's interview video presenting the project and ben...  
Watch later Share

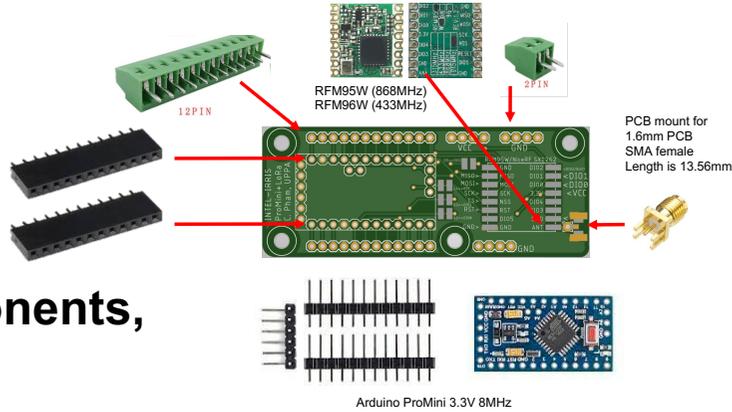
Barriers to IoT Solutions  
• Technology Cost  
• Internet Challenges  
• Vendor Lock  
• Complexity of Deployed Solutions

**Intel-IrriS and Edge-Computing Technologies**  
Watch on YouTube

# Low-cost design space

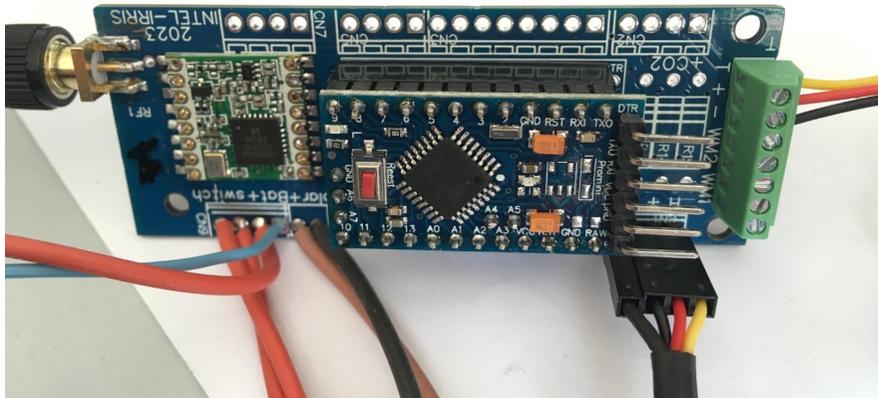
1

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



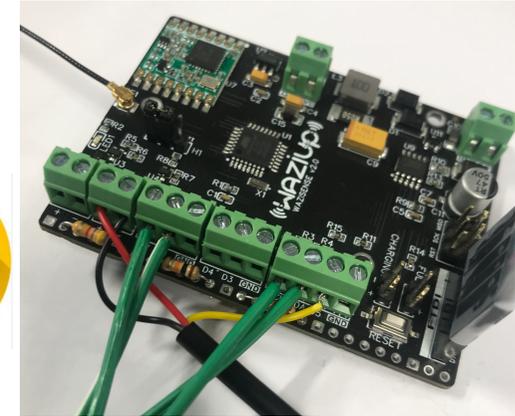
Simple design, off-the-shelves components, **low-cost support for solar panel, some components already soldered, mixed-DIY**

2

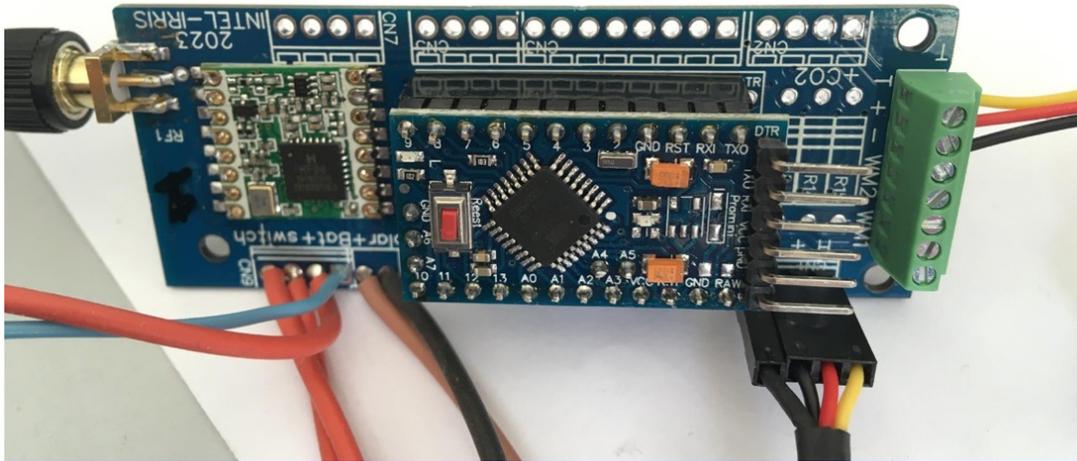


3

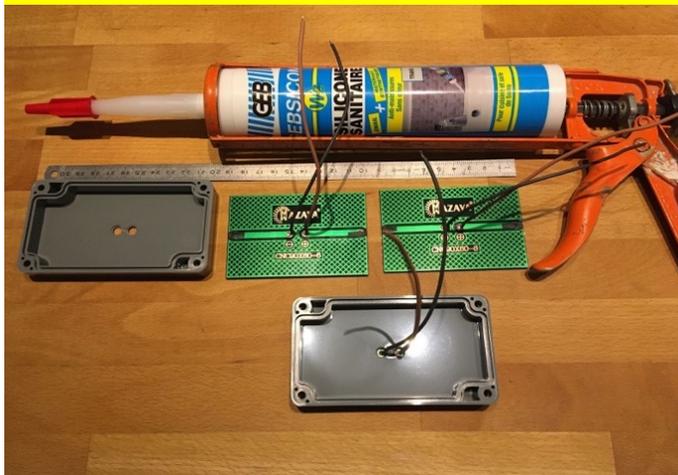
Integrated design, off-the-shelves components, **full support for solar panel, all components already soldered**

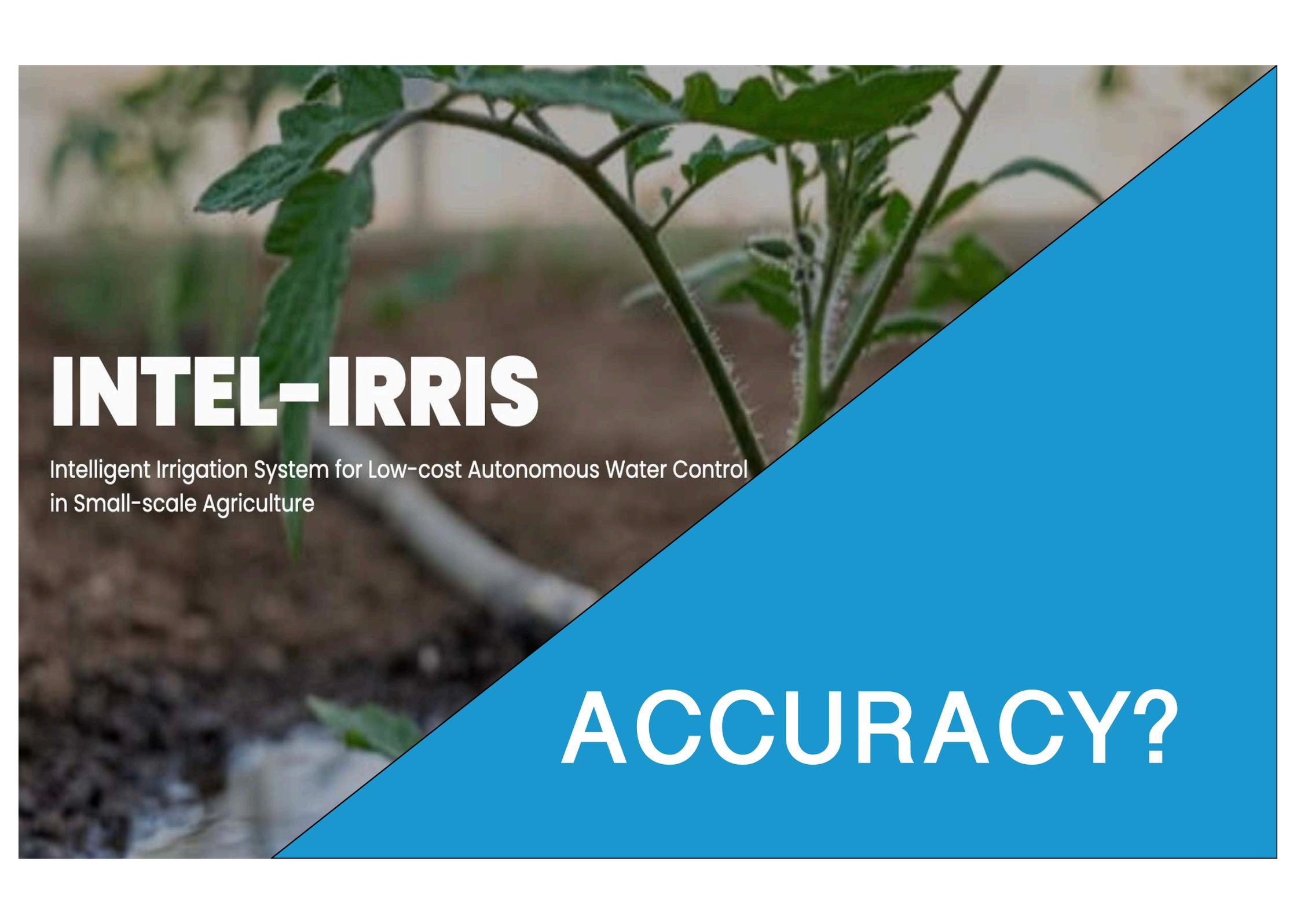


# Low-cost solar variant



**Add about 5€ only**



A photograph of a tomato plant in a field, with a blue diagonal overlay on the right side. The text is overlaid on the image.

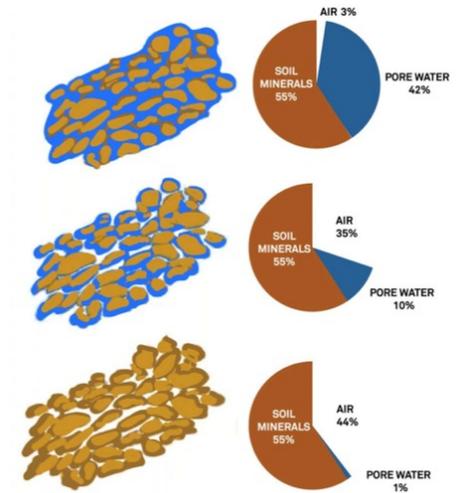
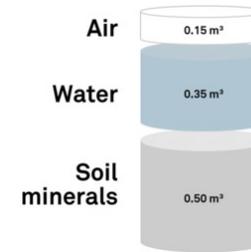
# INTEL-IRRIS

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

# ACCURACY?

# Capacitive sensor

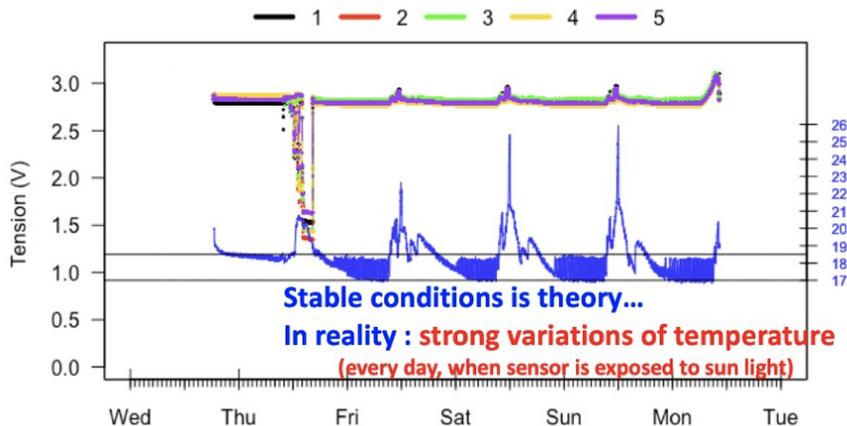
- Capacitive soil moisture sensors usually measure volumetric water content
- Soil density & soil texture are important parameters



From METER group



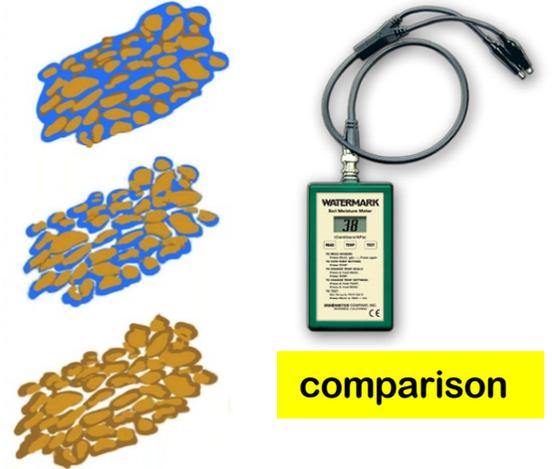
Impact of temperature ?



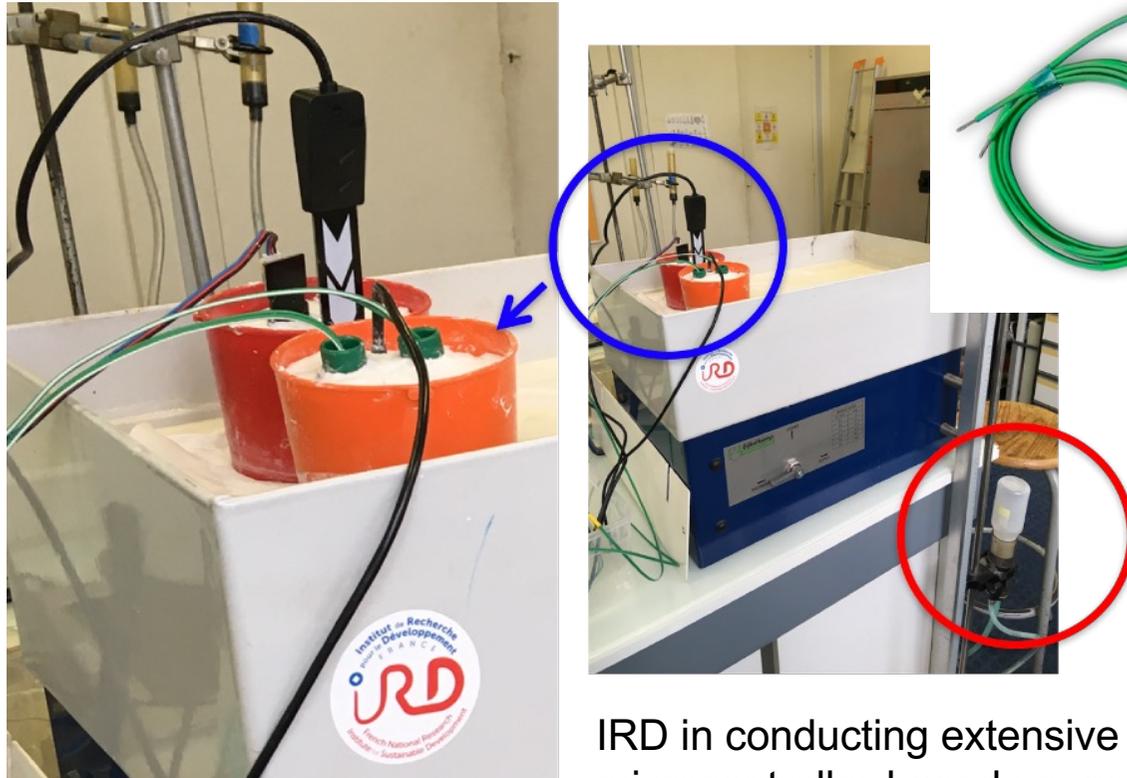
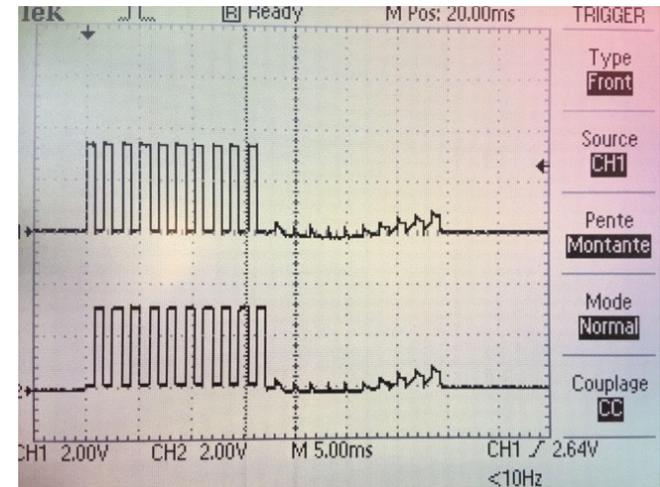
IRD in conducting extensive test on the accuracy and the stability of the low-cost SEN0308 capacitive sensor 27

# Water tension sensor

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



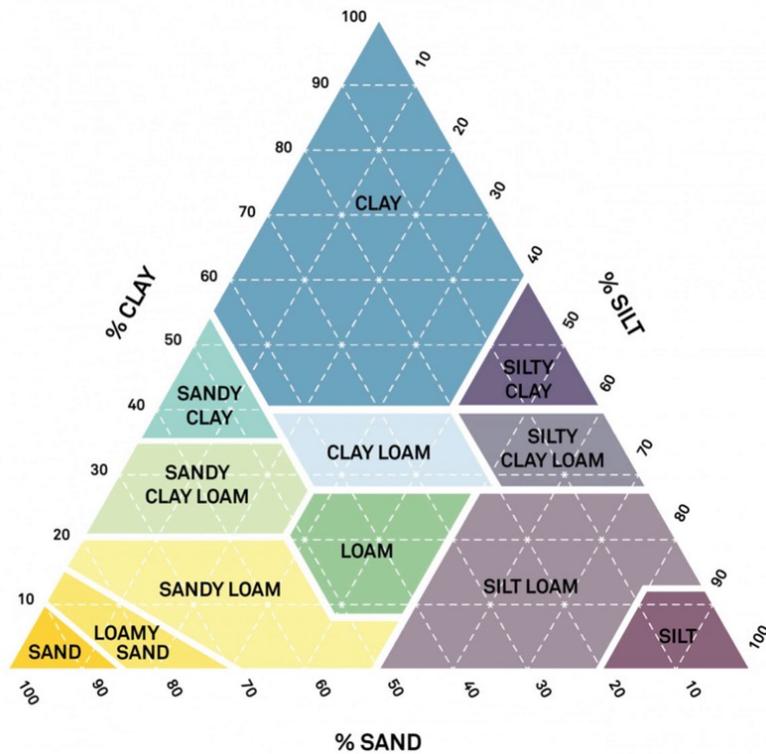
From METER group



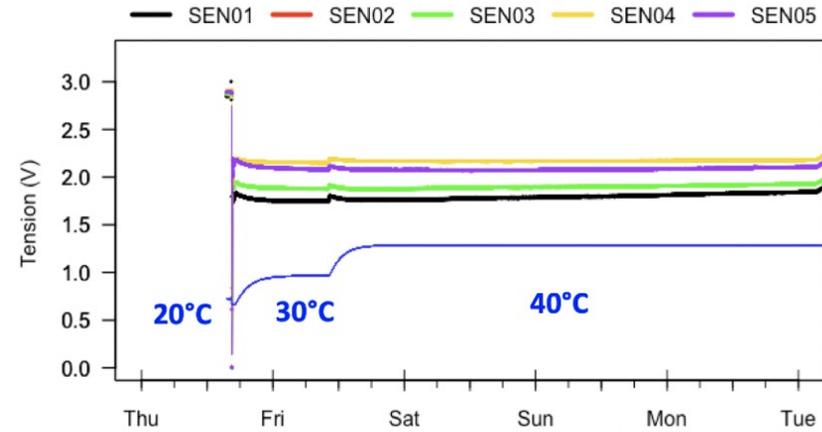
IRD in conducting extensive tests on the stability & suitability of microcontroller-based usage of the Watermark water tension sensor

# Calibration

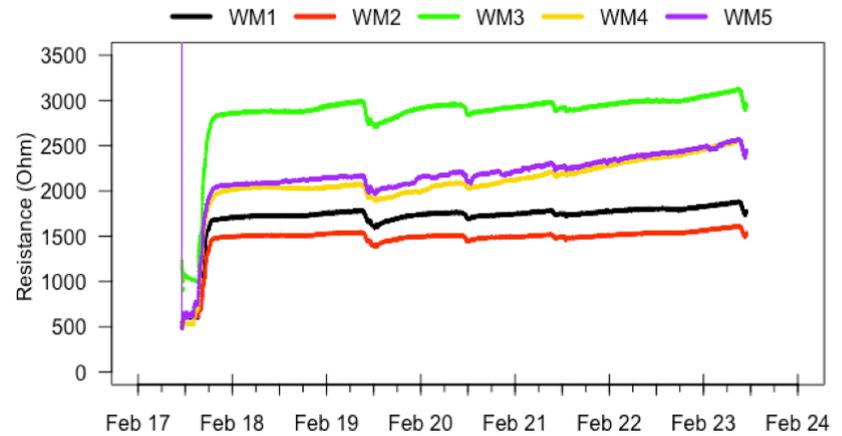
- Soil-specific calibration
- Impact of external "noise"



SEN 0308

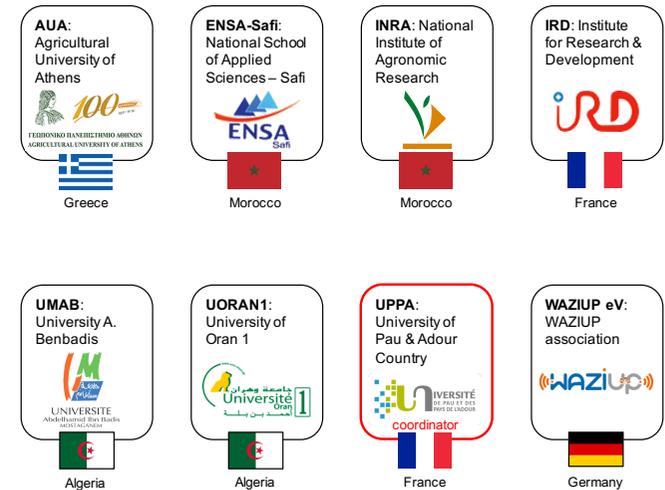
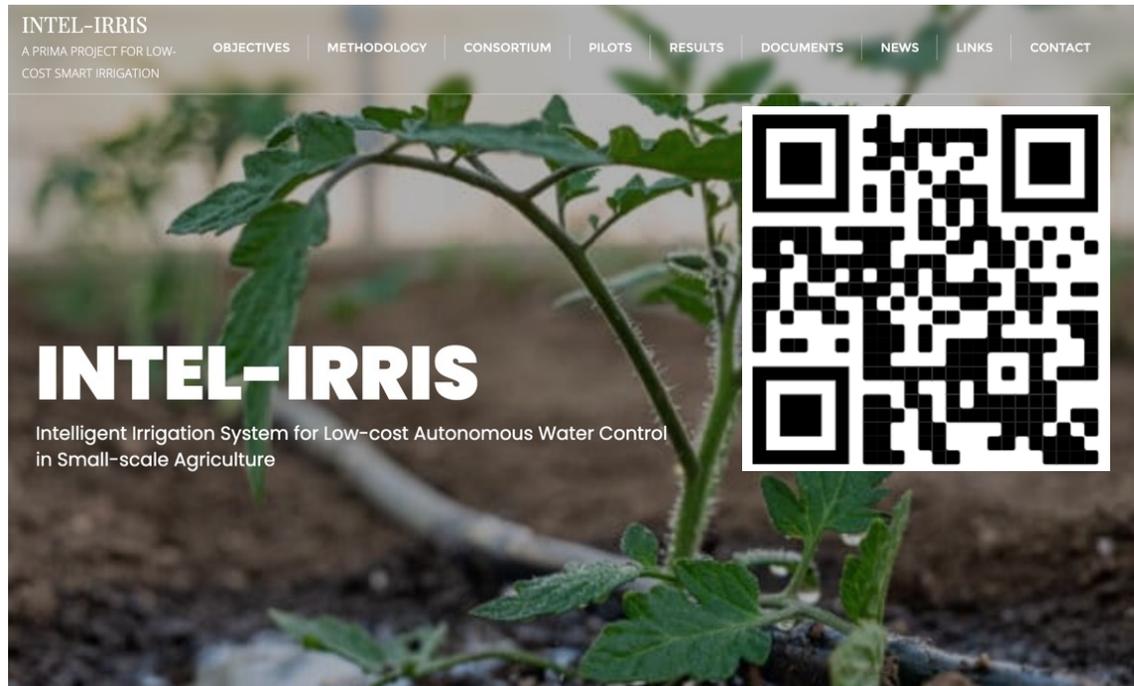


Ambient air emperature has low impact, except...



# More information

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



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

