

# INTEL-IRRIS

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



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

*Système intelligent, autonome et à faible coût pour optimiser l'irrigation dans les petites exploitations agricoles*



## The INTEL-IRRIS starter-kit targeting smallholder farmers

Prof. Congduc Pham  
<http://www.univ-pau.fr/~cpham>



**Intel-IrriS**    **RESICOOLINK**  
Advanced and disruptive IoT/AI technologies targeting the smallholder community for increased resilience

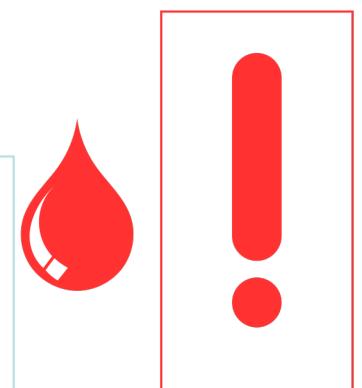
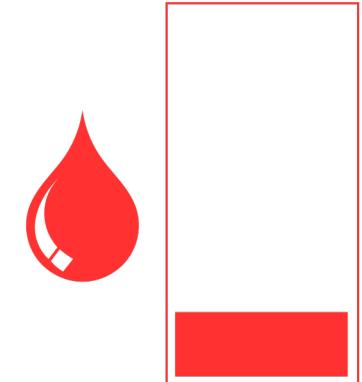
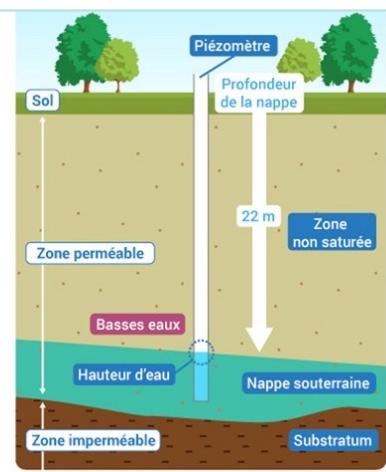
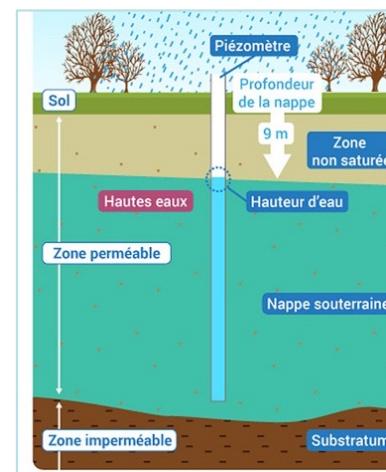
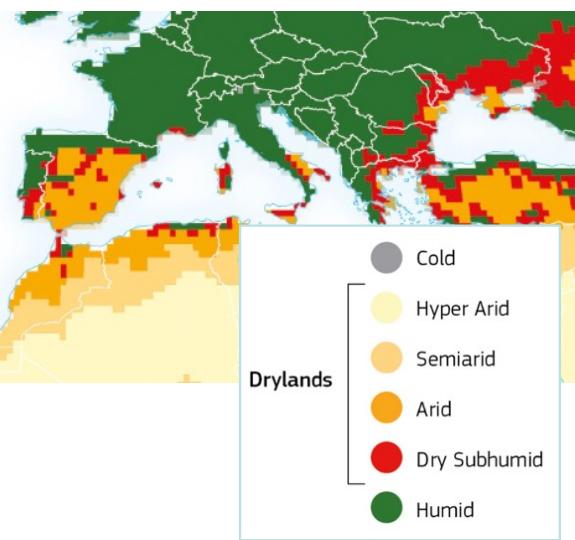
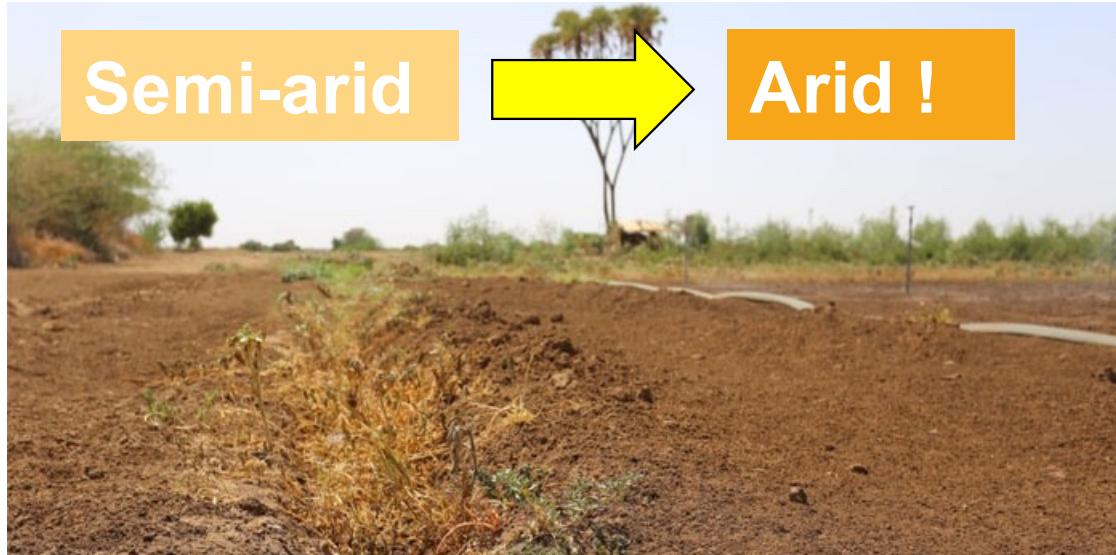
# PRIMA S2 2020 INTEL-IRRIS

- Partnership for Research and Innovation in the Mediterranean Area
- R&I approaches to improve water availability and sustainable agriculture distressed by climate change, urbanisation and population growth
- Appel à projet: Section 2 Multitopic 2020
- Thematic Area 1-Water management
  - Low cost, lean solutions for enhancing irrigation efficiency of small-scale farms

<https://prima-med.org/>



# Water resource is precious!



# Optimizing irrigation in agriculture

- About 70% of water is used for agriculture activities
- **Digital technologies** can help reducing and optimizing usage of water, **but...**



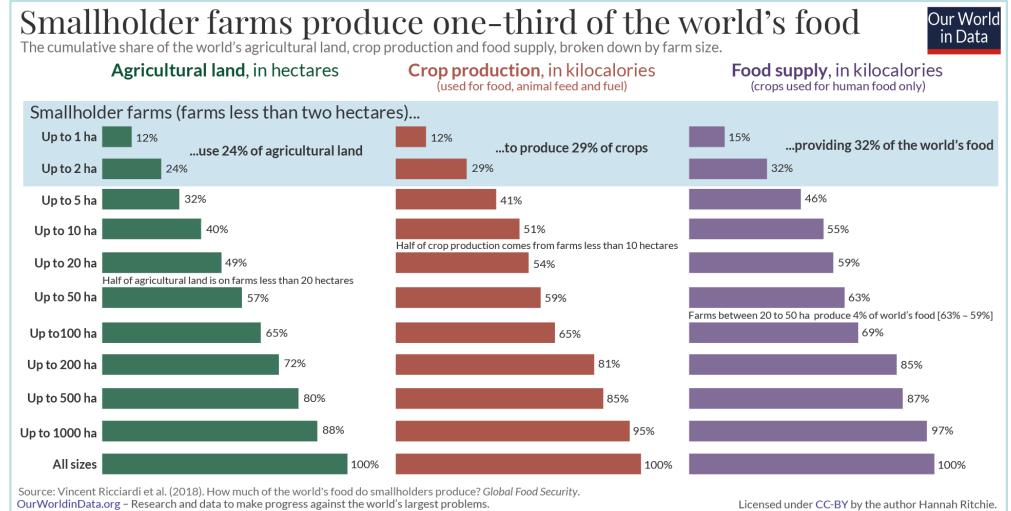
Possible for large farms



**Out of reach for smallholders!**

# Smallholders – up to 2ha

- Most (84%) of the world's 570 million farms are smallholdings
- Provide about 32% of world food supply, on about 24% of agriculture land



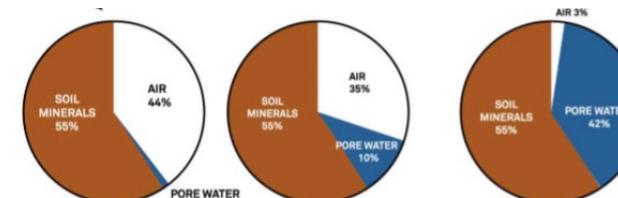
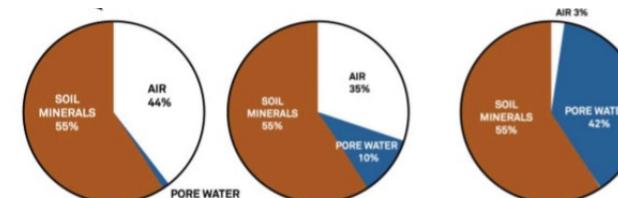
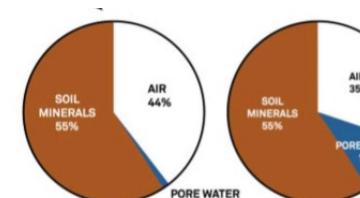
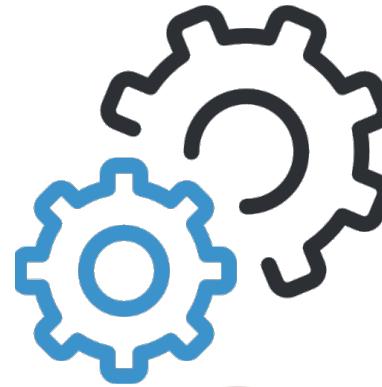
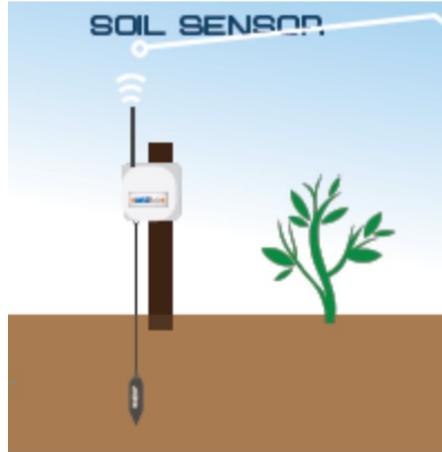
<https://ourworldindata.org/smallholder-food-production>



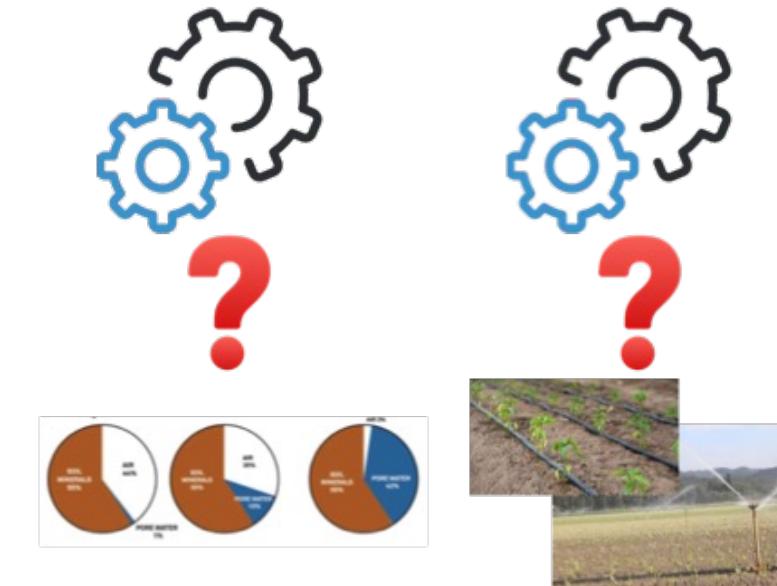
## Technologies

Too expensive  
 Too integrated  
 Highly specialized  
 Difficult to customize  
 Difficult to upgrade

# Irrigation with soil moisture sensing



# Not as simple as it seems 😞



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

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

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

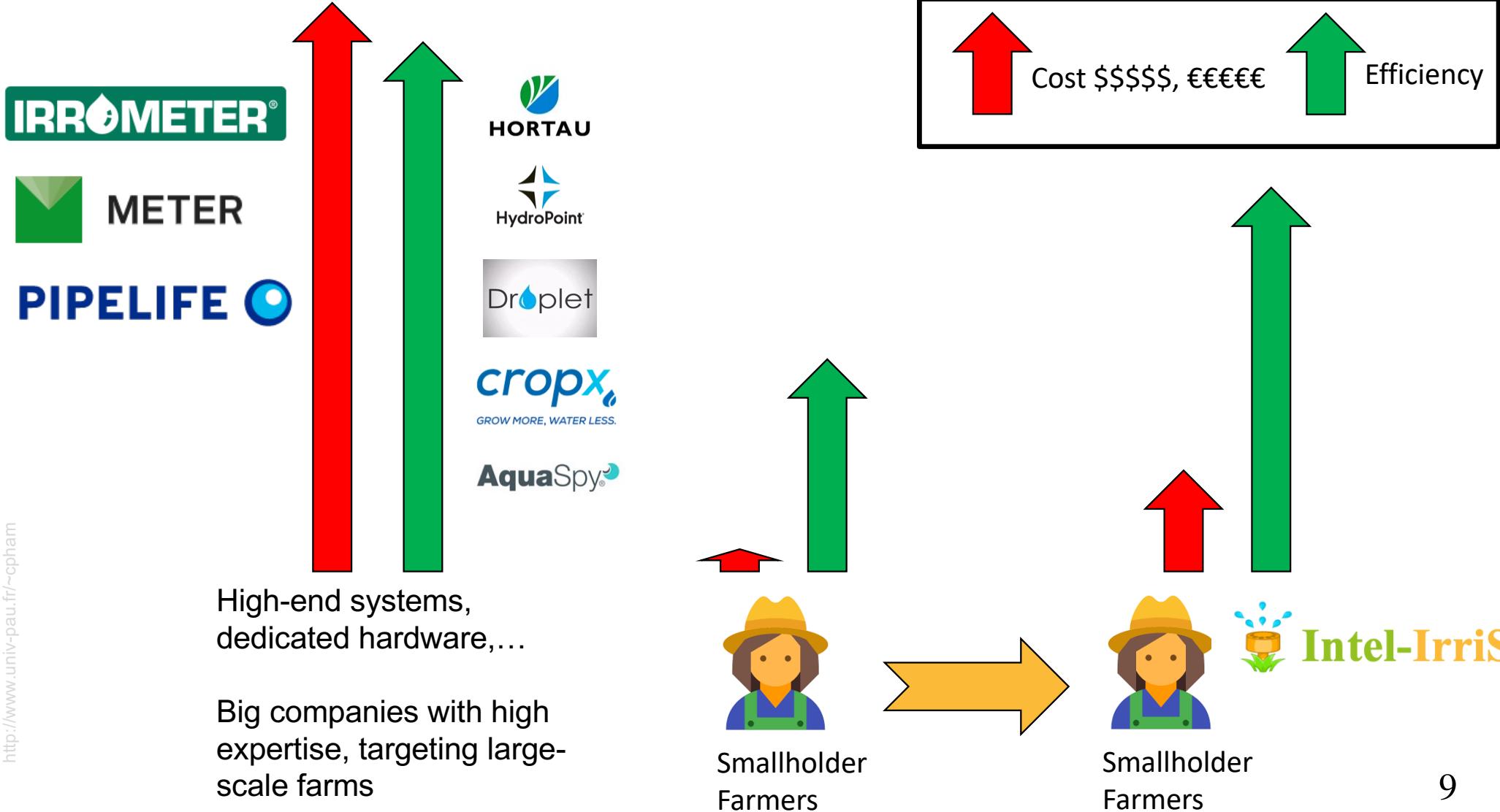
Evapotranspiration, soil-  
 plant-atmosphere  
 continuum,....

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

Plant/Crop varieties

Relationship with other  
 agriculture inputs

# It is always a tradeoff...



# Not only the cost barrier...



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

4

Improve farmer's knowledge on water-related issues, foster local adaptation of technologies, increase local innovation capacity and facilitate technology appropriation

5

Large-scale adoption of low cost smart irrigation system by smallholders, stimulating synergies between various local actors

# INTEL-IRRIS starter-kit

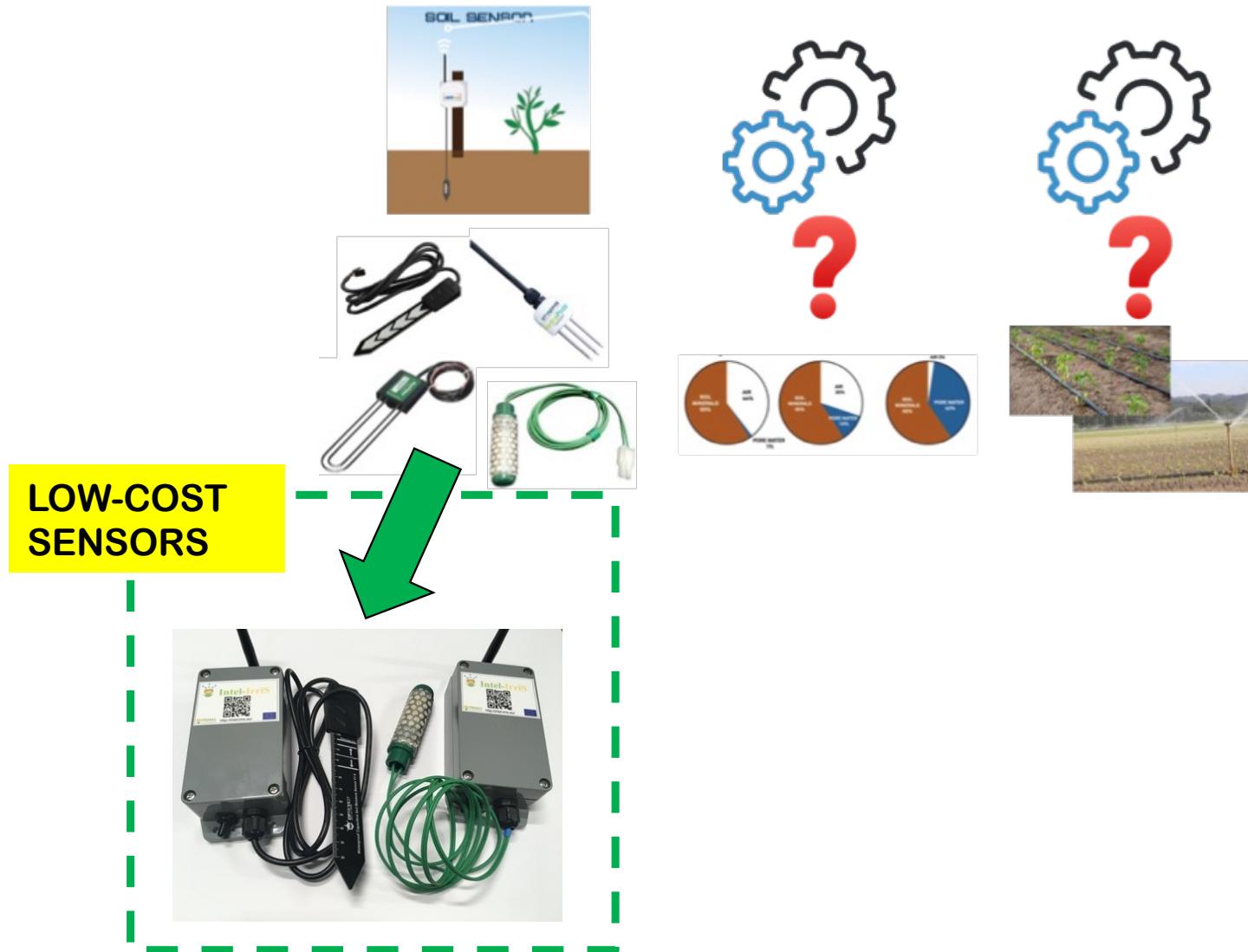
- At the beginning: **an idea...**
- "Intelligent Irrigation in-the-box", "plug-&-sense"



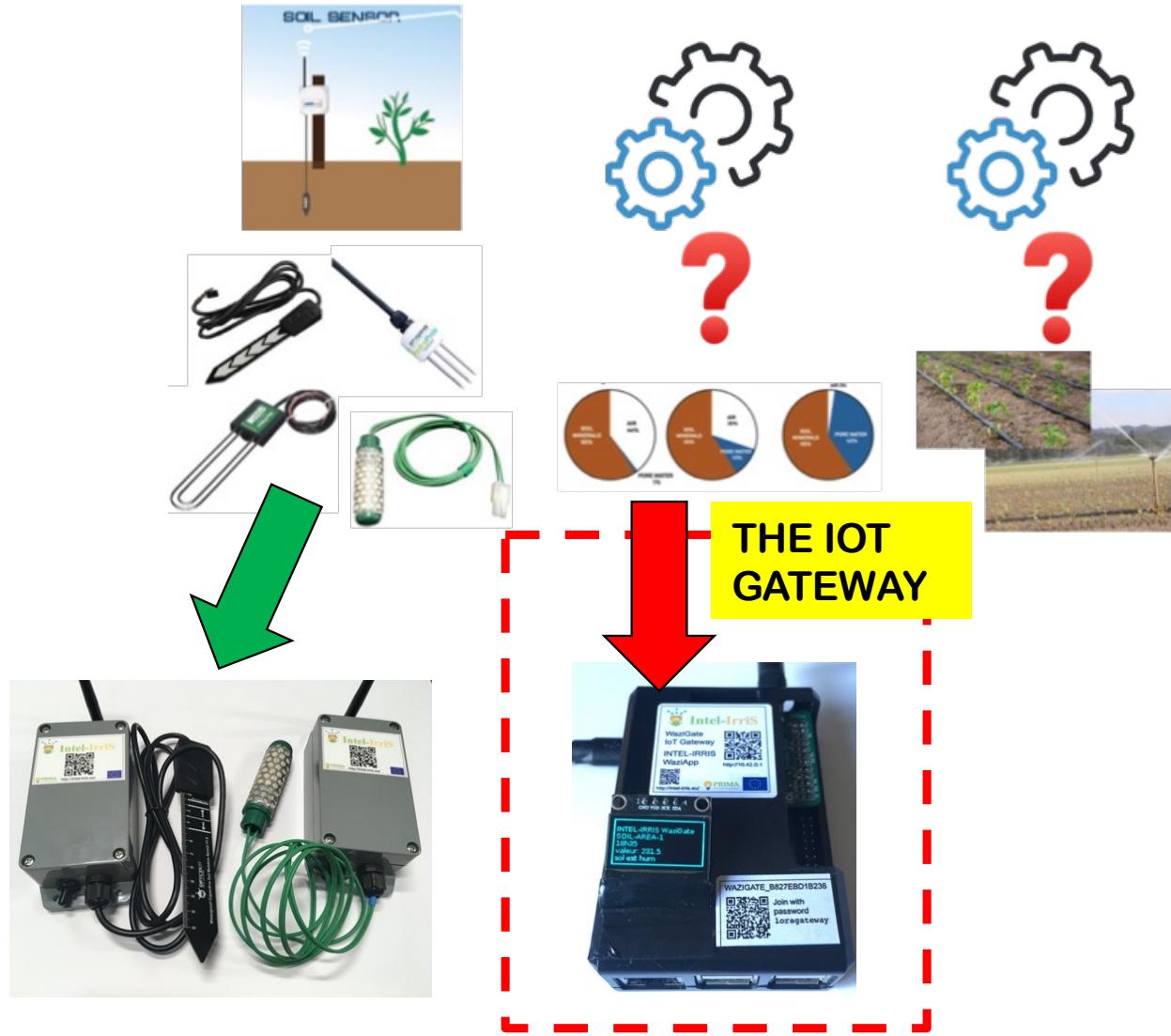
# 2 versions of the soil device



A soil temperature sensor can be added



# INTEL-IRRIS: gateway part



**نظام ري ذكي - النموذج الابتدائي - Intel-IrrIS**

عرض آخر قيمة تم الحصول عليها وحالة رطوبة التربة

INTEL-IRRIS Wazigate SOIL-AREA-1 0 mins valeur: 915 sol est très sec

SEN0308 capacitive sensor Watermark WM200 Water tension sensor

يتم تسليمها مع بوابة واحدة ومستشعر سعوي أو مقاييس رطوبة التربة

دالة الرطوبة

مرتوفي  
رطب  
رطب  
جاف  
جاف

Testing with capacitive device

INTEL-IRRIS Wazigate SOIL-AREA-1 0m30 valeur: 915 sol est très sec

Testing with tensiometer device

INTEL-IRRIS Wazigate SOIL-AREA-2 0m30 valeur: 34 sol sec-hum

SOL-AREA-1 915 0mins très sec

SOL-AREA-2 34 0mins sec-hum

اختر المزيد من الميزات مع تطبيق INTEL-IRRIS IRRIGATION WAZIGATE! الذي تم تثبيته على!

https://www.irrometer.com/basics.html#using

نطاق الري المعناد

-1 :		255 :	
بدون جهاز استشعار		بدون جهاز استشعار	
0 - 83	مرتوفي	0 - 10	مرتوفي
84 - 166	رطب	11 - 30	رطب
167 - 249	رطب	31 - 60	جاف
250 - 333	جاف	61 - 100	جاف
334 - 416	> 416	> 100	!

النموذج الابتدائي لا يزال في مرحلة التطوير والاختبار والتغذية. القيم المميتة هي إرشادية لمرحلة الاختبار.

لوحة العيادة التي تعرض بيانات المصنع الأصلية لأجهزة الاستشعار

ID b827eb6d21eb1c

http://10.42.0.1

PRIMA

SOIL-AREA-1 ID 639c34b368f3190904...

Soil Humidity Sensor Raw value from SEN0308 3 hours ago

Battery voltage volt, low battery when lower than 2.85V 3 hours ago

SOIL-AREA-2 ID 639c34b468f3190904...

Soil Humidity Sensor centbars from WM200 3 hours ago

Soil Humidity Sensor scaled value from WM200 realx10 3 hours ago

Soil Temperature Sensor degree Celsius 3 hours ago

Battery voltage volt, low battery when lower than 2.85V 3 hours ago

عرض آخر قيمة مستلمة وحالة رطوبة التربة

Testing with capacitive device

INTEL-IRRIS Wazigate SOIL-AREA-1 0m30 valeur: 915 pas de capteur!

Testing with tensiometer device

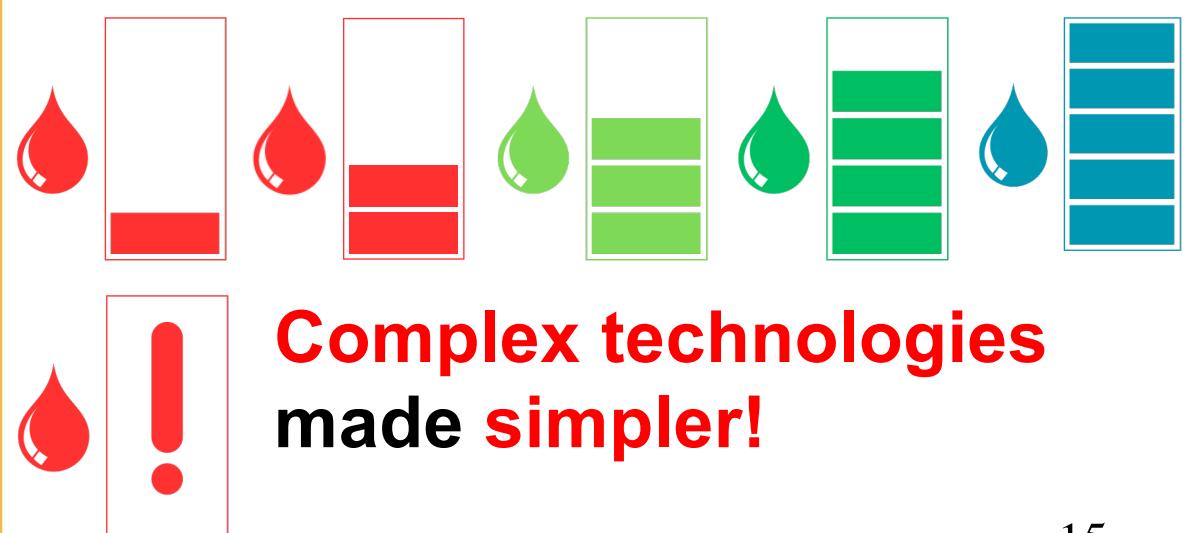
INTEL-IRRIS Wazigate SOIL-AREA-2 0m30 valeur: 34 pas de capteur!

SOL-AREA-1 915 0mins très sec

SOL-AREA-2 34 0mins sec-hum

اختر المزيد من الميزات مع تطبيق INTEL-IRRIS IRRIGATION WAZIGATE! الذي تم تثبيته على!

10.42.0.1:5000



**Complex technologies made simpler!**

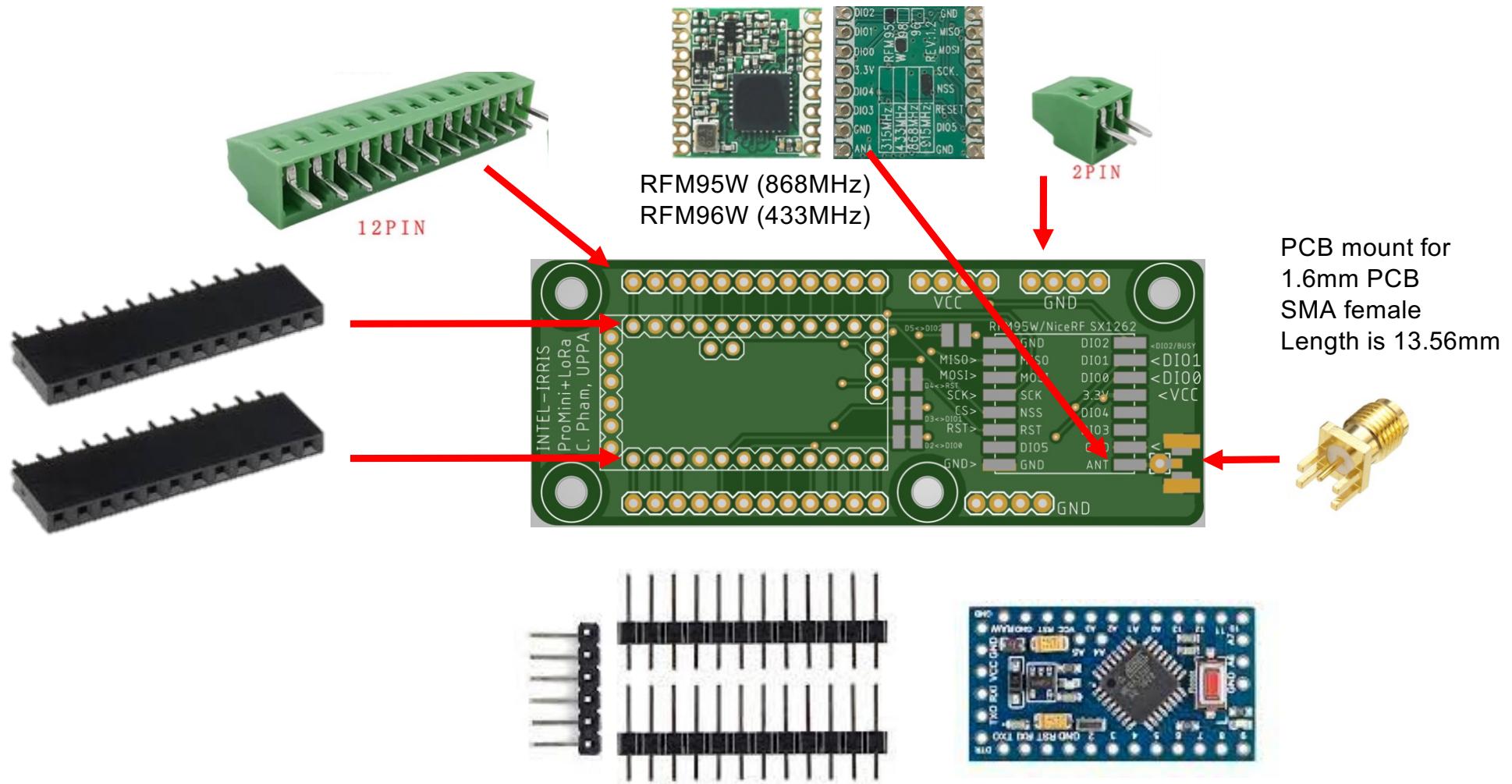
A close-up photograph of a young green plant with several leaves and a thin stem, growing out of dark brown soil. The background is slightly blurred.

# INTEL-IRRIS

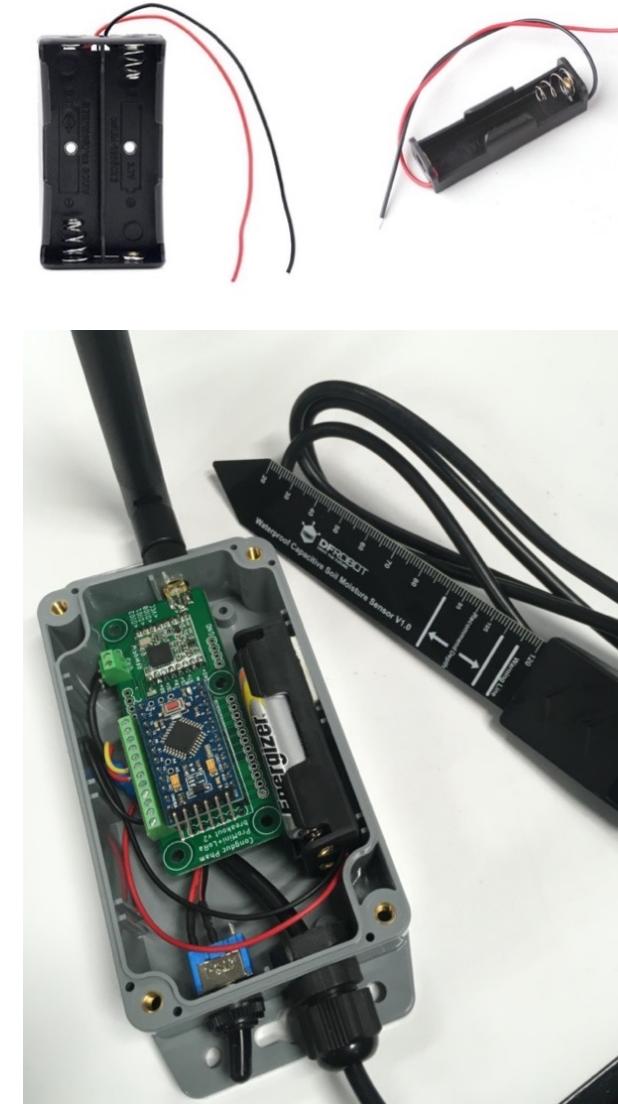
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LOW-COST?

# Soil sensor: simple electronic parts

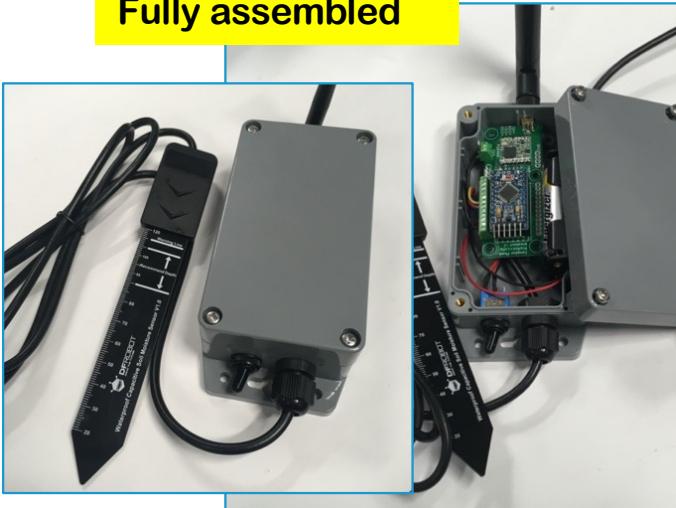


# Soil sensor: easy integration



# Starter-kit...in kit!

Fully assembled



Packaging in enclosure



To be assembled

# A generic platform

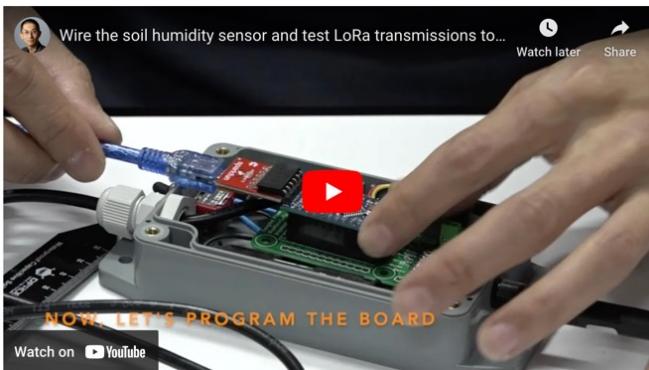
- Low-cost: < 20€
- Off-the-shelves composants
- Easily duplicated
- Assembling by local partners
- Can connect several sensors
- Can be further adapted by local partners

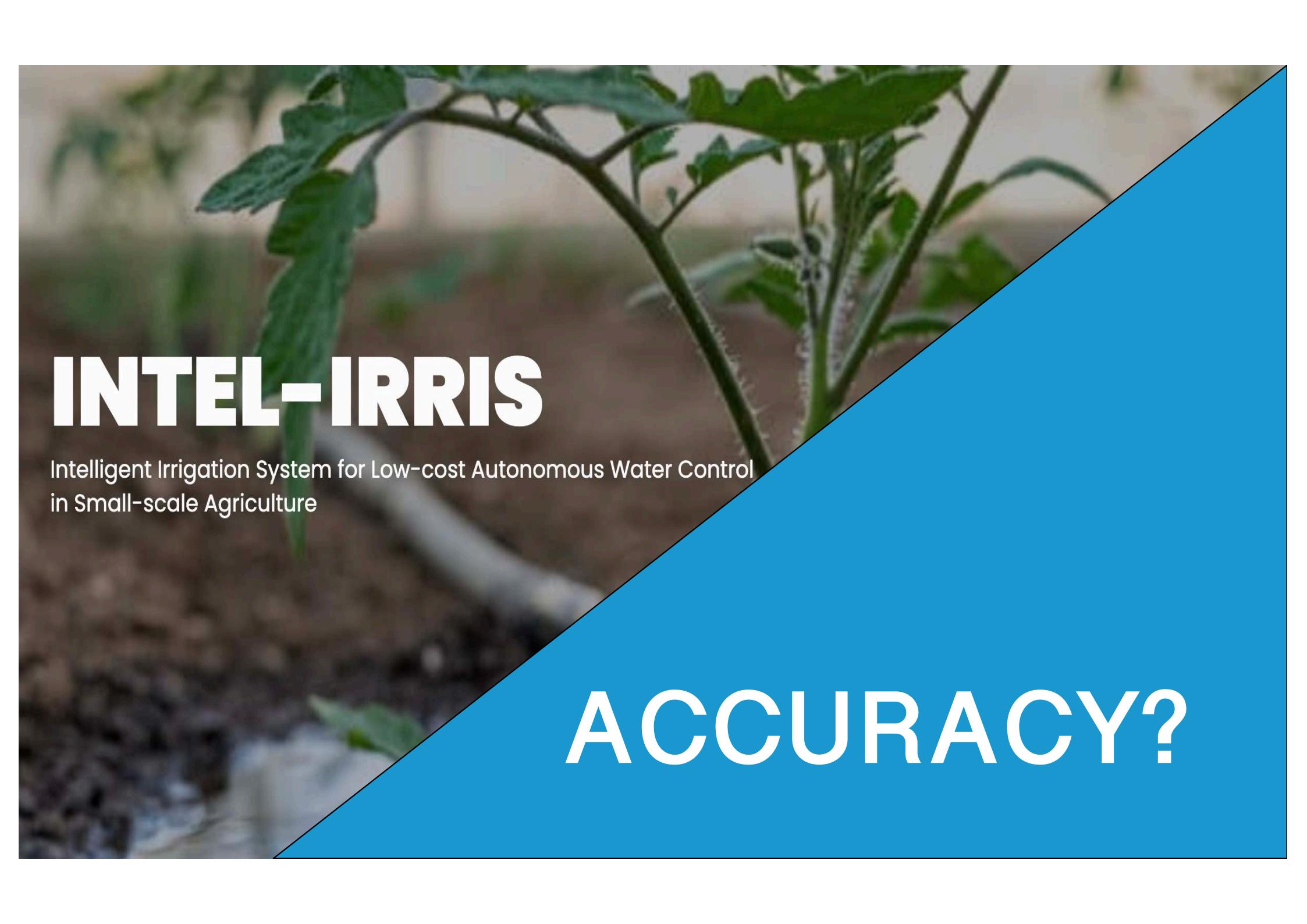


# Available tutorials

- Instructional videos provide technical information for local partners to build locally the soil sensor devices

<https://intel-irris.eu/tutorials-slides>



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.

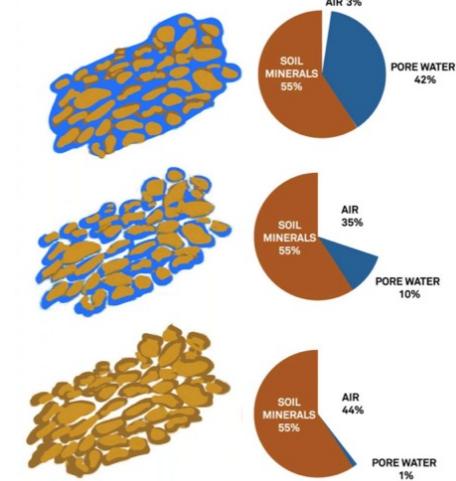
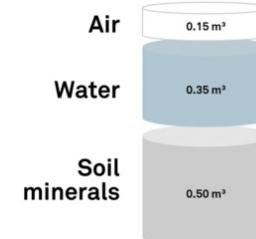
# INTEL-IRRIS

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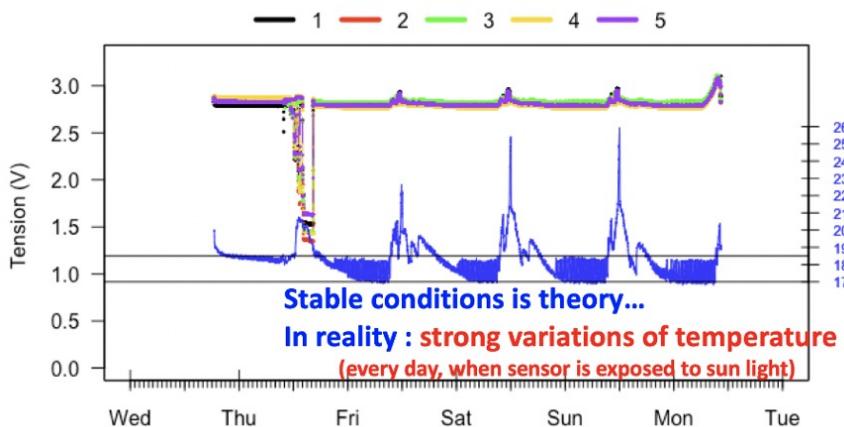
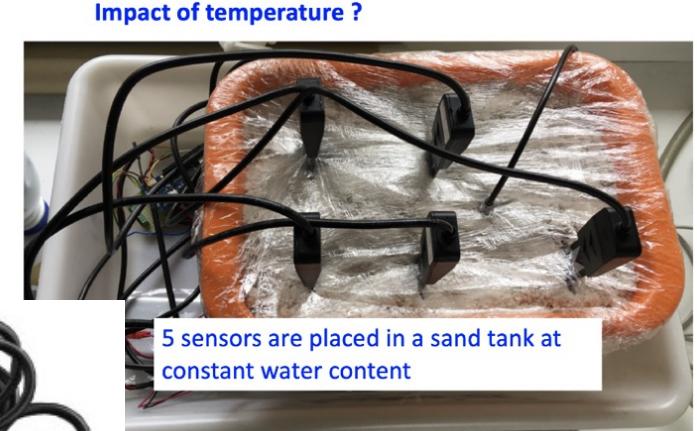
# ACCURACY?

# Capacitive sensor

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



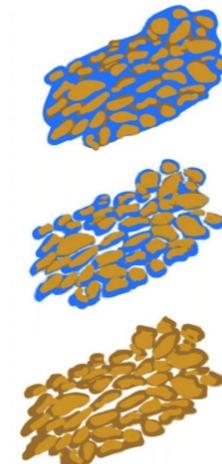
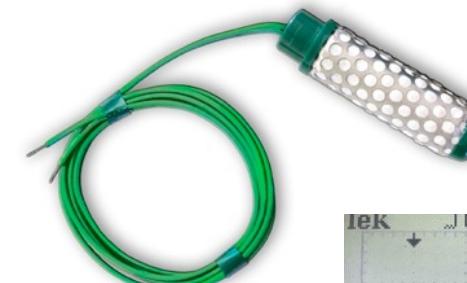
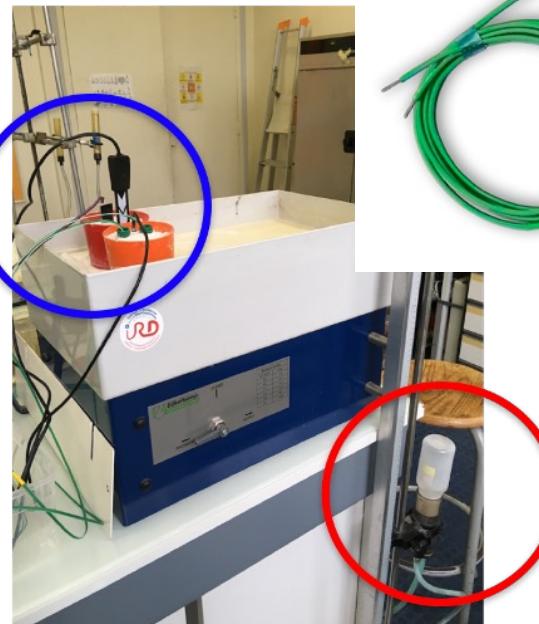
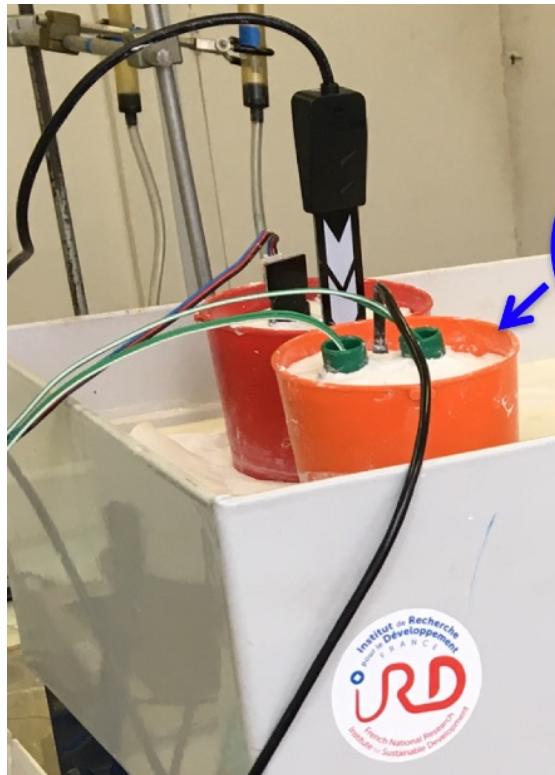
From METER group



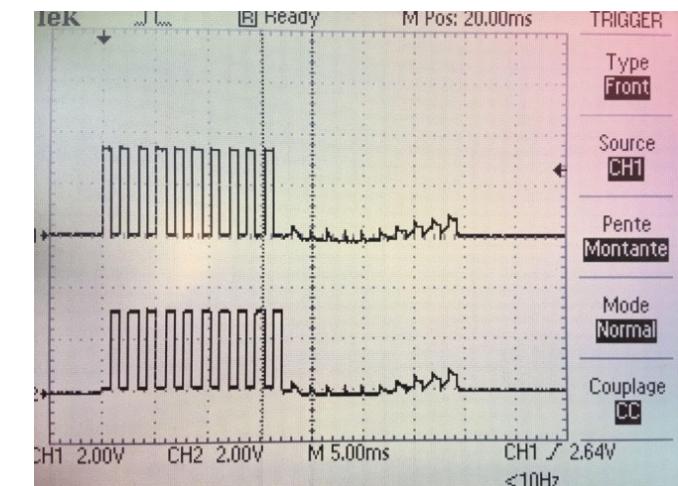
IRD in conducting extentise test on the accucary and the stability of the low-cost SEN0308 capacitive sensor    23

# Water tension sensor

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



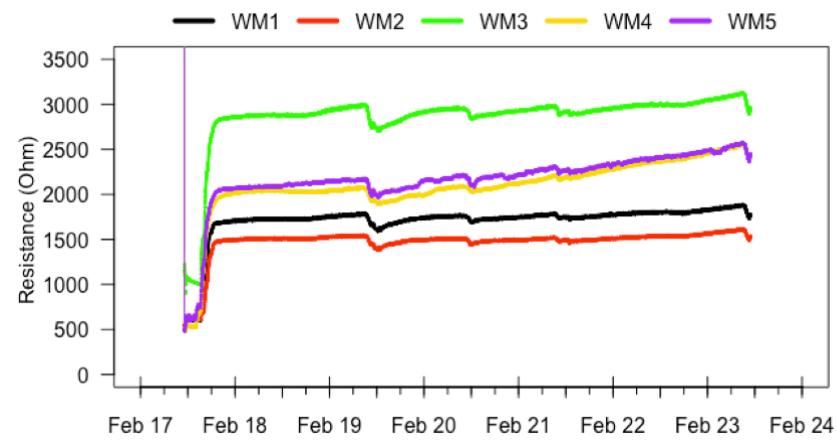
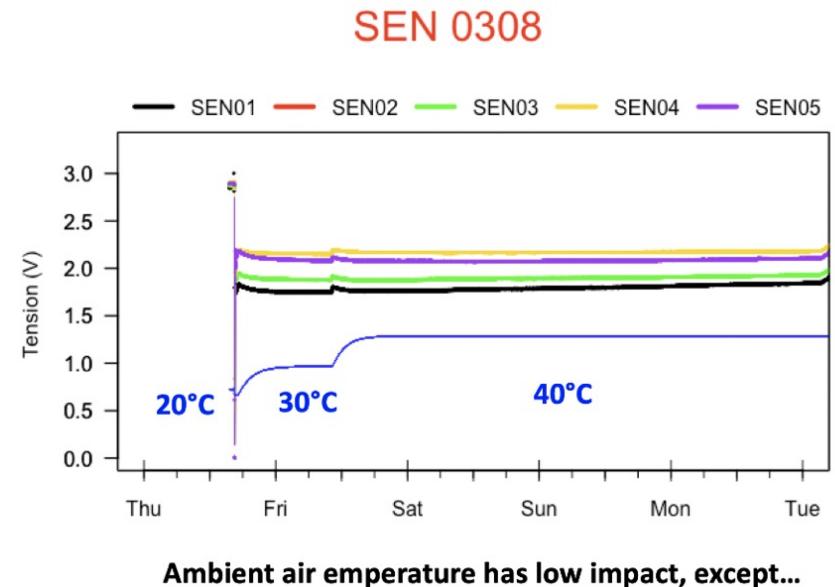
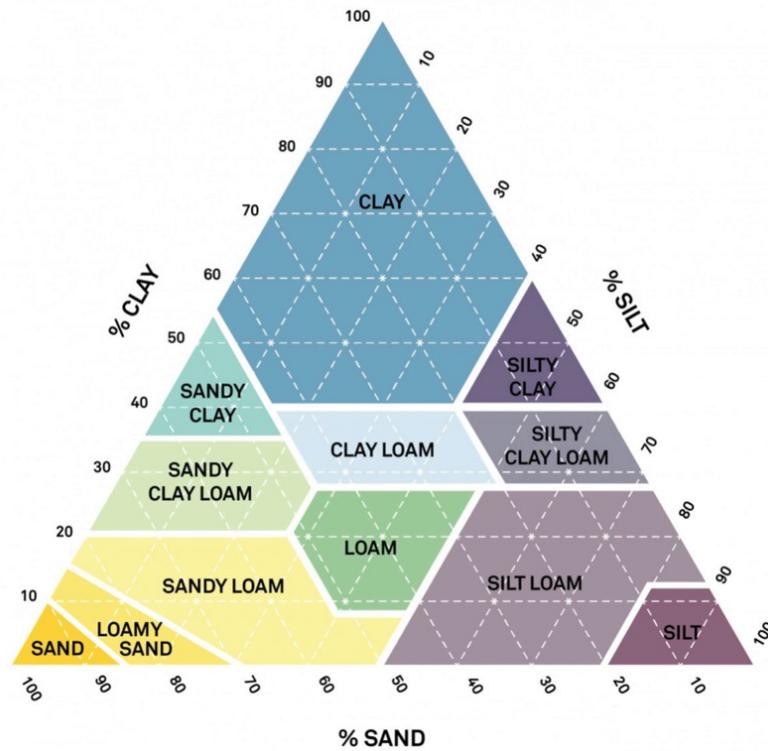
From METER group

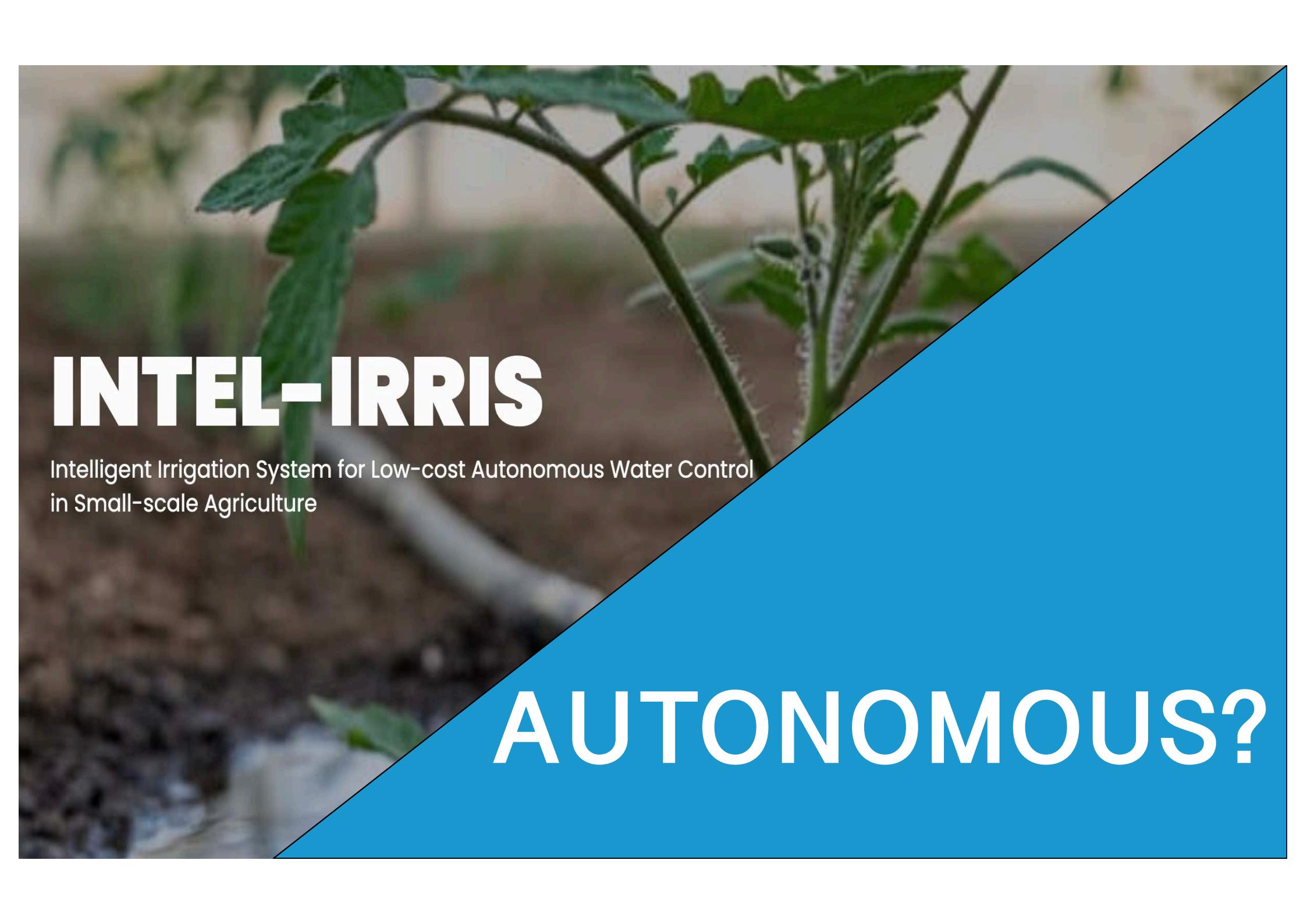


IRD in conducting extensive tests on the stability & suitability of microcontroller-based usage of the Watermark water tension sensor

# Calibration

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



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

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in Small-scale Agriculture

# AUTONOMOUS?

# Gateway: collect sensor data

WAZIGATE GATEWAY

FULL EDGE-COMPUTING  
 (NO INTERNET)

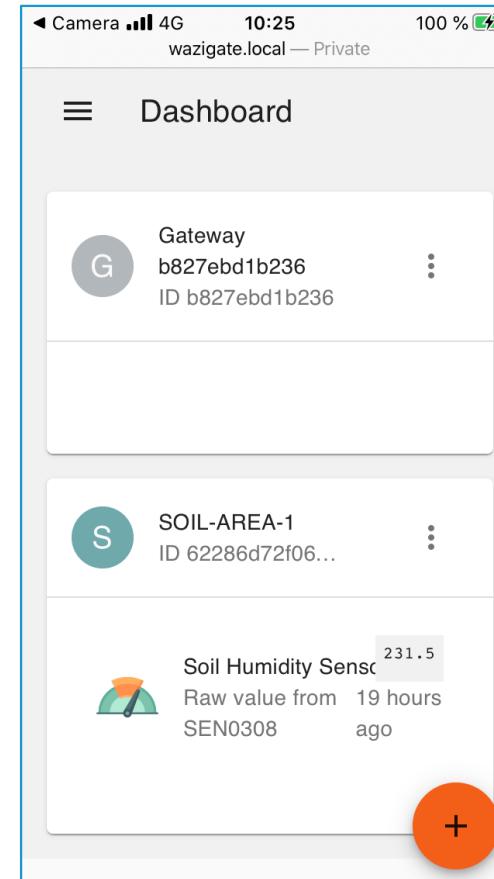
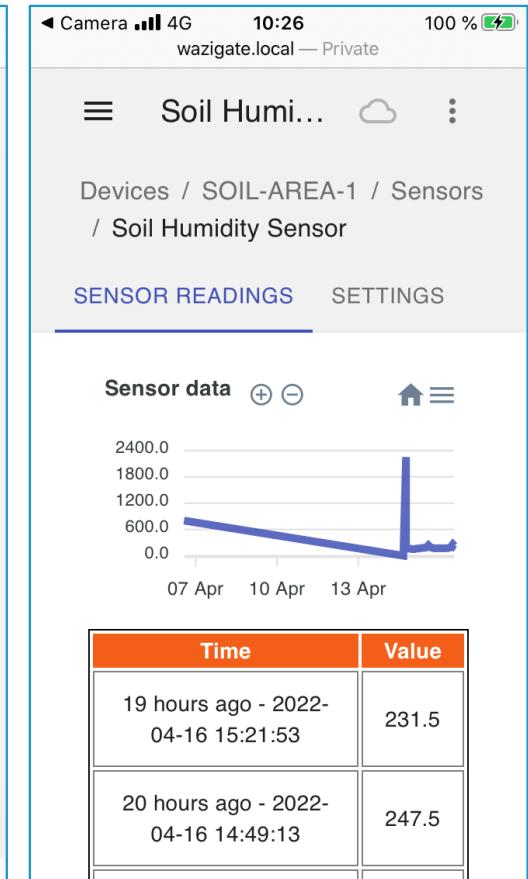
ALL DATA PROCESSING  
 CAN BE DONE LOCALLY



1 GATEWAY HANDLES  
 SEVERAL DEVICES

< 50€

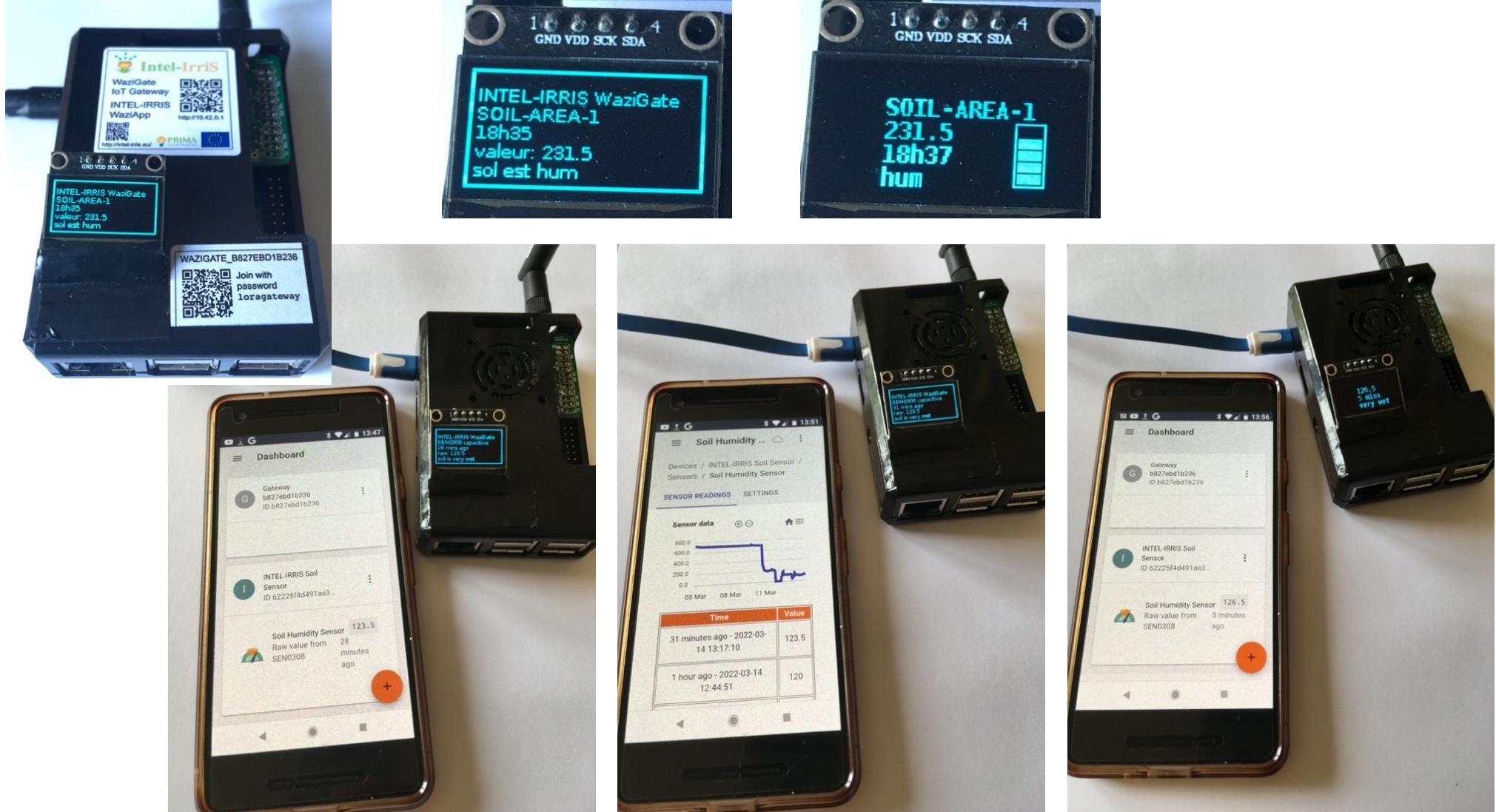
EMBEDDED WEB INTERFACE

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

ACCESSED FROM A SMARTPHONE

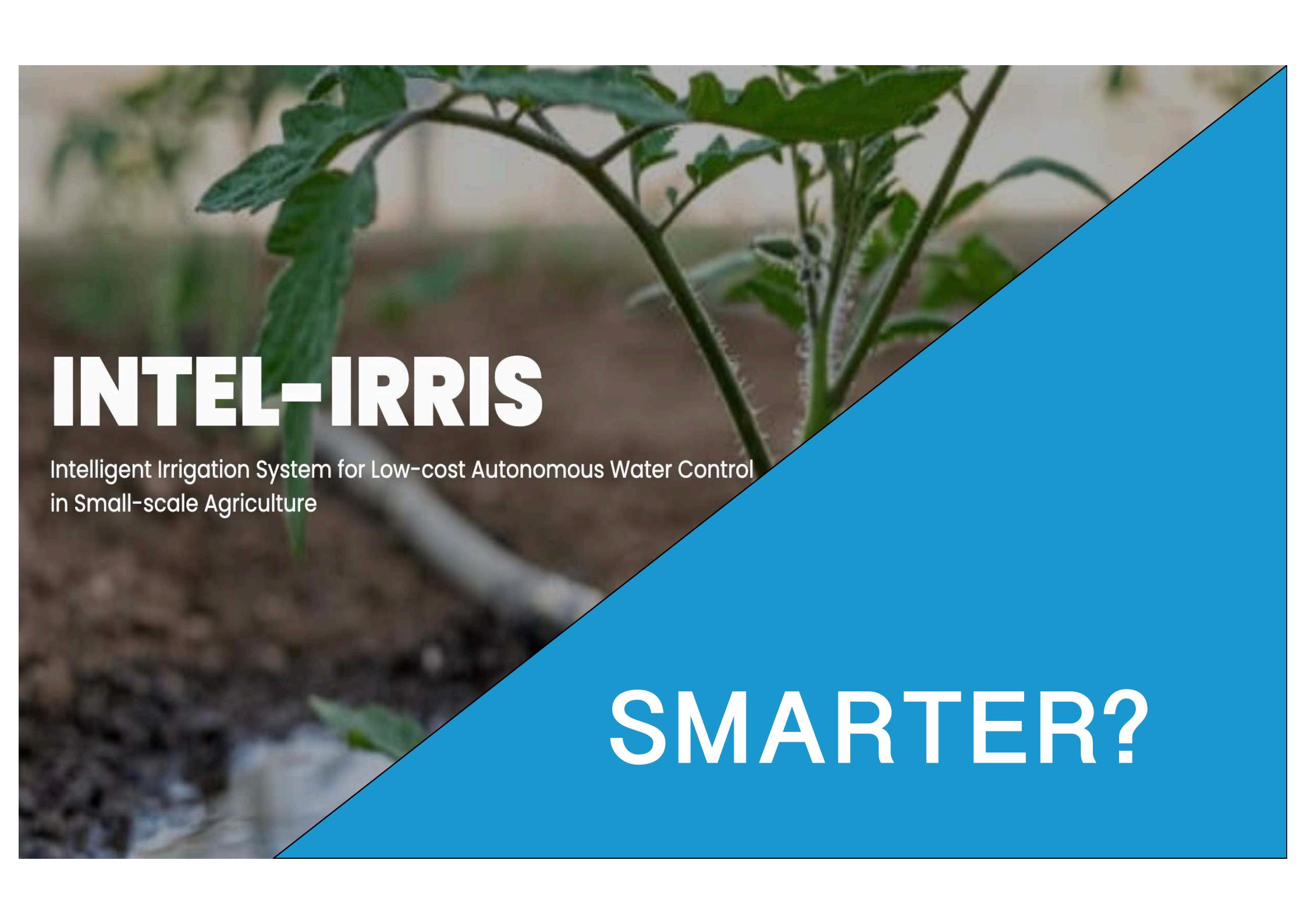
# Multiple user interfaces



# INTEL-IRRIS starter-kit

- "Intelligent Irrigation in-the-box", "plug-&-sense"
- From idea to reality!



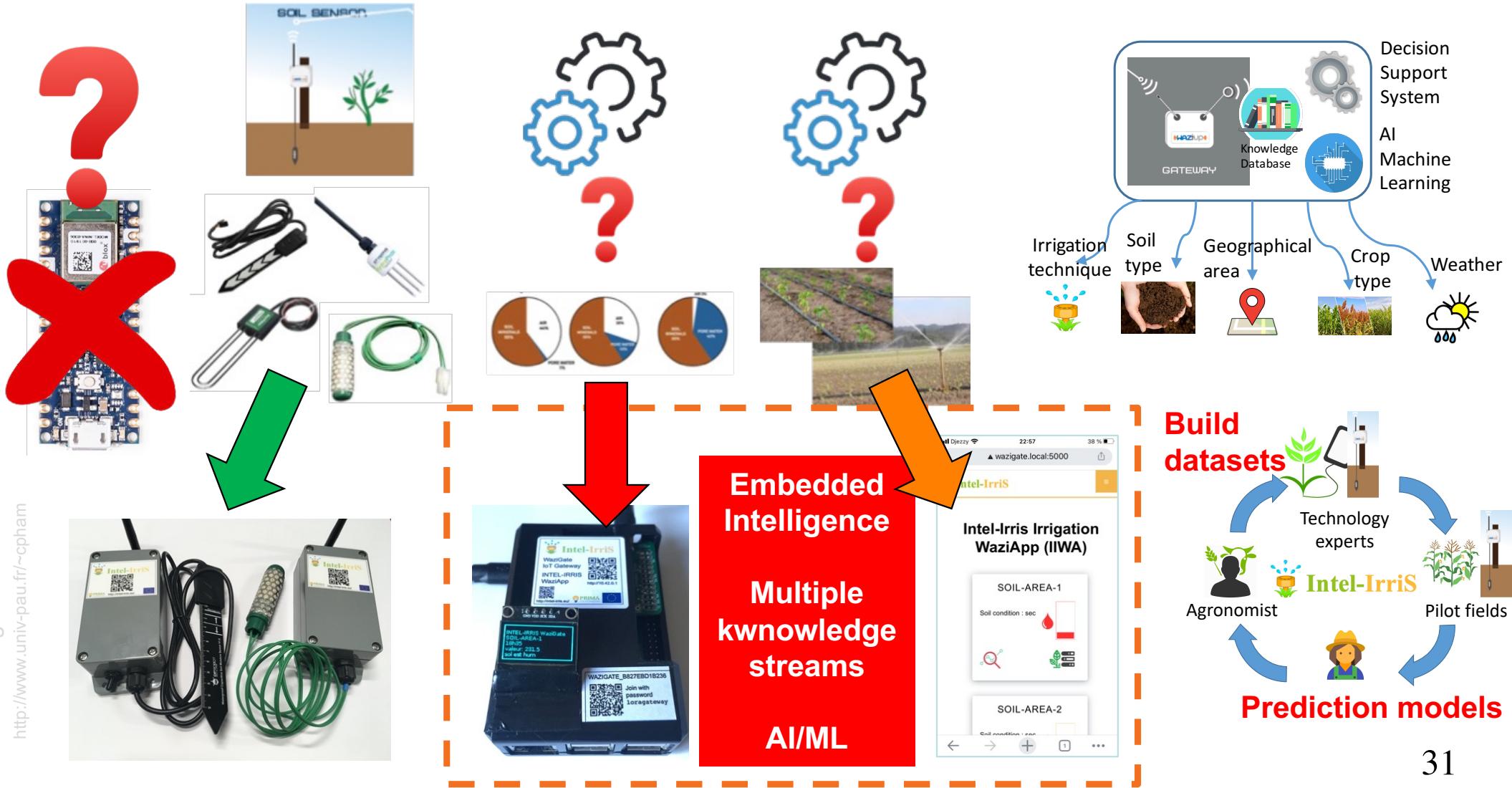
A close-up photograph of a green plant with several leaves and a thin stem. In the background, a white, ribbed irrigation tube or pipe is visible, suggesting a smart irrigation system. The image has a shallow depth of field, focusing on the plant in the foreground.

# INTEL-IRRIS

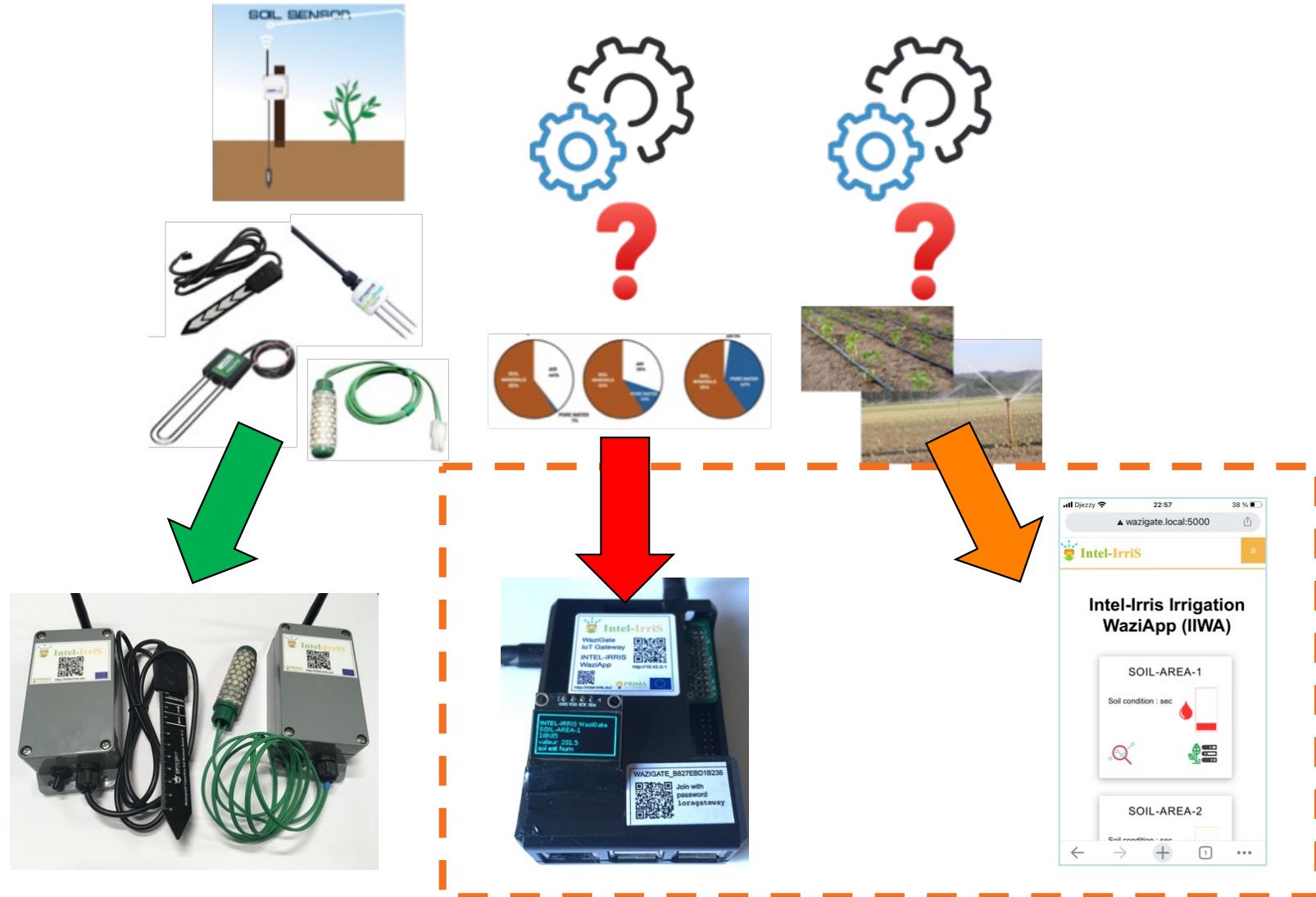
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SMARTER?

# Embedding intelligence

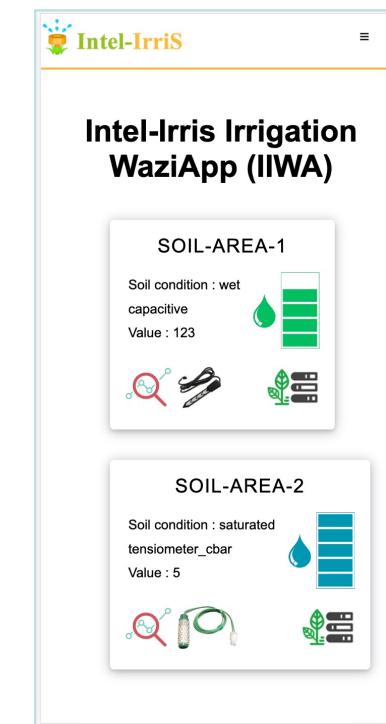


# INTEL-IRRIS Irrigation WaziApp



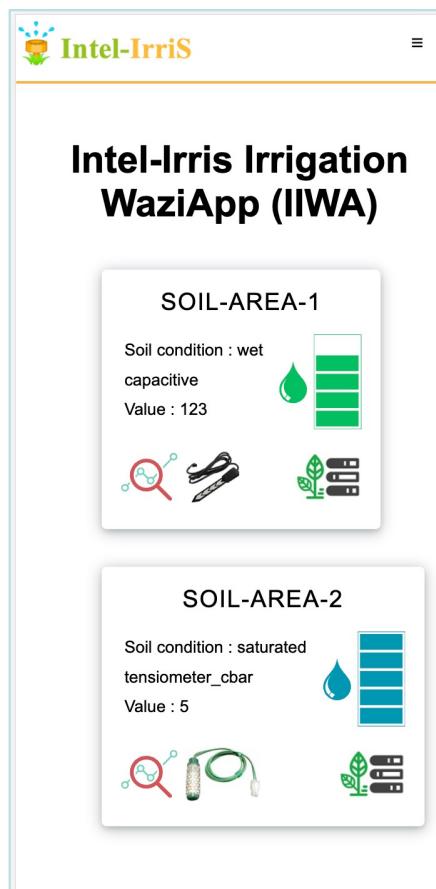
# INTEL-IRRIS Irrigation WaziApp

- Embedded application running on the INTEL-IRRIS WaziGate
- Included in the starter-kit to implement the "**intelligent Irrigation in-the-box**" & "**plug-&-sense**" approach
- Enhances the irrigation indication by applying sensor calibration models with soil/plant/weather parameters

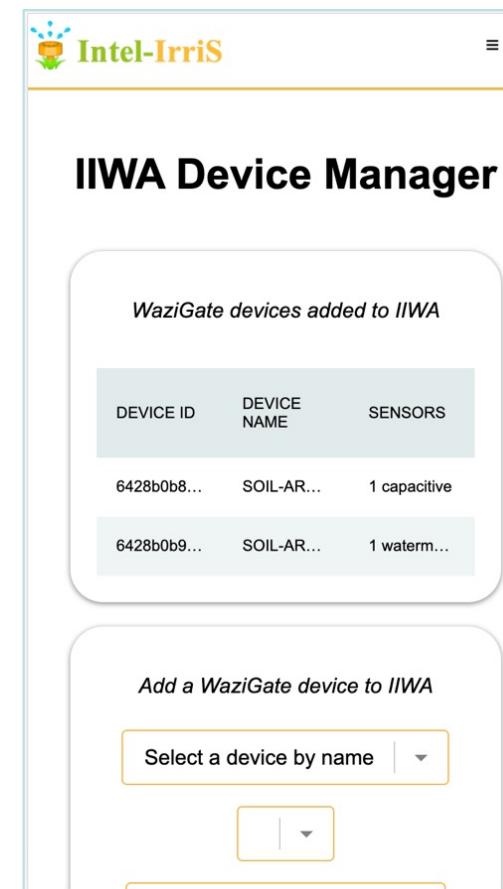


# IIWA main screens

- Dashboard, Device Manager and Sensor Configuration



Dashboard



**IIWA Device Manager**

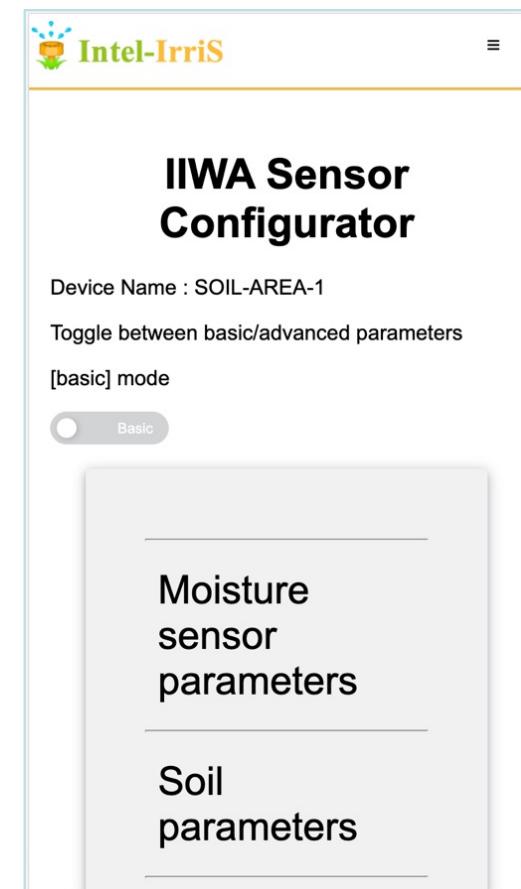
*WaziGate devices added to IIWA*

DEVICE ID	DEVICE NAME	SENSORS
6428b0b8...	SOIL-AR...	1 capacitive
6428b0b9...	SOIL-AR...	1 waterm...

**Add a WaziGate device to IIWA**

Select a device by name

Device Manager



**IIWA Sensor Configurator**

Device Name : SOIL-AREA-1

Toggle between basic/advanced parameters

[basic] mode

Basic

---

**Moisture sensor parameters**

---

**Soil parameters**

Sensor Configuration

# List of advanced parameters

Basic

## 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

- Submergence
- 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

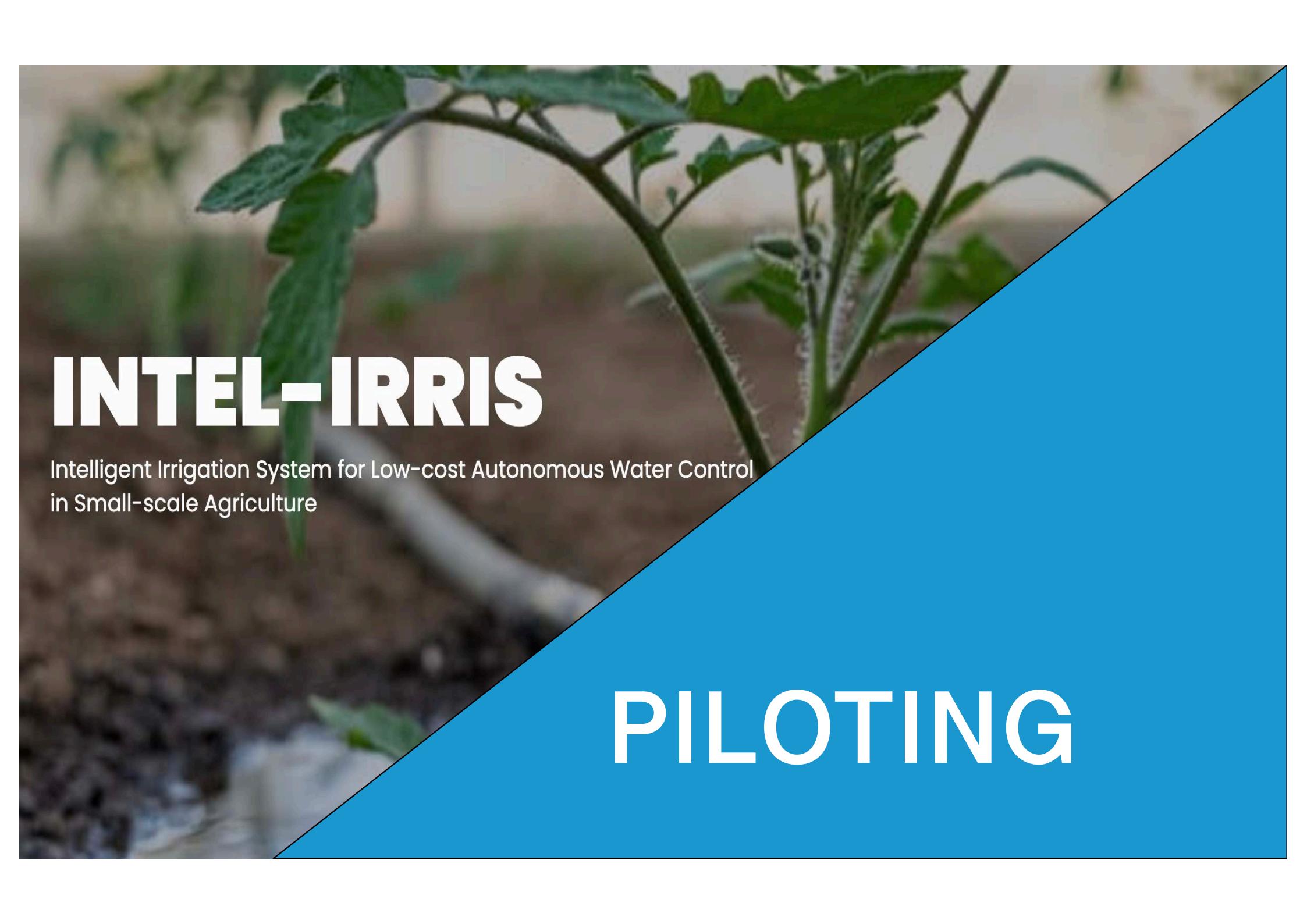
## Moisture sensor parameters

## Weather parameters

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

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

Save configuration



# **INTEL-IRRIS**

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# **PILOTING**

# Smallholder Piloting Program

- Participatory approach to co-design & test the innovative solutions in fields
- Take into account region-dependent technical, agricultural, social, climatic and environmental aspects
- Runs for 24 months to ensure that the proposed irrigation systems are well tailored for the specificities of the regional context
- 13 farms already enrolled to participate in the Piloting Program



Bousfer farm, Algeria



UMAB farm #1, Algeria



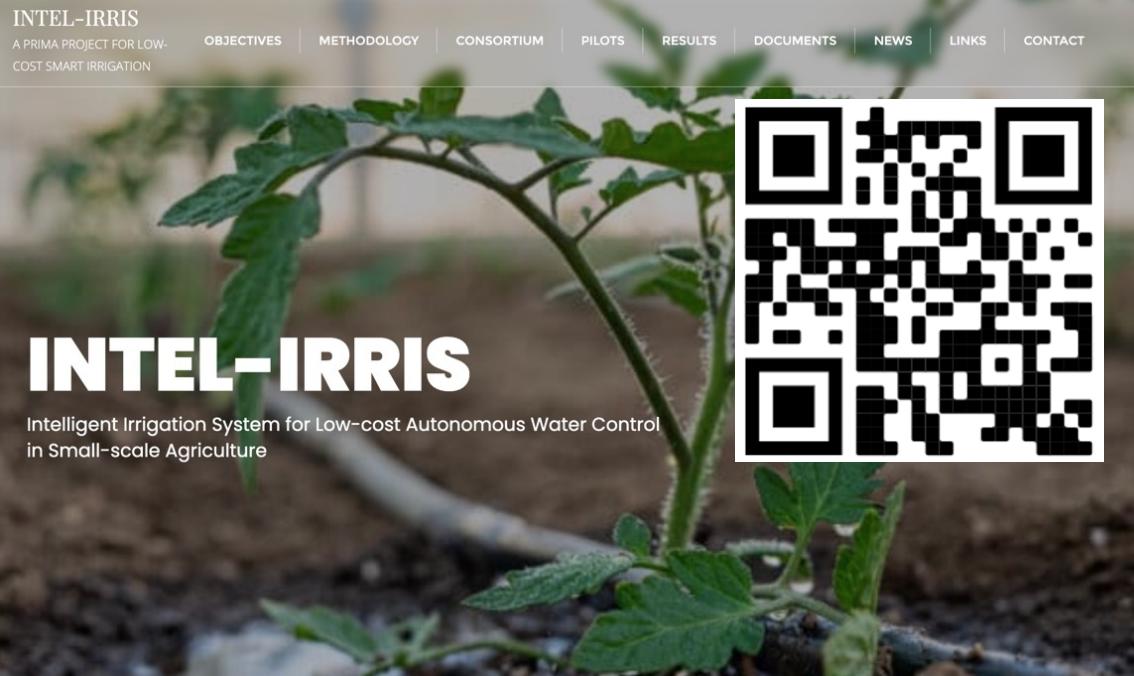
INRA farm #1, Morocco



INRA farm #2, Morocco

# More information

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



The screenshot shows the INTEL-IRRIS website homepage. The 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. Overlaid on the image is the text "INTEL-IRRIS" in large white letters, followed by a subtitle "Intelligent Irrigation System for Low-cost Autonomous Water Control in Small-scale Agriculture". To the right of the image is a large QR code.

**INTEL-IRRIS**  
A PRIMA PROJECT FOR LOW-COST SMART IRRIGATION

INTEL-IRRIS

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

QR code

**AUA:**  
Agricultural University of Athens  
 100<sup>th</sup> Anniversary  
TECHNICO HANSEATICUM ATHENIENSIS  
AGRICULTURAL UNIVERSITY OF ATHENS  
 Greece

**ENSA-Safi:**  
National School of Applied Sciences – Safi  
 ENSA Safi  
 Morocco

**INRA:** National Institute of Agronomic Research  
 INRA  
 Morocco

**IRD:** Institute for Research & Development  
 IRD  
 France

**UMAB:**  
University A. Benbadis  
 UNIVERSITE A. BENBADIS  
MÉTACADEMIE  
 Algeria

**UORAN1:**  
University of Oran 1  
 Université d'Oran 1  
 Algeria

**UPPA:**  
University of Pau & Adour Country  
 UPPA  
UNIVERSITÉ DE PAU ET DES PAYS DE L'ADOUR  
coordinator  
 France

**WAZIUP eV:**  
WAZIUP association  
 WAZIUP  
 Germany

- Twitter: [@Intel\\_Irris](https://twitter.com/Intel_Irris)



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

