

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>

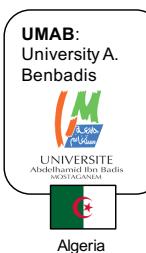


Intel-IrriS **RESICOOLINK**
Advanced and disruptive IoT/AI technologies targeting the smallholder community for increased resilience

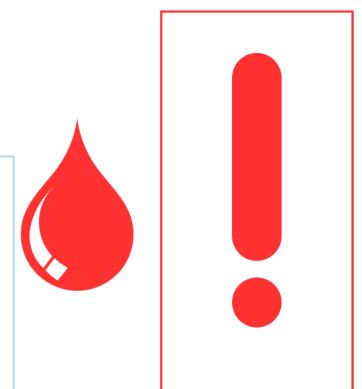
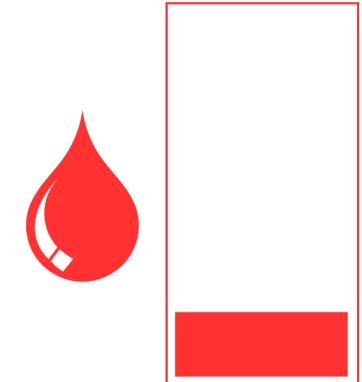
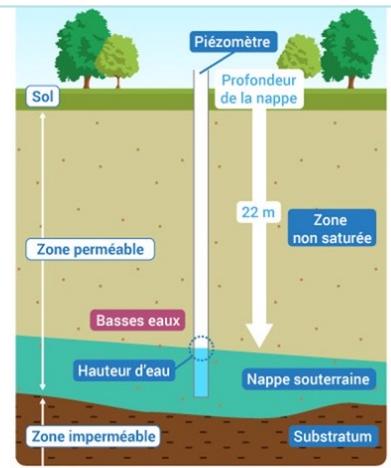
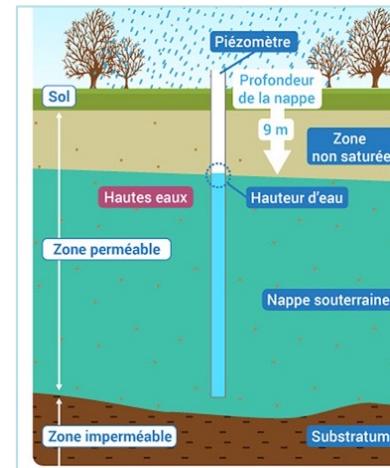
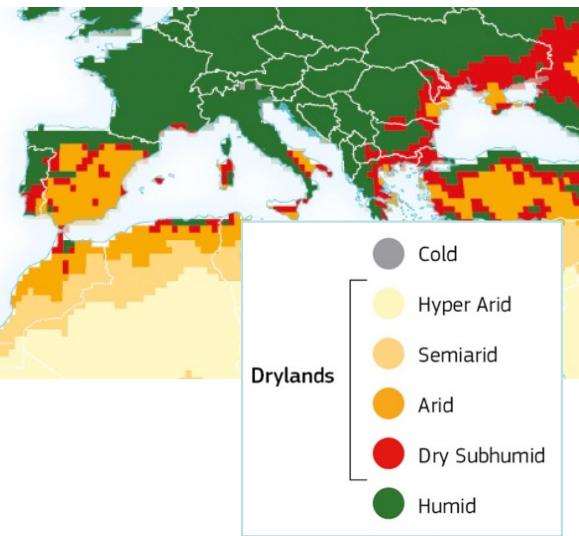
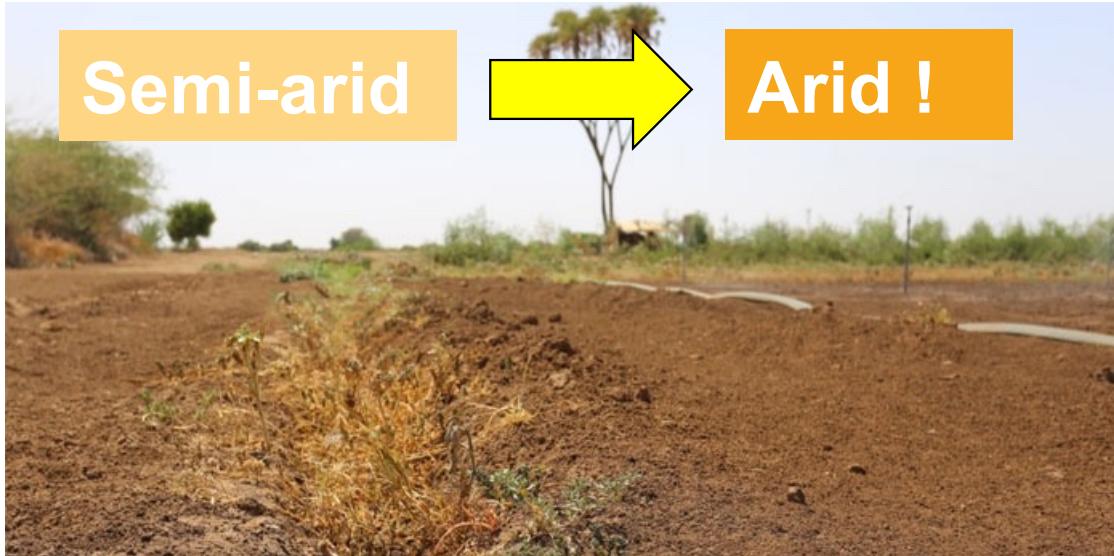
PRIMA S2 2020 INTEL-IRRIS

- 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...**



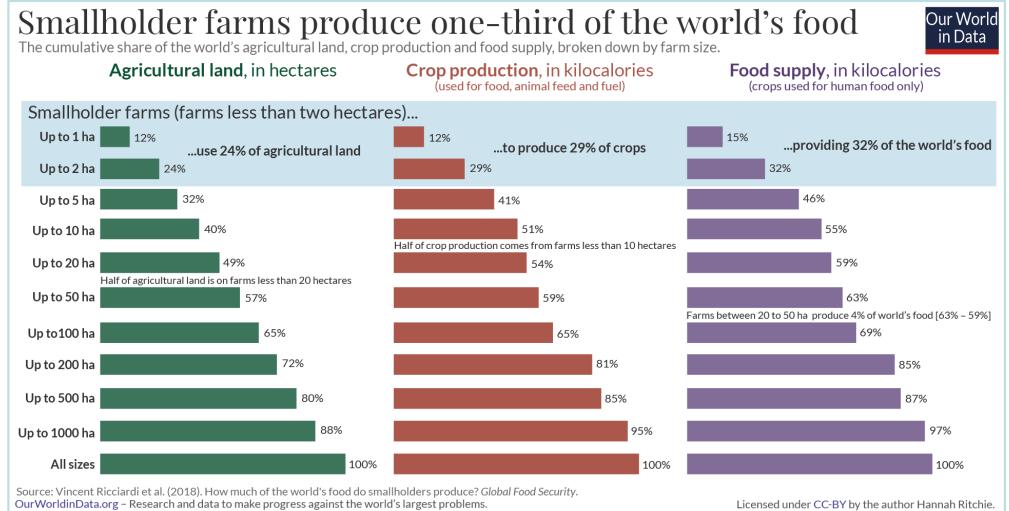
Possible for large farms



**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

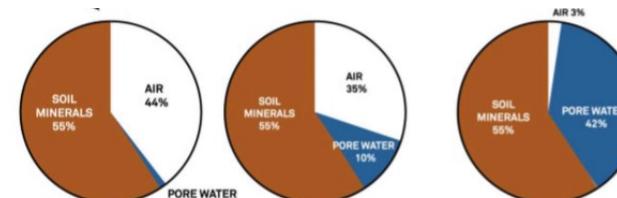
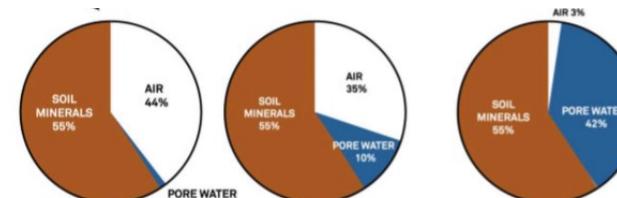
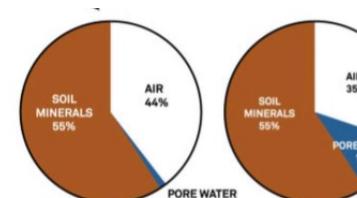
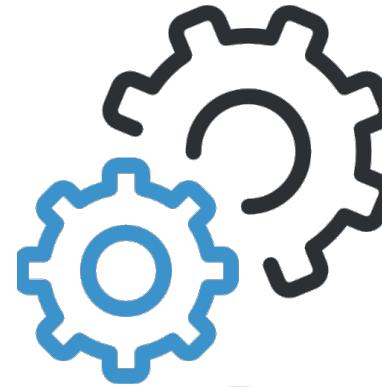
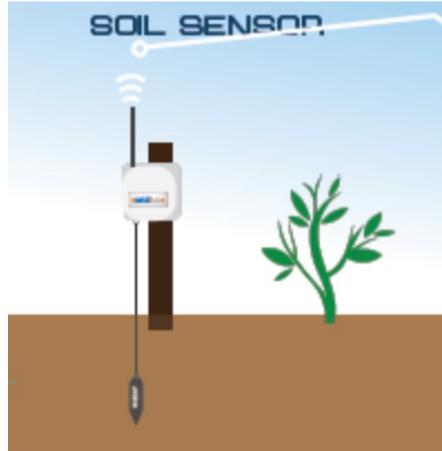


<https://ourworldindata.org/smallholder-food-production>

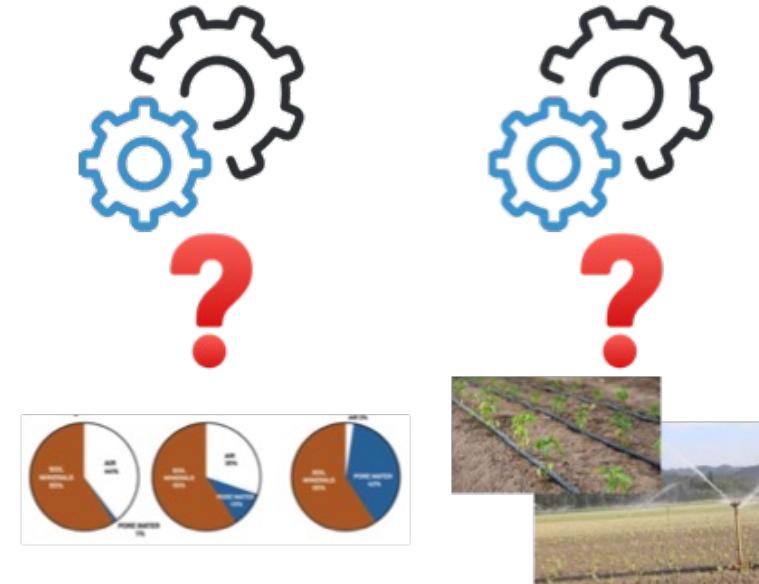


Too expensive
 Too integrated
 Highly specialized
 Difficult to customize
 Difficult to upgrade

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

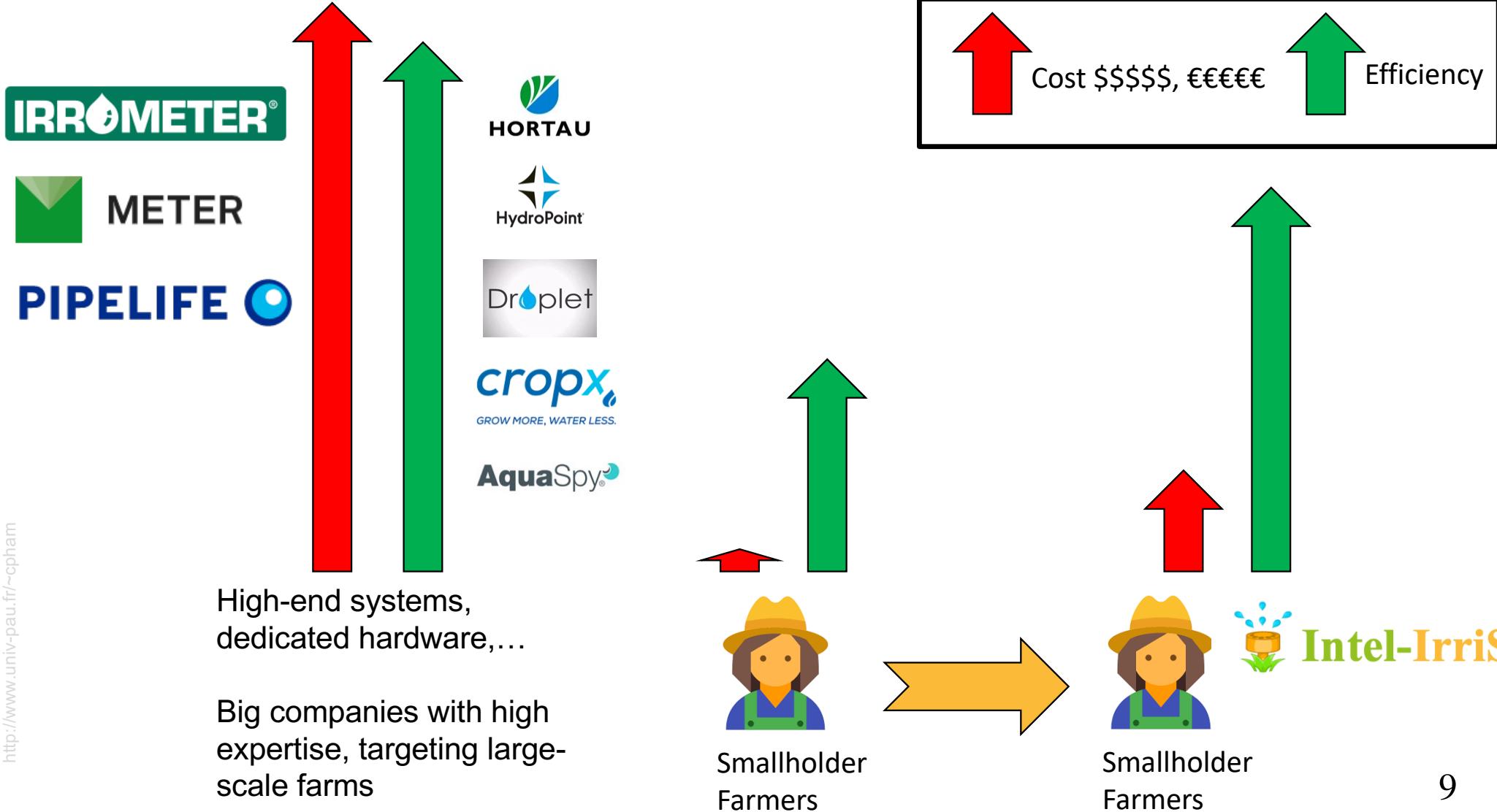
Evapotranspiration, soil-
plant-atmosphere
continuum,....

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

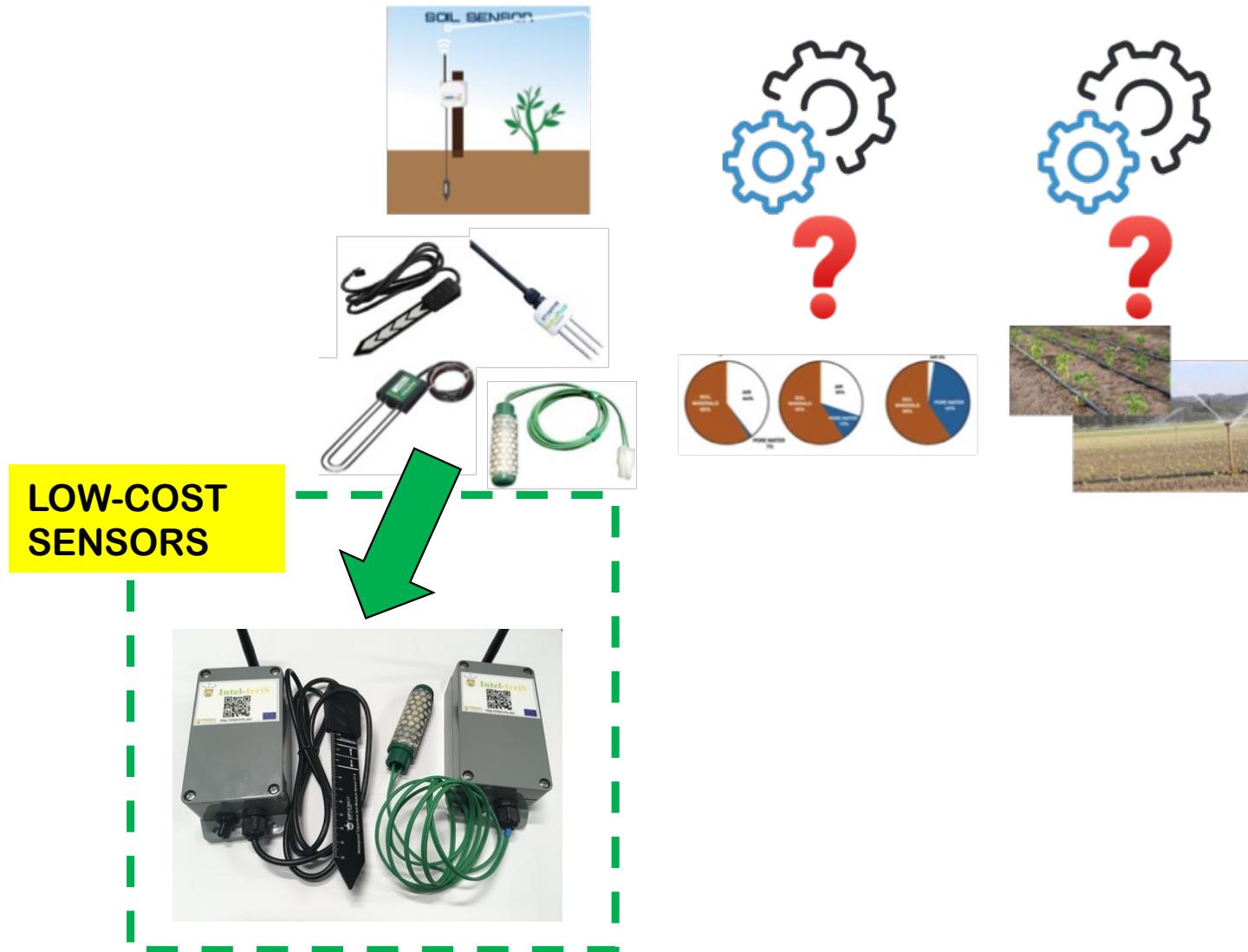
- At the beginning: **an idea...**
- "Intelligent Irrigation in-the-box", "plug-&-sense"



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 0m00 valeur: 915 sol est très sec

Testing with tensiometer device

INTEL-IRRIS Wazigate SOIL-AREA-2 0m00 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 والتغليف. 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 0m00 valeur: 915 pas de capteur!

Testing with tensiometer device

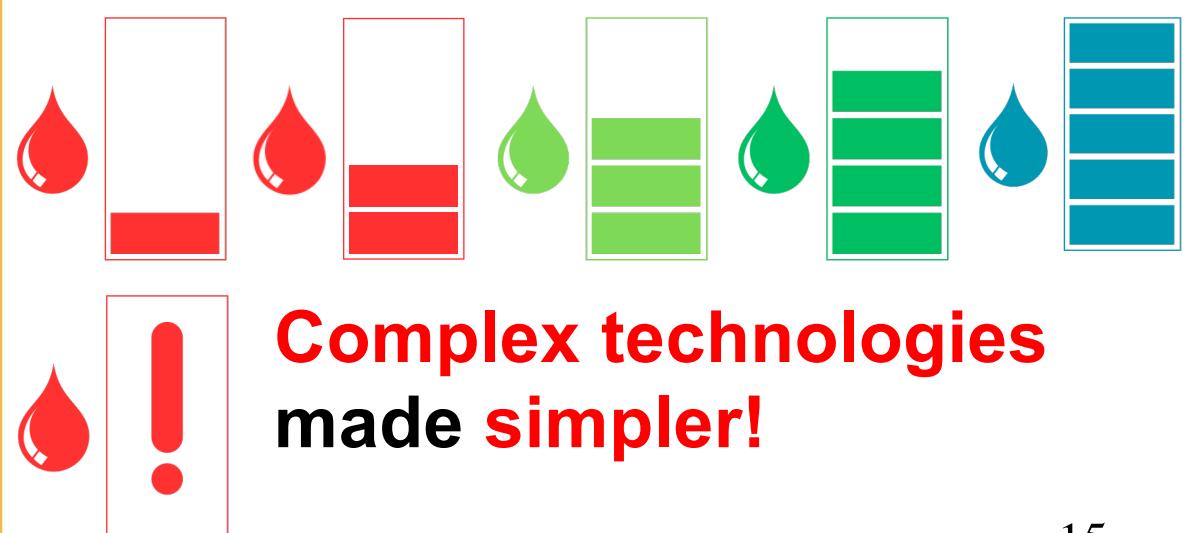
INTEL-IRRIS Wazigate SOIL-AREA-2 0m00 valeur: 34 pas de capteur!

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



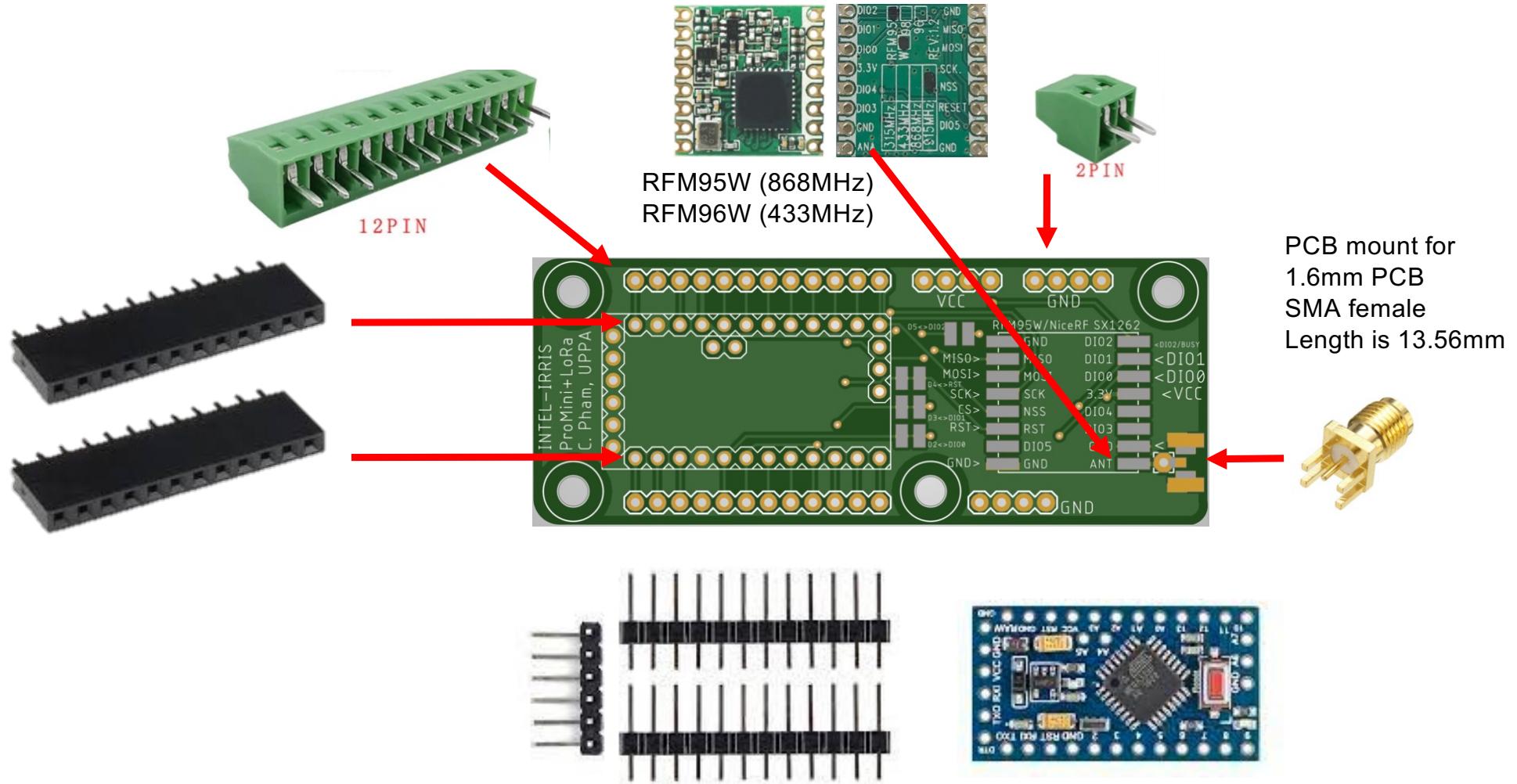
A close-up photograph of a young green plant with several leaves and a thin stem, growing out of dark brown soil. The background is slightly blurred.

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LOW-COST?

Soil sensor: simple electronic parts

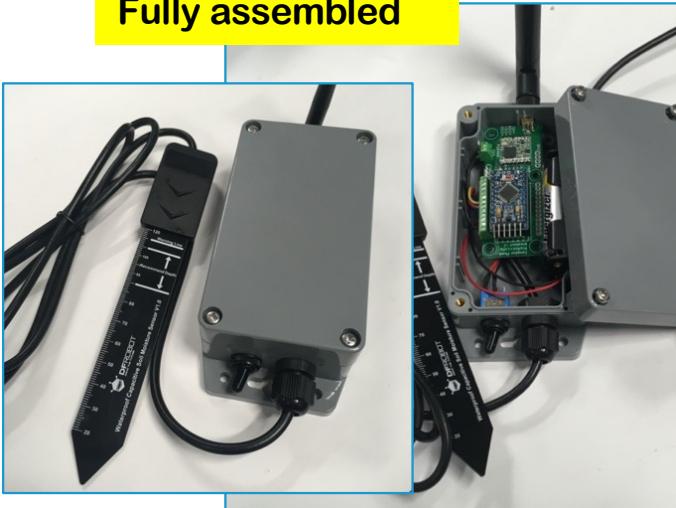


Soil sensor: easy integration

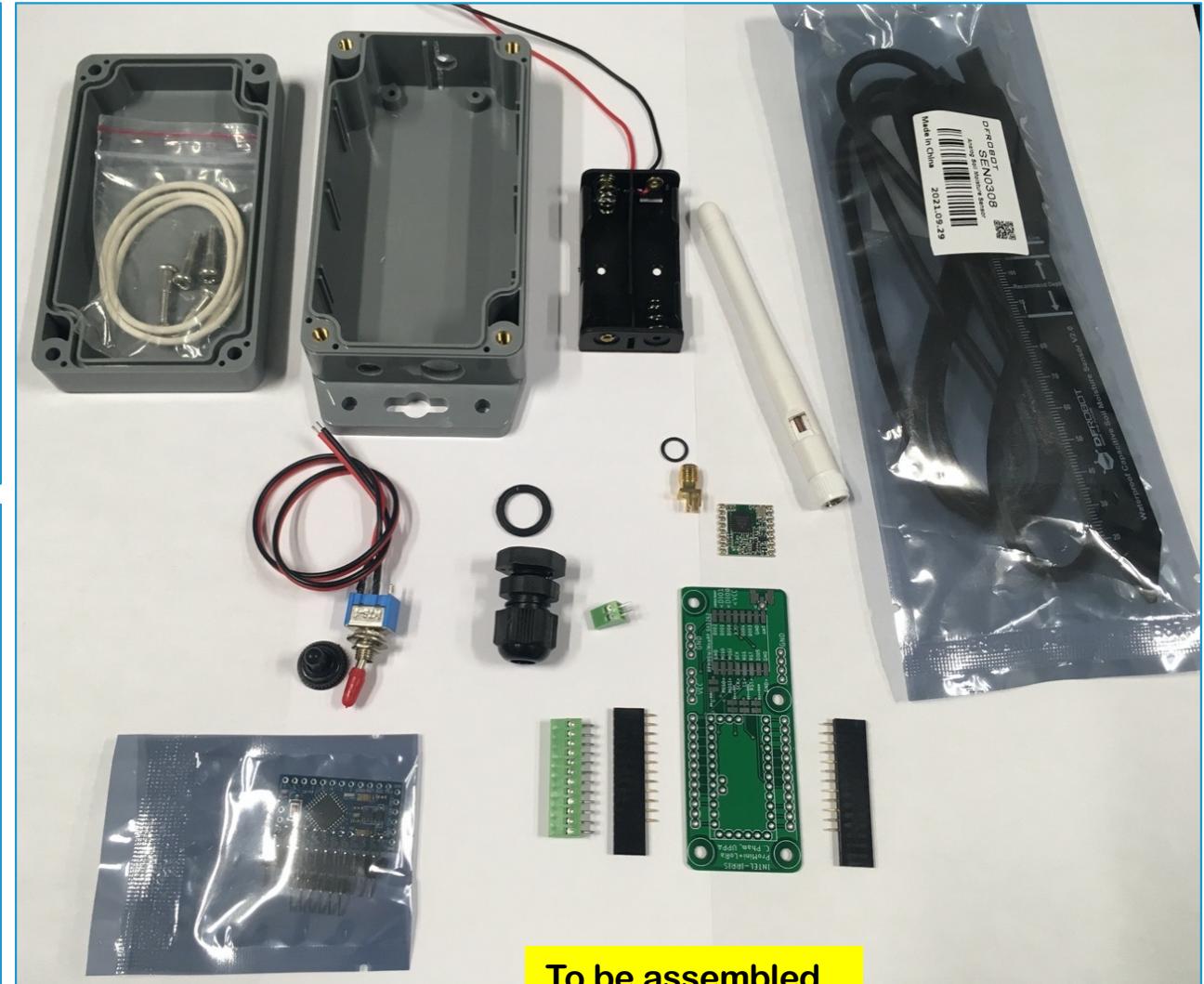


Starter-kit...in kit!

Fully assembled



Packaging in enclosure



To be assembled

A generic platform

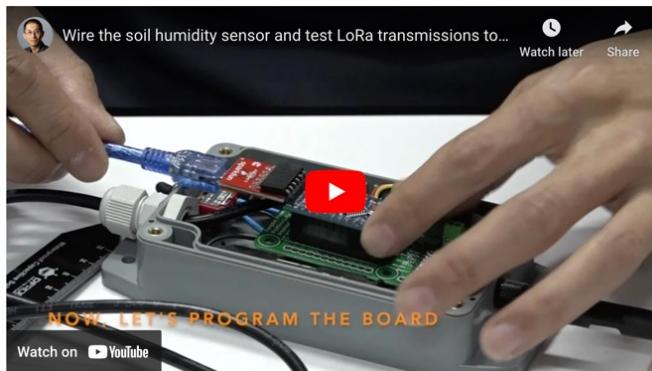
- Low-cost: < 20€
- Off-the-shelves composants
- Easily duplicated
- Assembling by local partners
- Can connect several sensors
- Can be further adapted by local partners

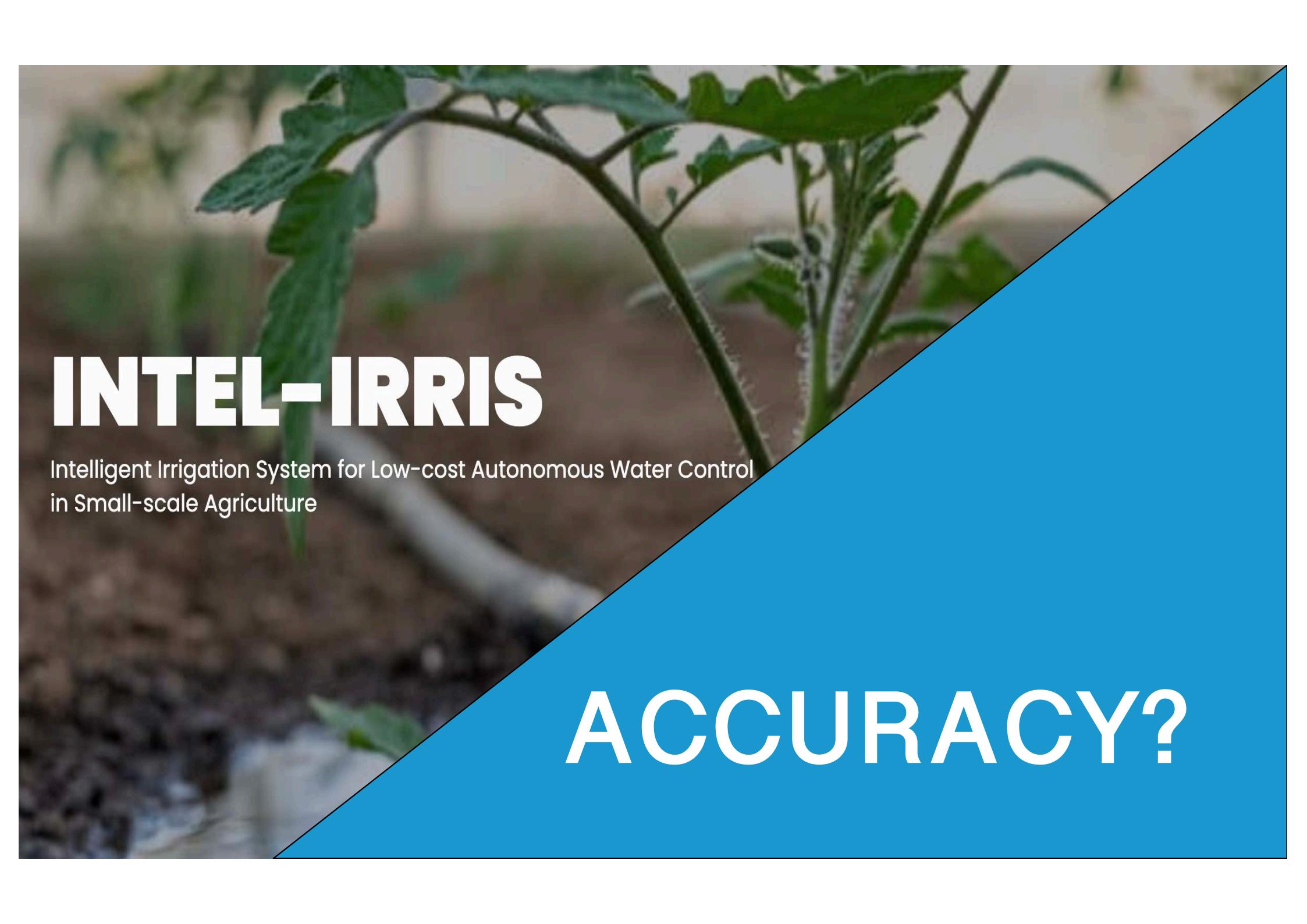


Available tutorials

- 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.

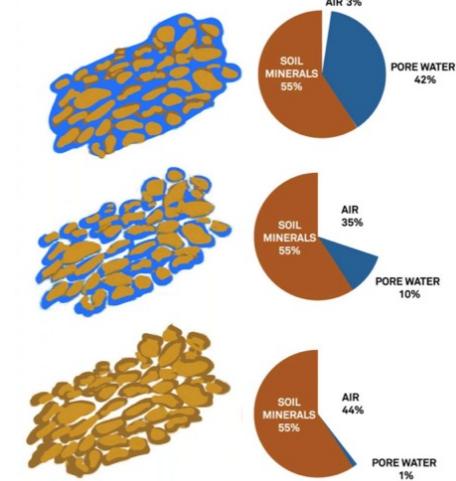
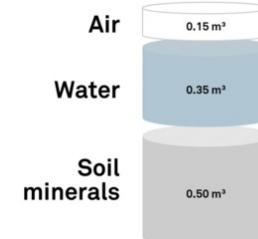
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ACCURACY?

Capacitive sensor

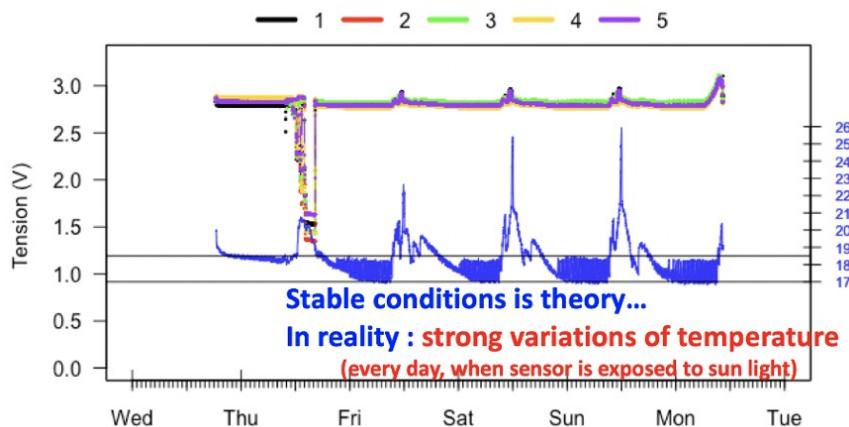
- Capacitive soil moisture sensors usually measure volumetric water content
- Soil density & soil texture are important parameters



From METER group



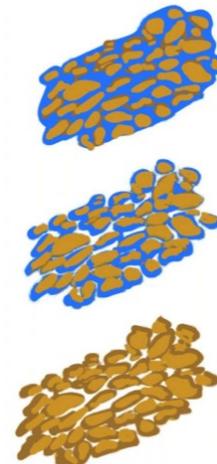
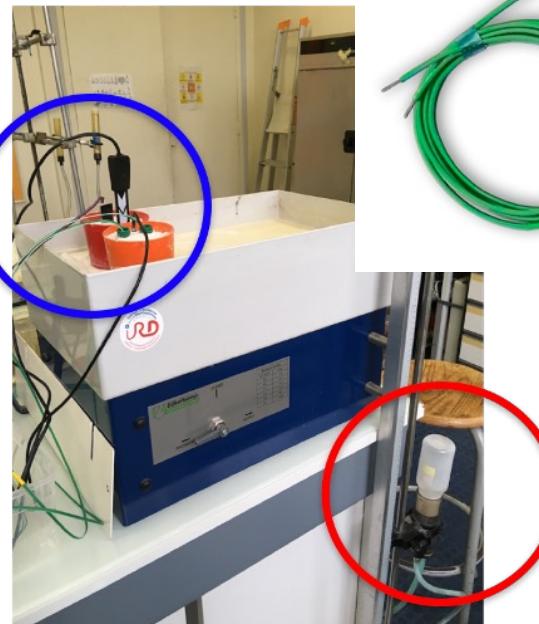
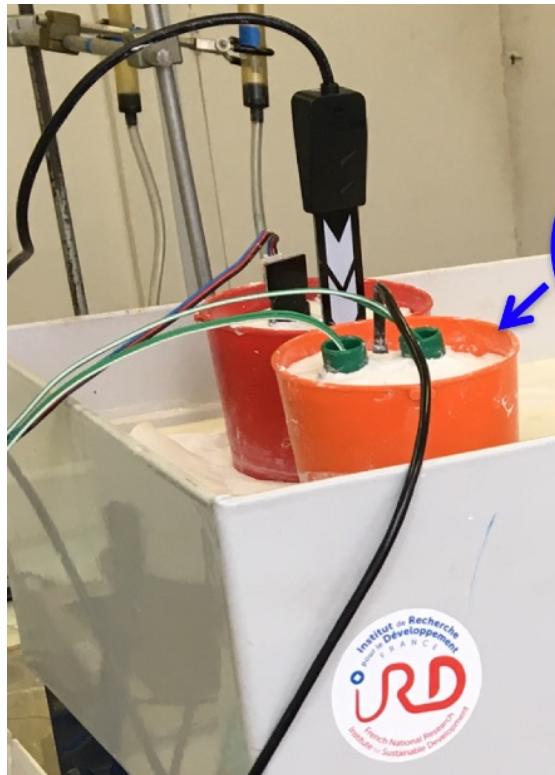
5 sensors are placed in a sand tank at constant water content



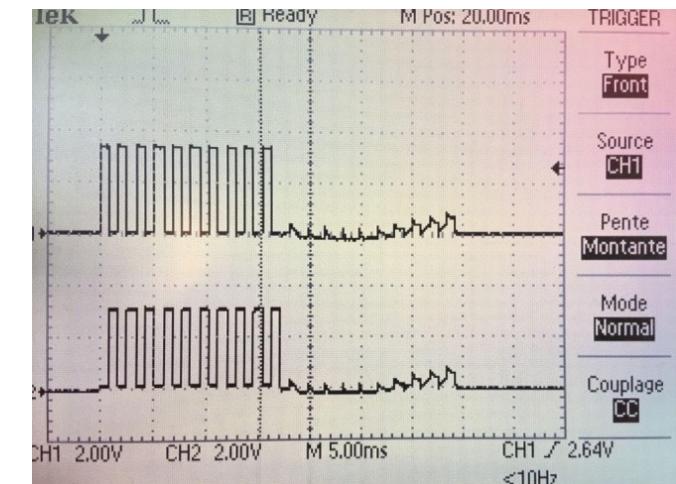
IRD in conducting extentise test on the accucary and the stability of the low-cost SEN0308 capacitive sensor 23

Water tension sensor

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



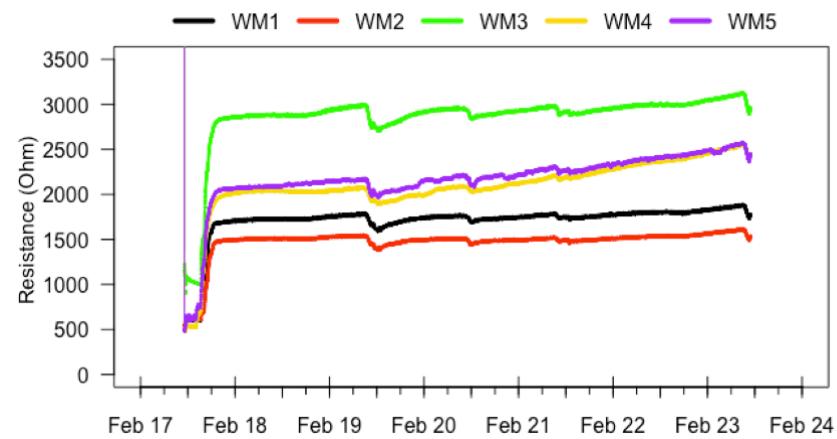
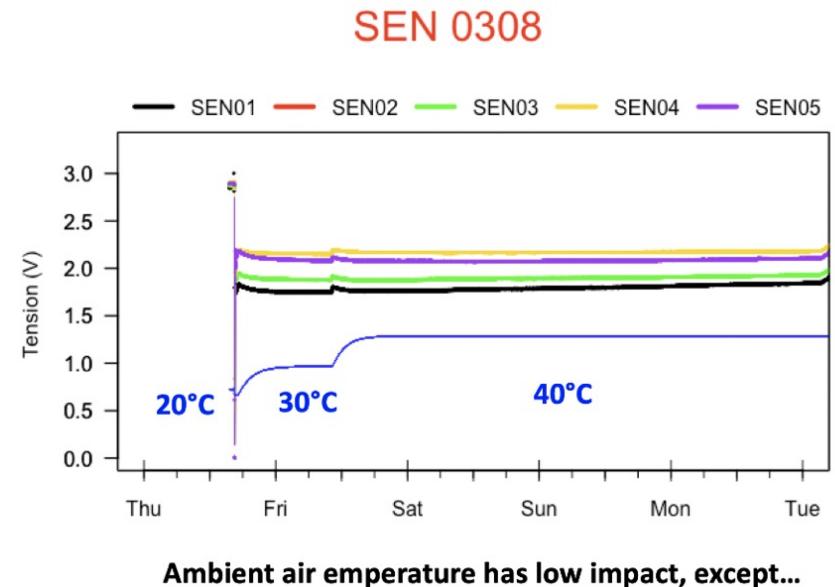
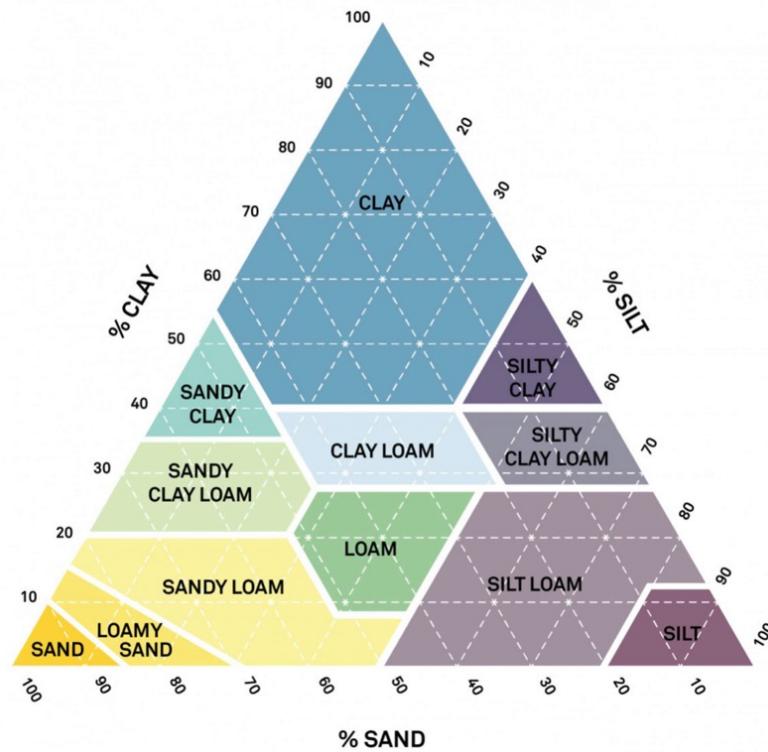
From METER group

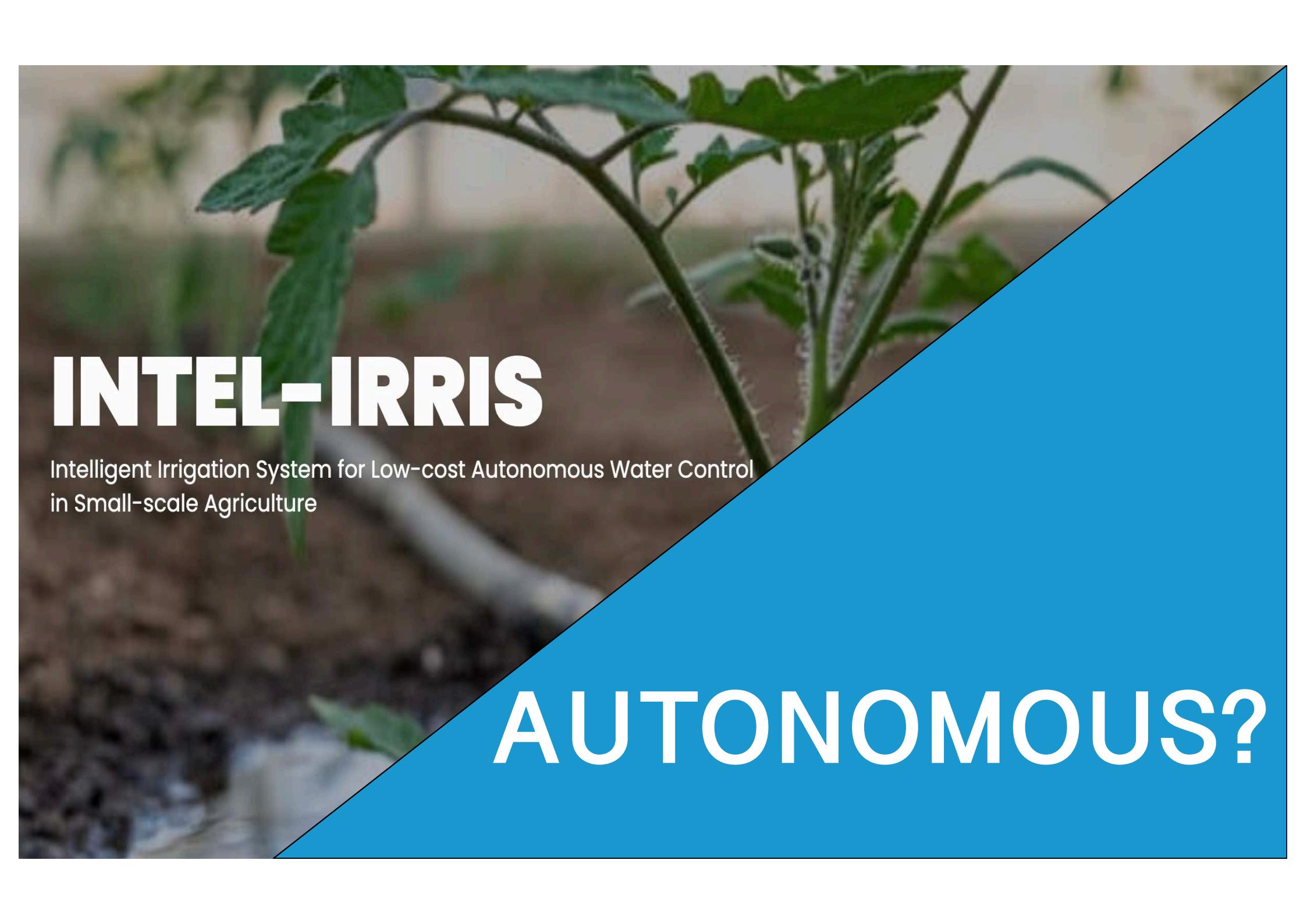


IRD in conducting extensive tests on the stability & suitability of microcontroller-based usage of the Watermark water tension sensor

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.

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AUTONOMOUS?

Gateway: collect sensor data

WAZIGATE GATEWAY

**FULL EDGE-COMPUTING
(NO INTERNET)**

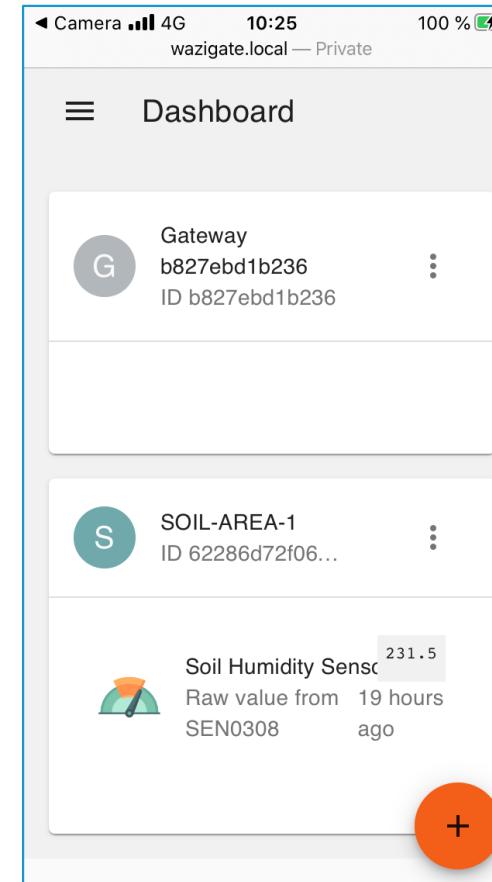
**ALL DATA PROCESSING
CAN BE DONE LOCALLY**



**1 GATEWAY HANDLES
SEVERAL DEVICES**

< 50€

EMBEDDED WEB INTERFACE



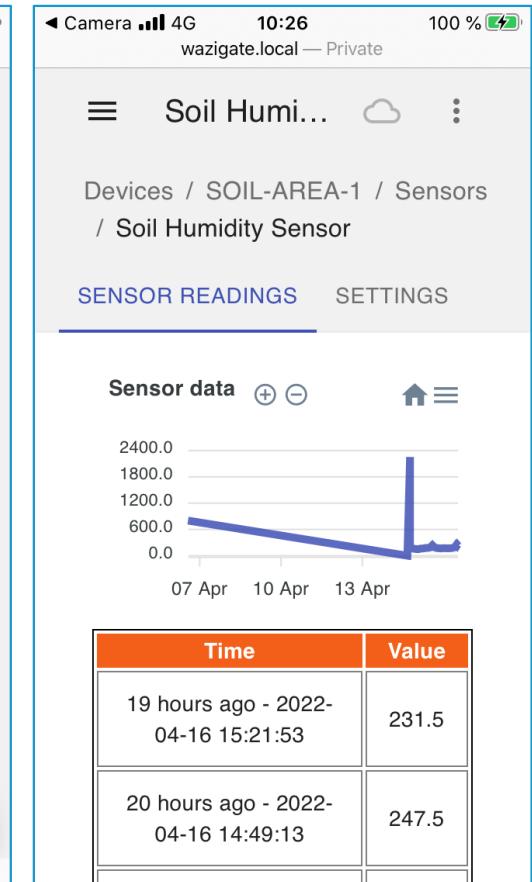
Camera 4G 10:25 100 % wazigate.local — Private

Dashboard

G Gateway b827ebd1b236 ID b827ebd1b236

S SOIL-AREA-1 ID 62286d72f06...

Soil Humidity Sensor 231.5 Raw value from 19 hours SEN0308 ago



Camera 4G 10:26 100 % wazigate.local — Private

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

SENSOR READINGS SETTINGS

Sensor data + ⌂ ⌂

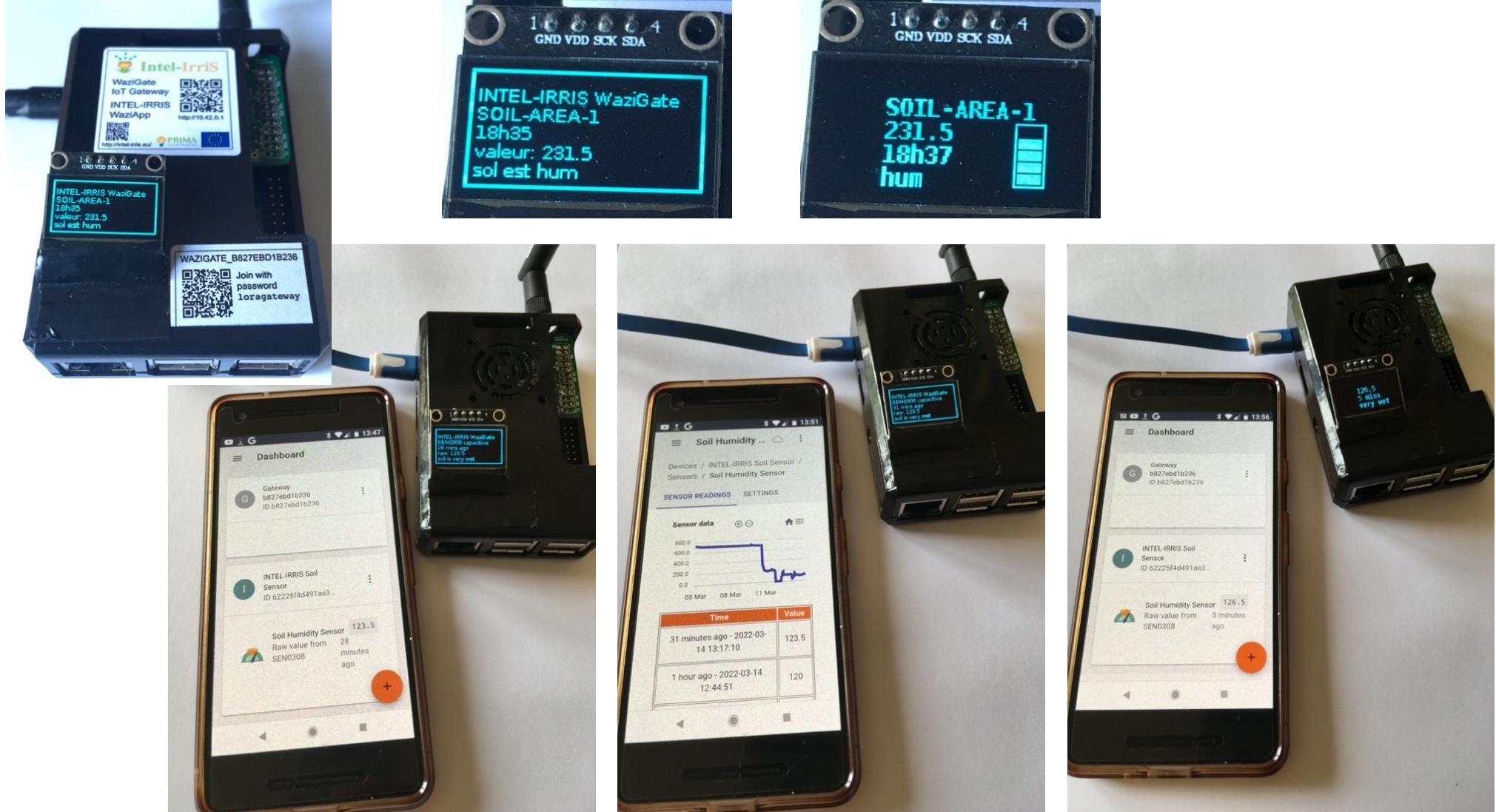
2400.0
1800.0
1200.0
600.0
0.0

07 Apr 10 Apr 13 Apr

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

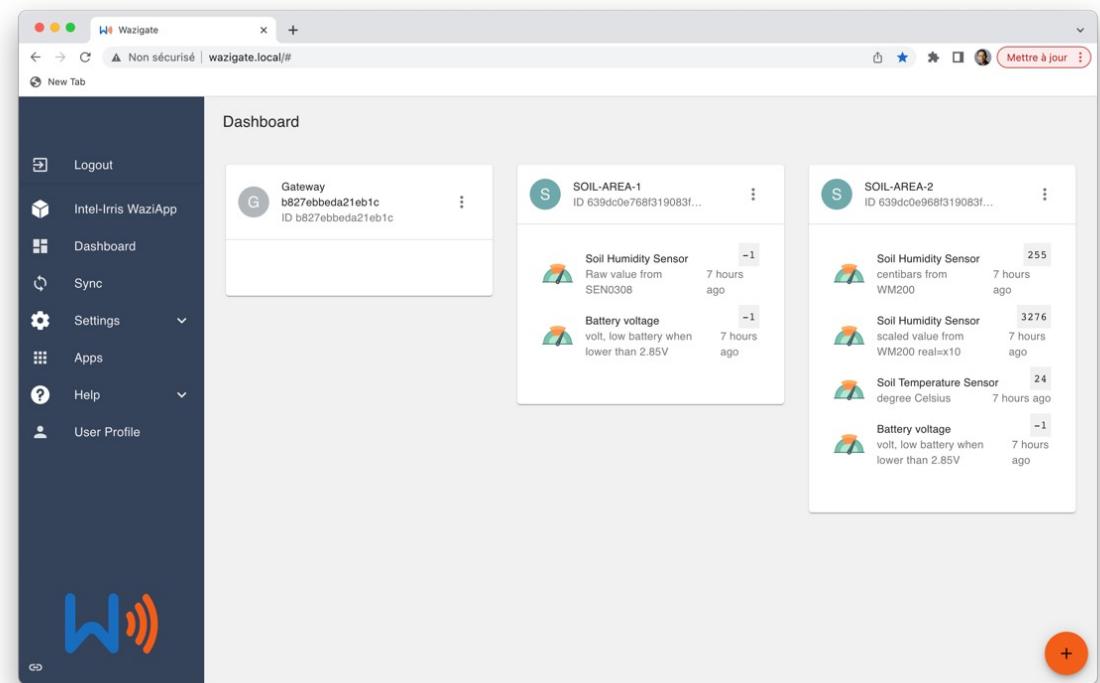
ACCESSED FROM A SMARTPHONE

Multiple user interfaces



Default gateway configuration

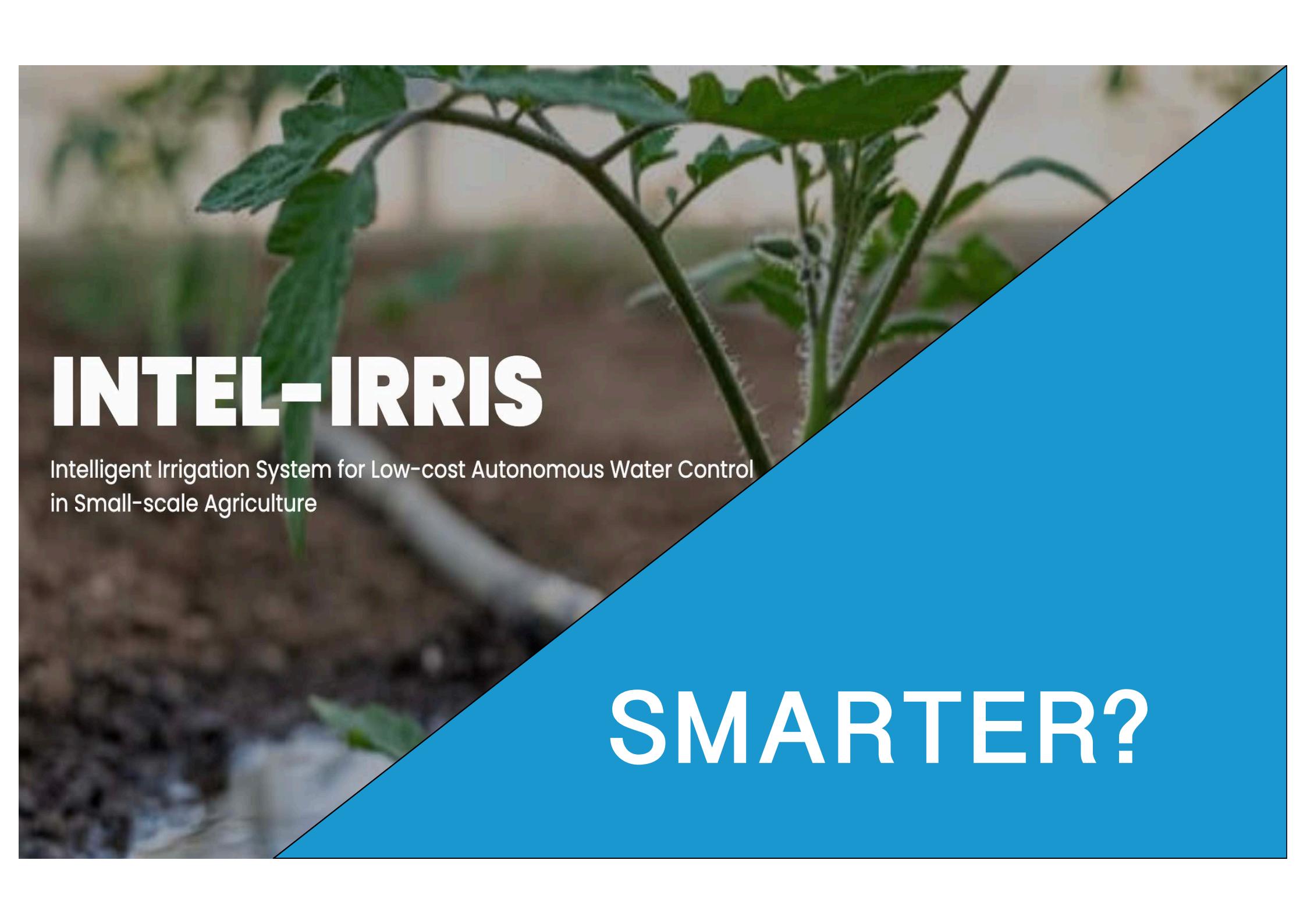
- For the starter-kit, the INTEL-IRRIS gateway will be ready for
 - 1 capacitive sensor named SOIL-AREA-1 with address 26011DAA
 - 1 tensiometer sensor named SOIL-AREA-2 with address 26011DB1
- Capacitive device will show humidity and battery values
- Tensiometer device will show centibar, raw resistance, soil temperature and battery values



INTEL-IRRIS starter-kit

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



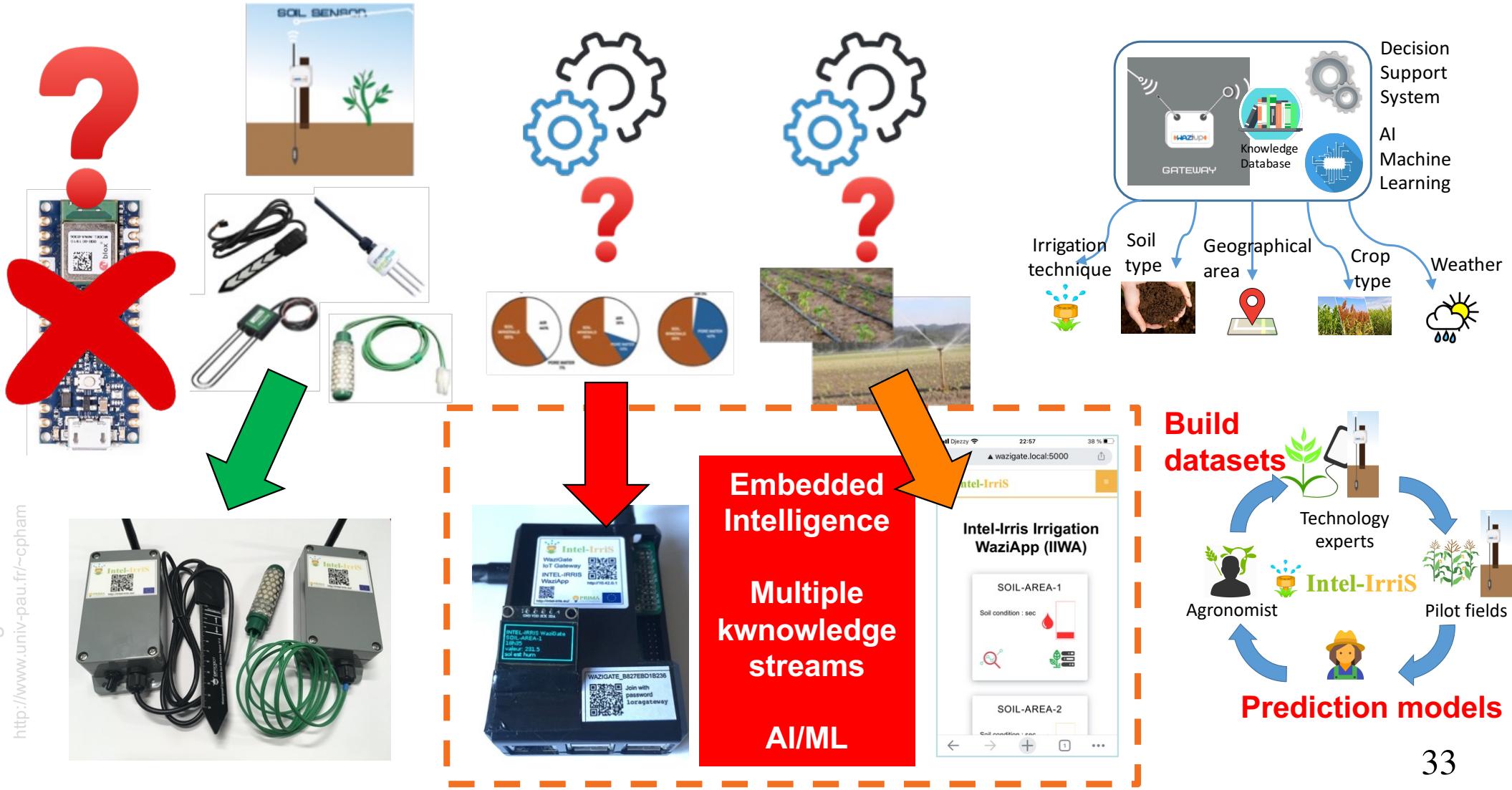
A close-up photograph of a green plant with several leaves and a thin stem. In the background, a white, ribbed irrigation tube or pipe is visible, suggesting a smart irrigation system. The entire image is framed by a large blue diagonal shape in the bottom right corner.

INTEL-IRRIS

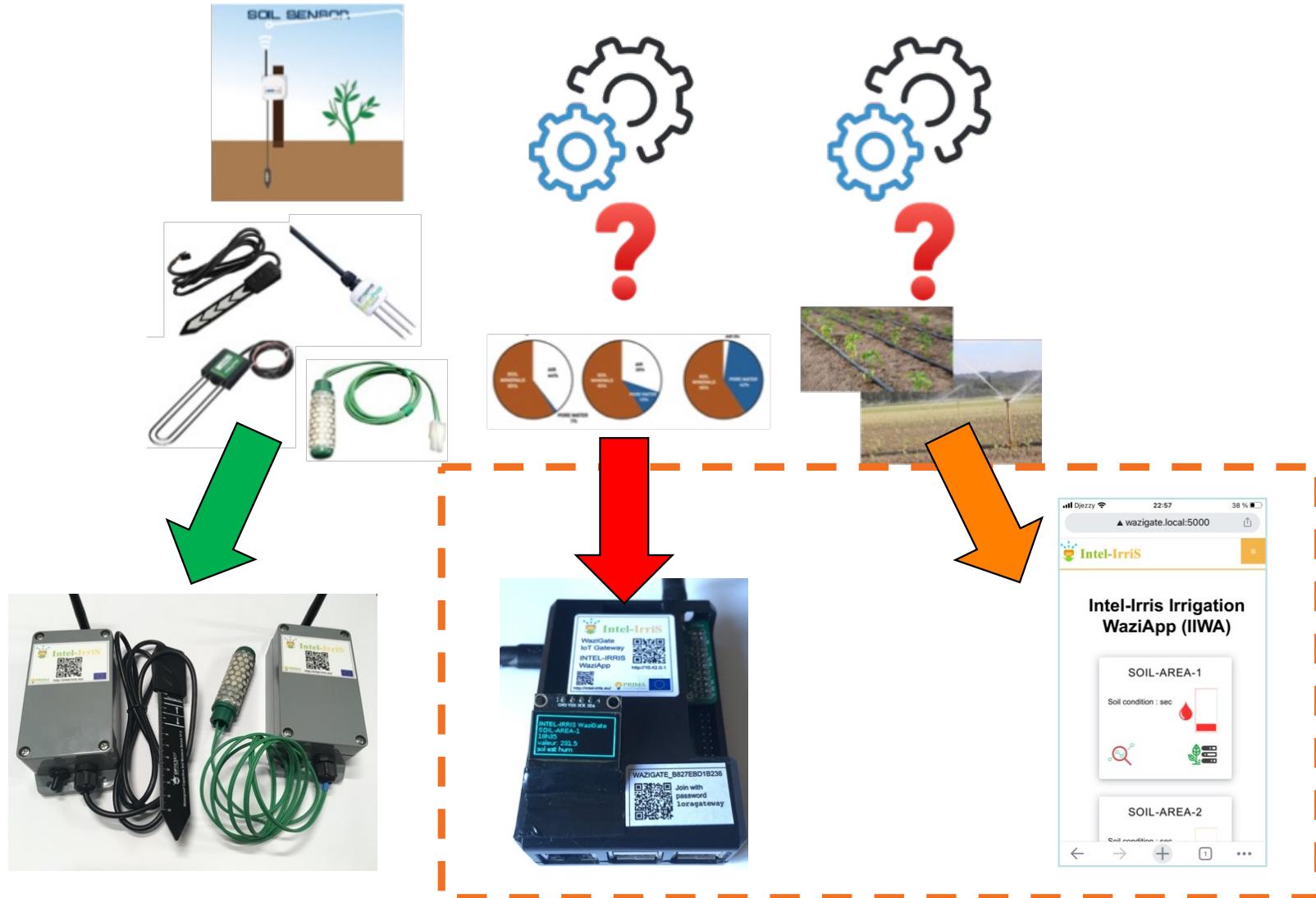
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SMARTER?

Embedding intelligence

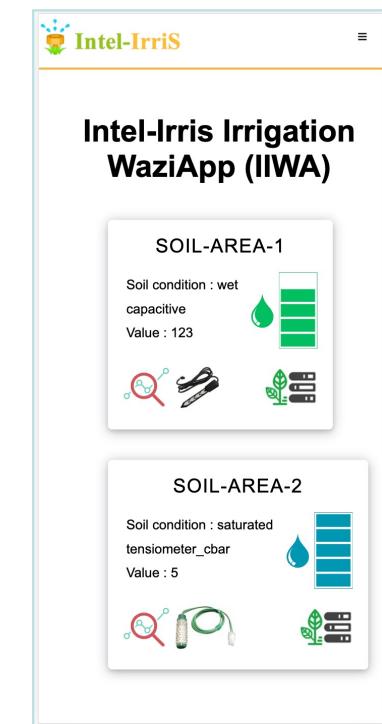


INTEL-IRRIS Irrigation WaziApp



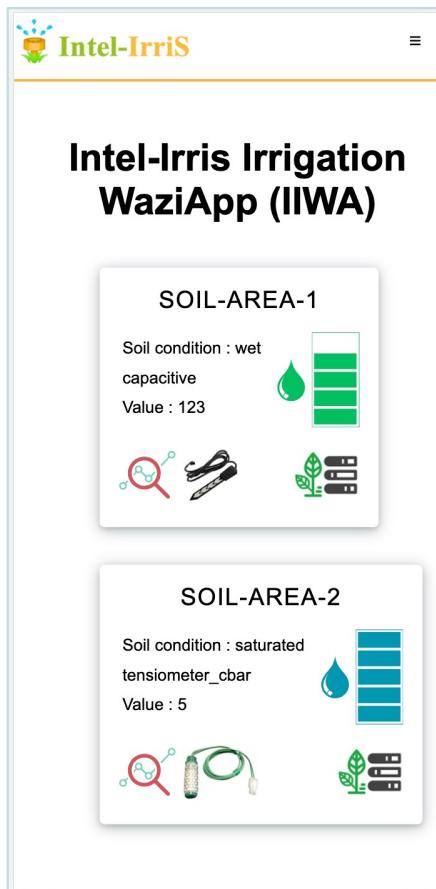
INTEL-IRRIS Irrigation WaziApp

- Embedded application running on the INTEL-IRRIS gateway
- 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

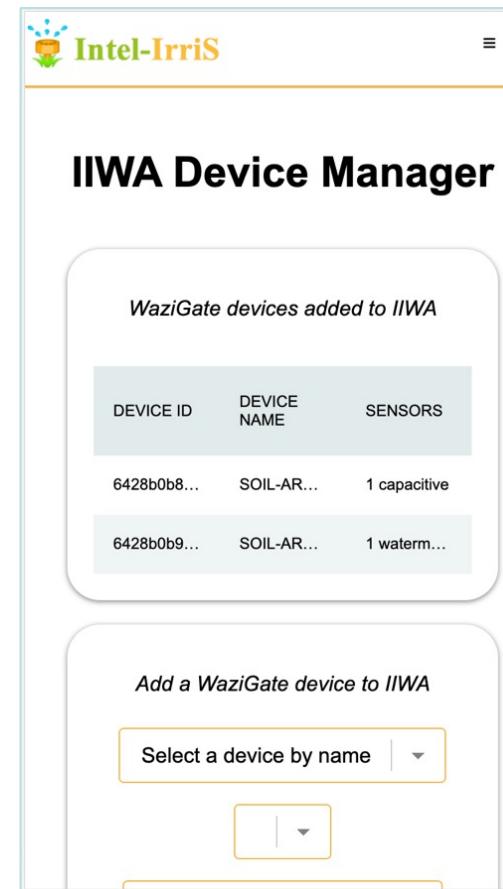
- Dashboard, Device Manager and Sensor Configuration



Intel-Irris Irrigation WaziApp (IIWA)

SOIL-AREA-1	SOIL-AREA-2
Soil condition : wet capacitive Value : 123	Soil condition : saturated tensiometer_cbar Value : 5

Dashboard



IIWA Device Manager

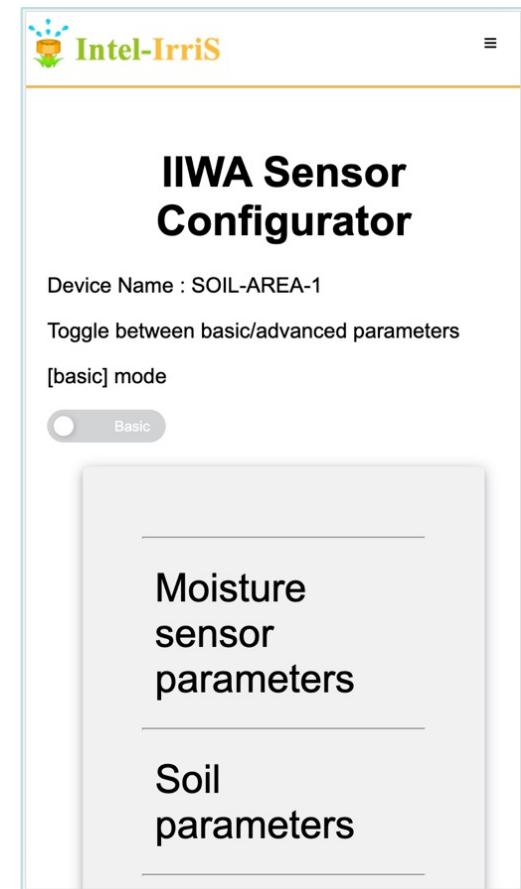
WaziGate devices added to IIWA

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

- 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

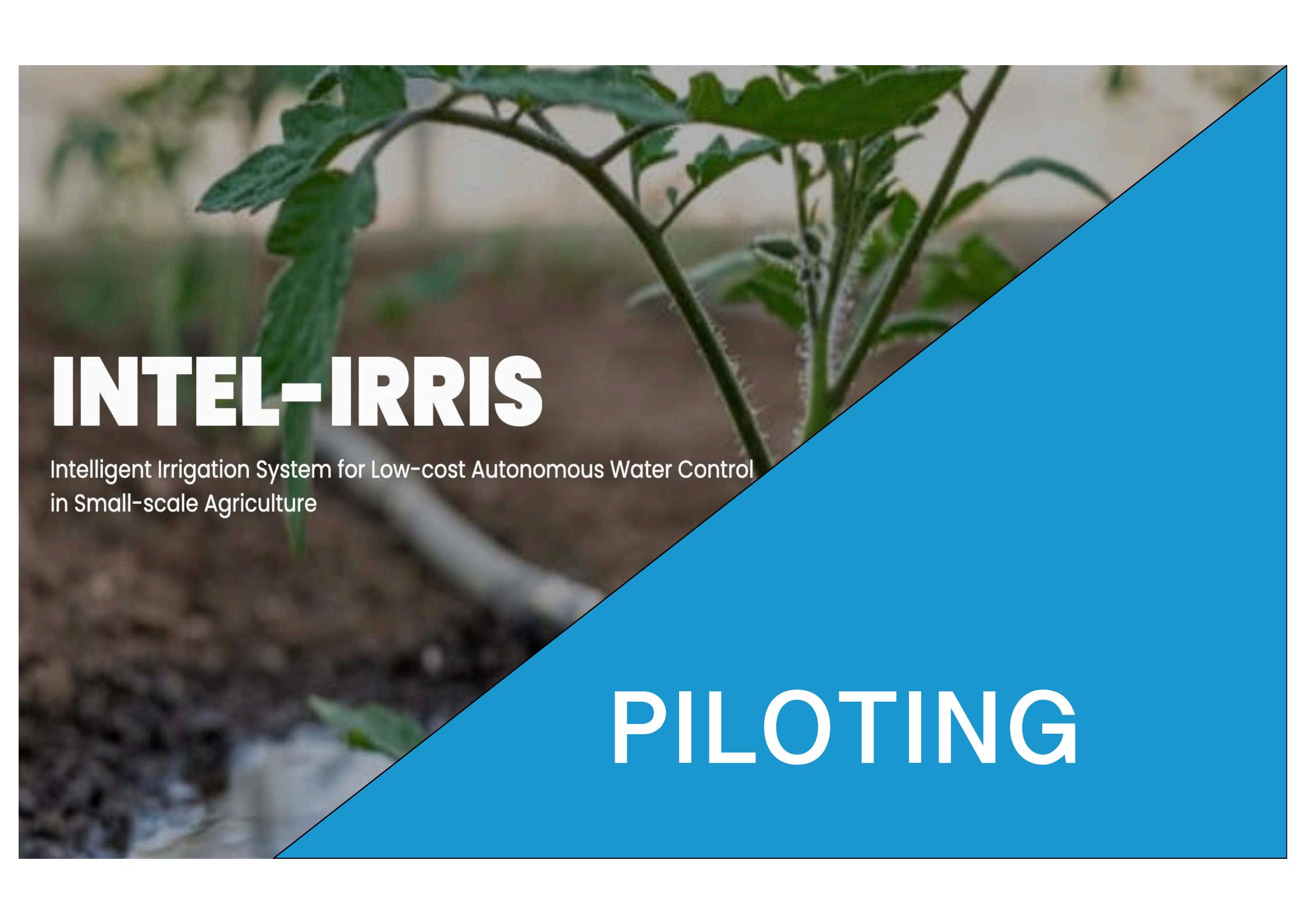
Weather parameters

Weekly evaporation (in mm) value in mm

Weekly pluviometry (in mm) value in mm

Save configuration

More parameters will be integrated in IIWA during the project

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.

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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

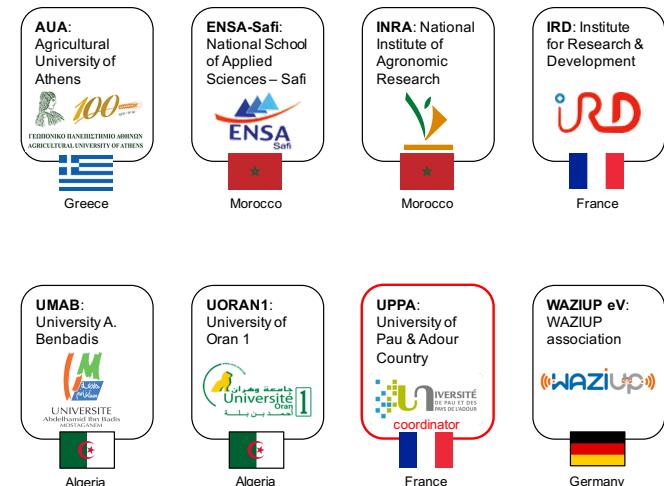
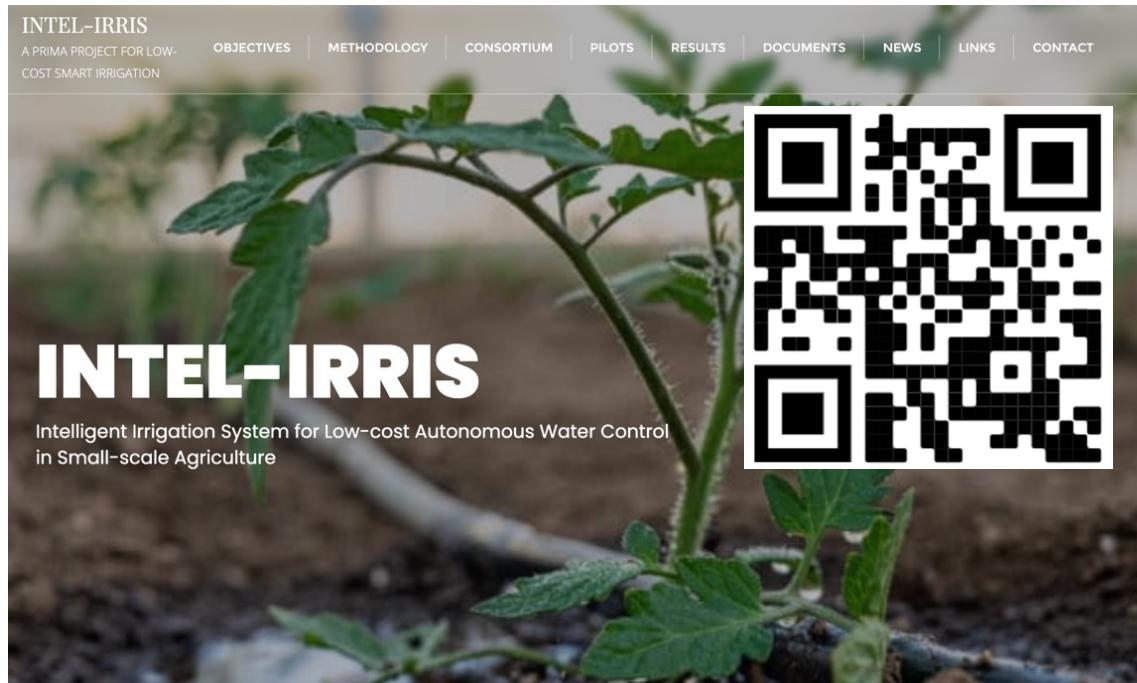


INRA farm #2, Morocco



More information

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



- Twitter: https://twitter.com/Intel_IrriS



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@Intel_IrriS

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