# Digital platforms and embedded AI to target the smallholder communities

***Transdisciplinary research for a healthy planet***

***March 30-31 mars 2023 – Université de Reims***

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

European Commission | Horizon 2020 European Union funding for Research & Innovation

WAZIUP
IoT – from idea to reality
WAZIHUB

HUBiquitous
Paving for the next 10 years of innovation in IoT and AI

PRIMA
PARTNERSHIP FOR RESEARCH AND INNOVATION IN THE MEDITERRANEAN AREA

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

# Healthy planet?

Google

healthy planet

Together Beyond Animal Health

Healthy Planet – Together Beyond Animal ...


Facebook

Healthy Planet - Home | Facebook

EURACTIV.com

healthy people on a healthy planet ...

123RF

Healthy Planet With Green Leav...

Down to Earth Organic and Natural

Healthy Living = Healthy Planet | Down ...


Trivitron Healthcare

A Healthy Planet for Healthy People ...

Campus Safety Magazine

Healthy People, Healthy Places, Healthy ...

The Big Carrot

Healthy People Healthy Planet - Carrot ...

Mars Petcare - Mars, Incorporated

Healthy Planet | Mars, Incorporated

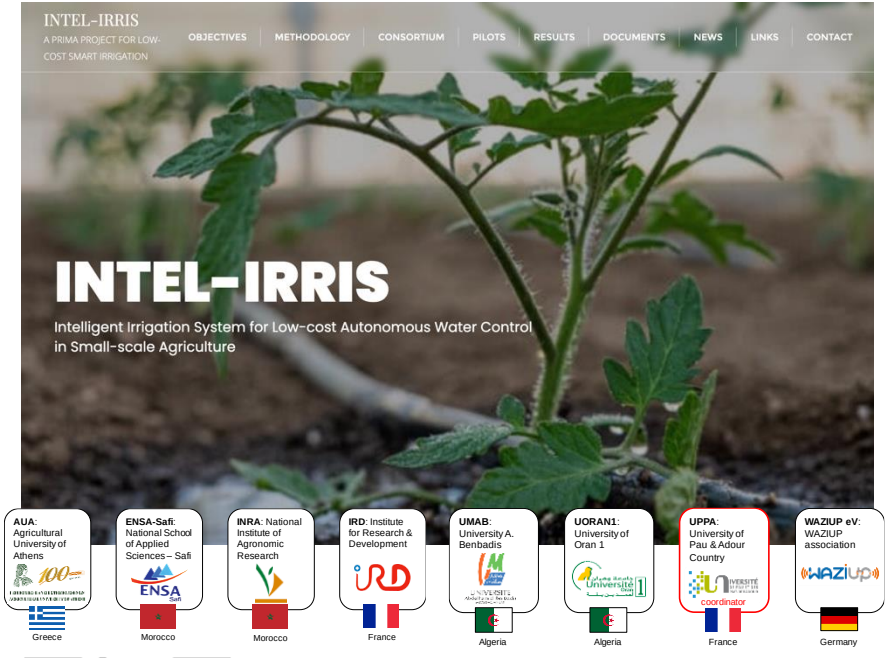
MAHB


ET HealthWorld

The George Institute for Global Health

healthyplanetusa.org

# 2 transdisciplinary projects





**Optimize irrigation in small-scale agriculture farms**

https://intel-irris.eu

Intel-IrriS

June 2021-24

**Resource sharing in smallholder communities**

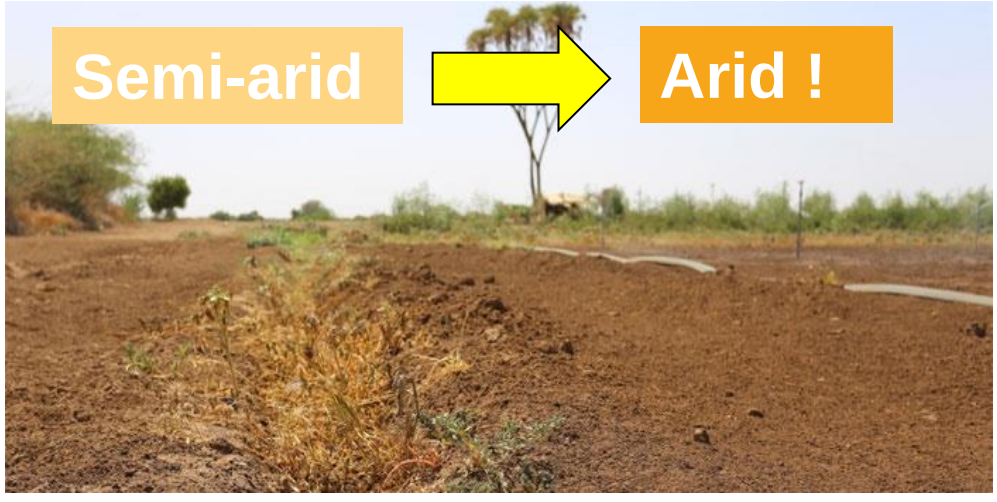
RESILINK

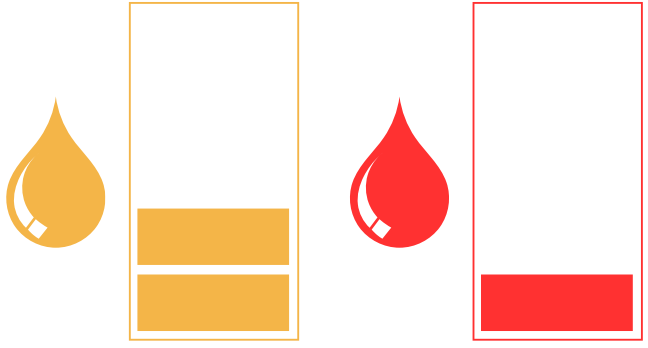
https://resilink.eu

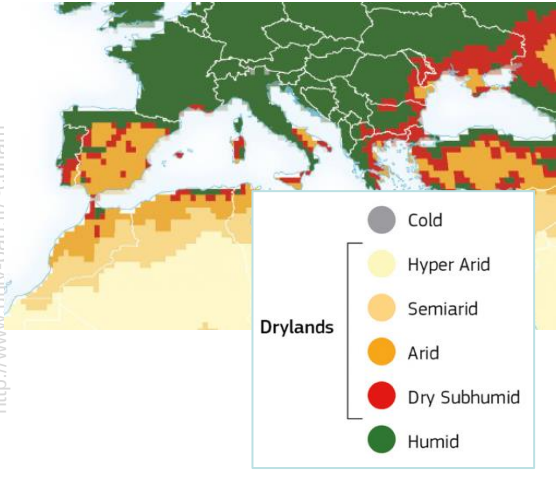
June 2022-26

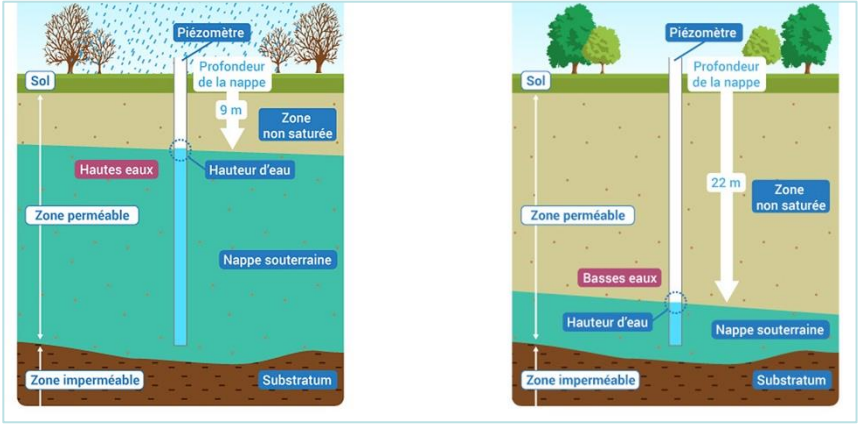
Pr. Congduc Pham
http://www.univ-pau.fr/~cpham

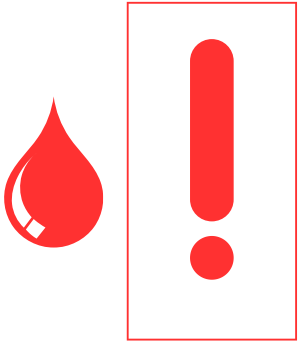
# Water resource is precious!





# Optimizing irrigation in agriculture

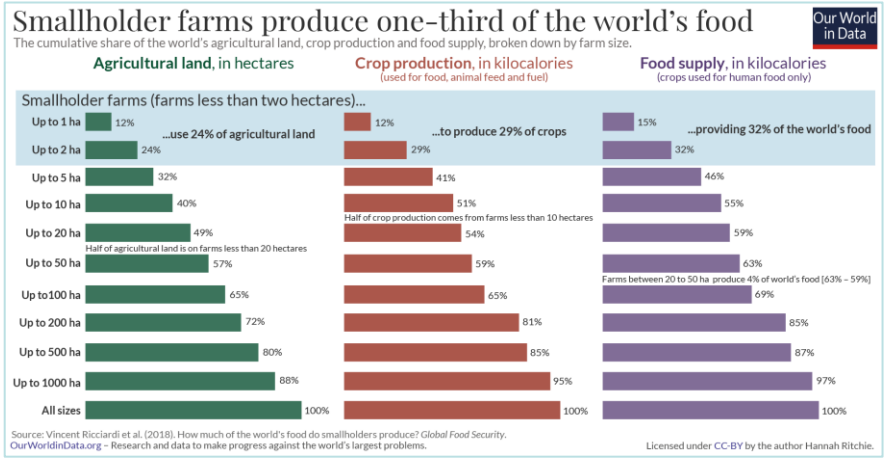
- About 70% of water is used for agriculture activities
- Digital technologies can help reducing and optimizing usage of water, **but…**


**Possible for large farms**

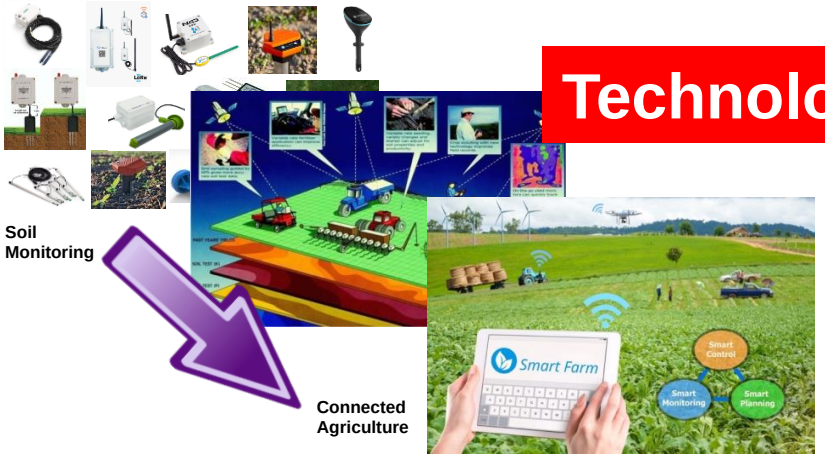
**Out of reach for smallholders!**

# 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



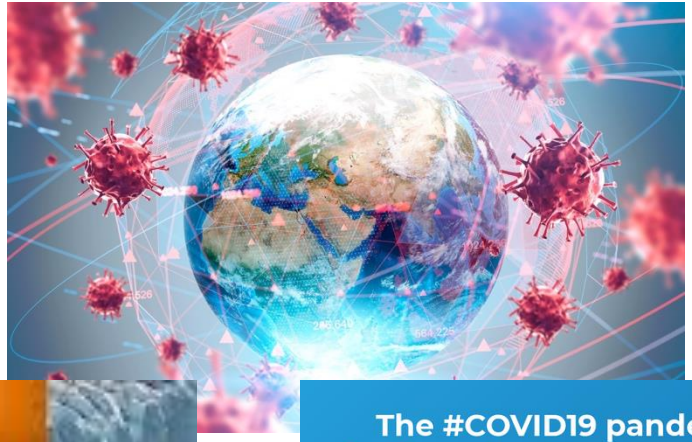

https://ourworldindata.org/smallholder-food-production

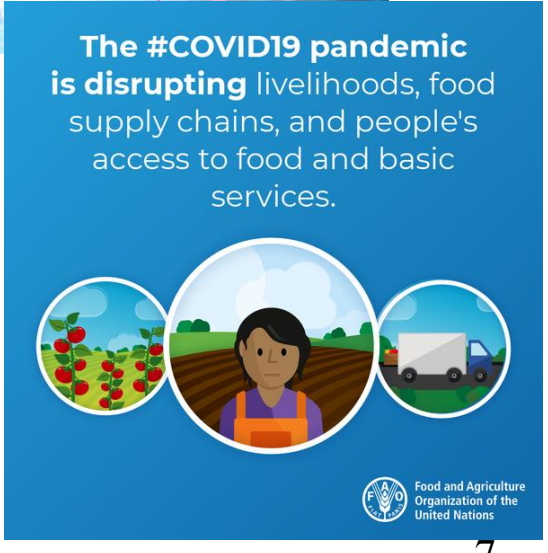



**Technologies**

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

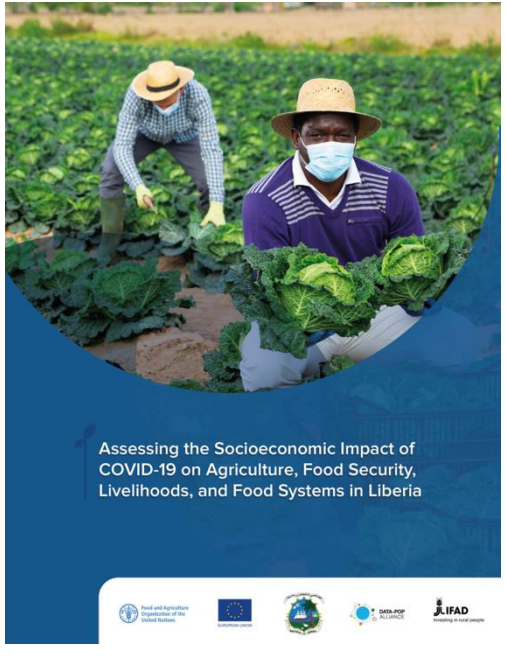
# Towards more frequent crisis?





# Smallholders are more vulnerable!

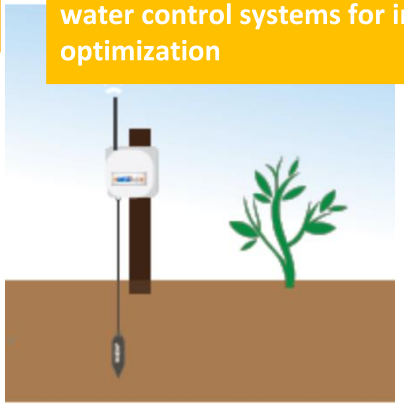
- Smallholder farmers: first to be impacted by climate change, unexpected crises. They are very economically fragile!

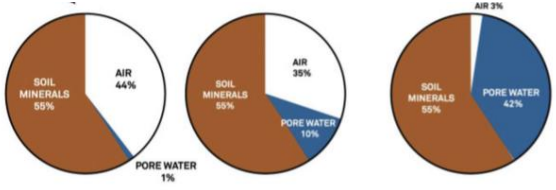




# Irrigation with soil moisture sensing

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



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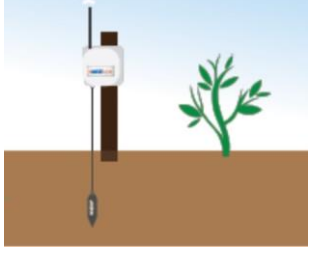
# Not as simple as it seems ☹

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

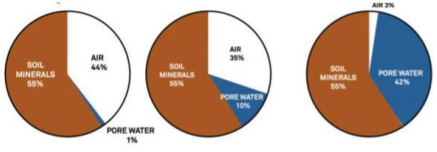


Volumetric Water Content, Water Potential, Water Tension,…

TDR, FDR, capacitance, resistance, ….

Low-cost sensor less accurate

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




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

Evapotranspiration, soil-plant-atmosphere continuum,…

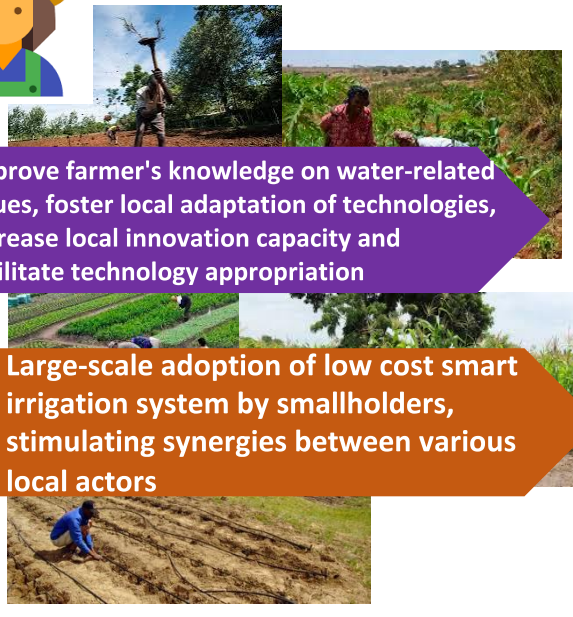
3 Seamless integration into existing irrigation system and/or local customs and practices

Irrigation type: drip, furrow, sprinkler,…

Plant/Crop varieties

Relationship with other agriculture inputs

# Not only the cost barrier…

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

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

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

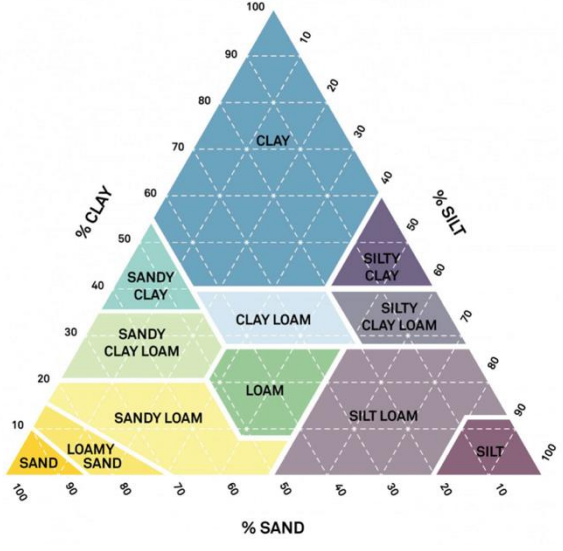
# INTEL-IRRIS starter-kit

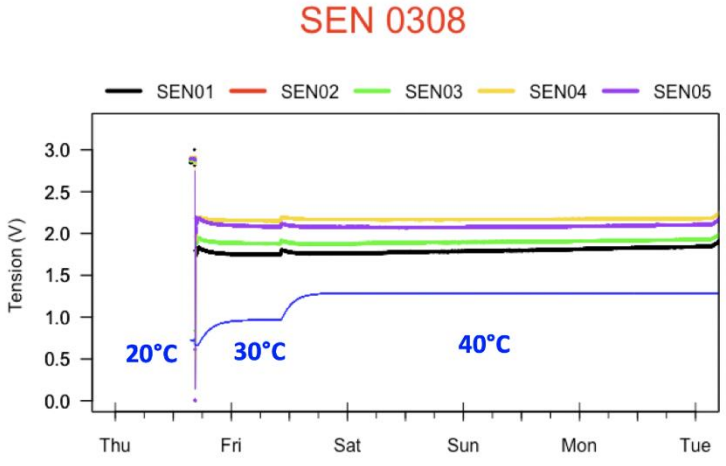
- "Intelligent Irrigation in-the-box", "plug-&-sense"
- From idea to reality!



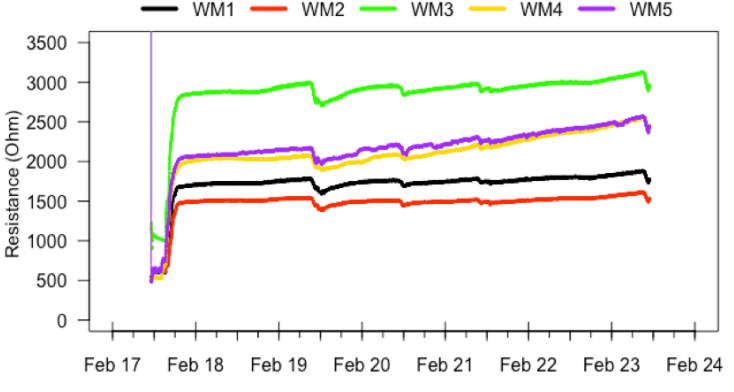

# Calibration for more accuracy

- Working with low-cost sensor means more calibration!
- Soil-specific calibration with soil specialist!
- Impact of external "noise"

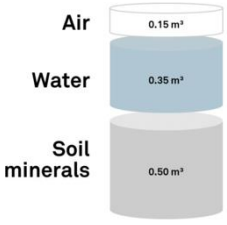


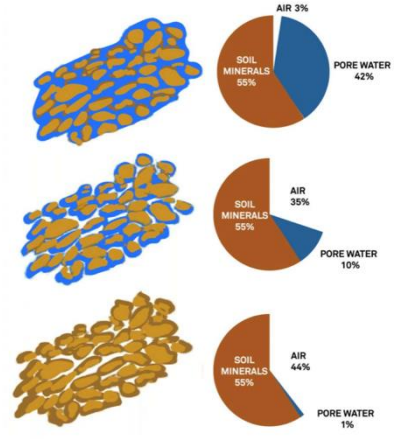




**Ambient air emperature has low impact, except…**



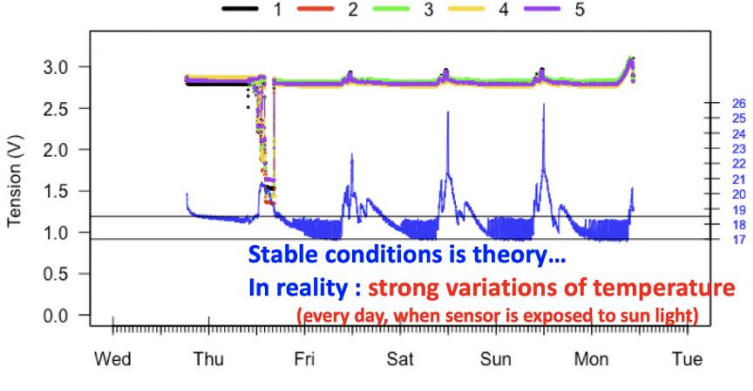
# Capacitive sensor




From METER group

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

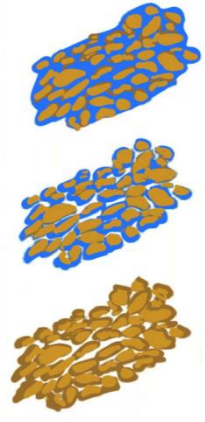



Impact of temperature ?

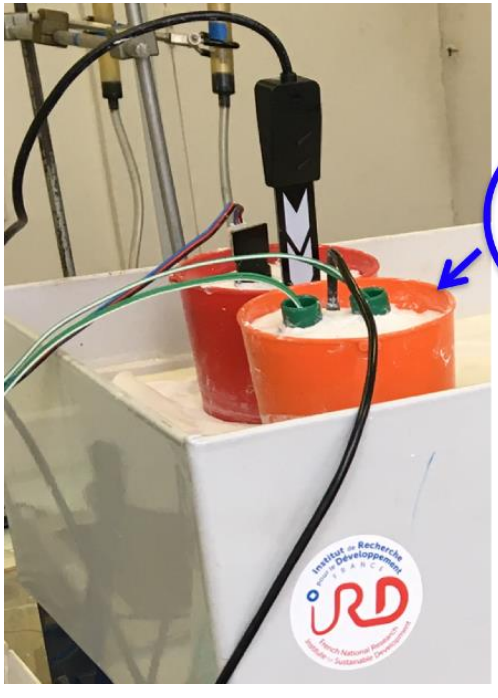

IRD in conducting extentise test on the accucary and the stability of the low-cost SEN0308 capacitive sensor

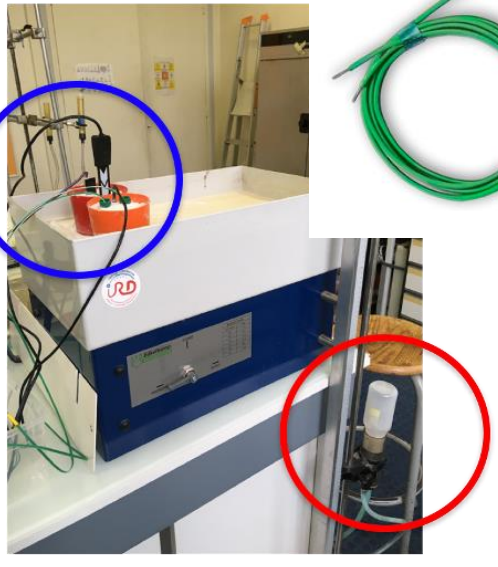
# Water tension sensor

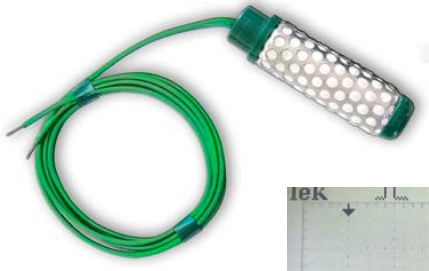
- Water tension sensor measures the amount of force required to extract water from soil's pores

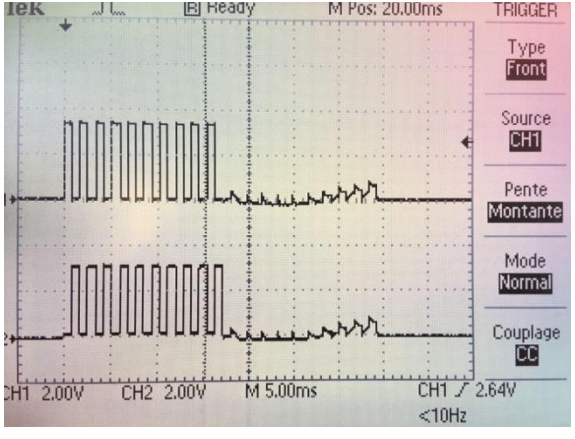


From METER group



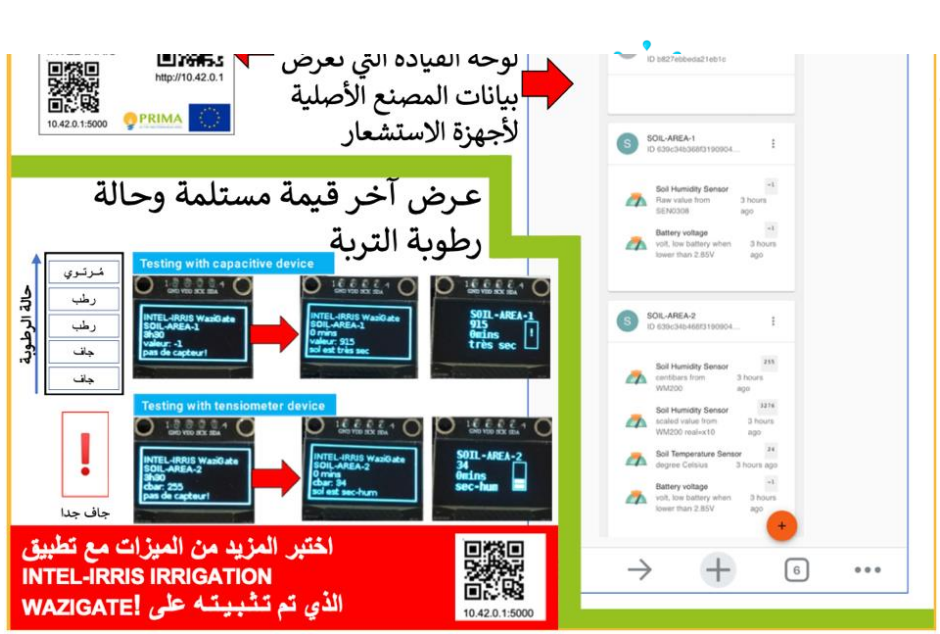


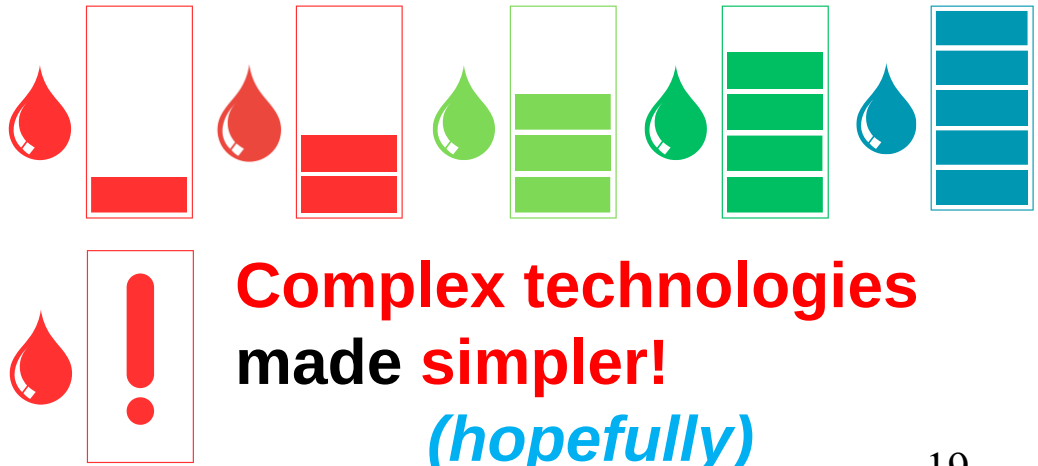




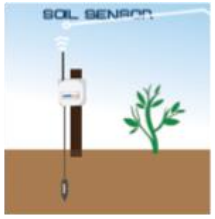

IRD in conducting extensive tests on the stability & suitability of microcontroller-based usage of the Watermark water tension sensor

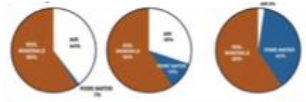

نـظـام ري ذكـي
-الـنـمـوذج الإبـتـدائي-
PRIMA
Intel-IrriS
INTEL-IRRIS WaziGate
SOIL-AREA-1
0 mins
valeur: 915
sol est très sec
عرض آخر قيمة تمّ
الحصول عليها وحالة
رطـوبـة التربة
SEN0308
capacitive sensor
Watermark WM200
Water tension sensor
يتم تسليمها مع بوابة واحدة ومستشعر سعوي أو مقياس رطوبة التربة
تفسير القيم المقاسة وعرض أوضاع التربة
-1 :
بـدون جهاز استشعار
255 :
بـدون جهاز استشعار
0 - 83
84 - 166
167 - 249
250 - 333
334 - 416
0 - 10
11 - 30
31 - 60
61 - 100
مُـرتـوي
رطب
رطب
جاف
جاف
نطـاق الري
المعتاد
نطـاق الري
المعتاد
> 416
> 100
جاف جدا
الـنـمـوذج الابتدائي لا يزال في مرحلة التطوير والاختبار
والتعديل .القيم المـبيّنـة هي إرشادية لمرحلة الاختبار.
https://www.irrometer.com/basics.html#using

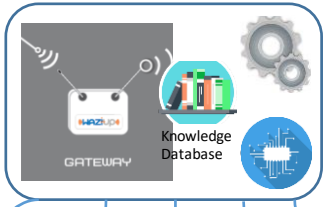

لوحة القيادة التي تعرض
بيانات المصنع الأصلية
لأجهزة الاستشعار
http://10.42.0.1
10.42.0.1:5000
PRIMA
عـرض آخر قيمة مستلمة وحالة
رطوبة التربة
حالة الرطوبة
مُـرتـوي
رطب
رطب
جاف
جاف
Testing with capacitive device
Testing with tensiometer device
جاف جدا
اختبر المزيد من الميزات مع تطبيق
INTEL-IRRIS IRRIGATION
WAZIGATE! الذي تم تـثـبـيـتـه على
10.42.0.1:5000
SOIL-AREA-1
Soil Humidity Sensor
Battery voltage
SOIL-AREA-2
Soil Temperature Sensor


Complex technologies
made simpler!
(hopefully)

# INTEL-IRRIS: embedded intelligence



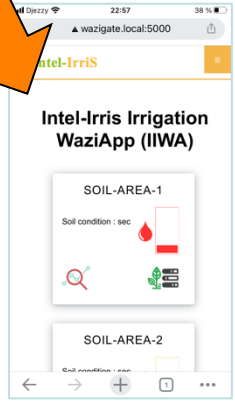


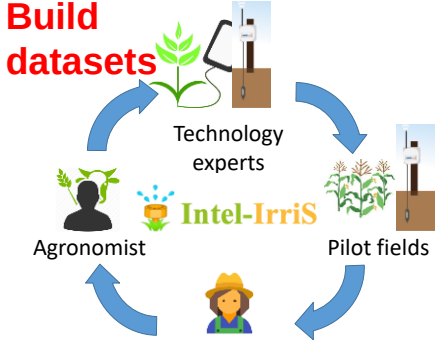



**Embedded Intelligence**

**Multiple kwnowledge streams**

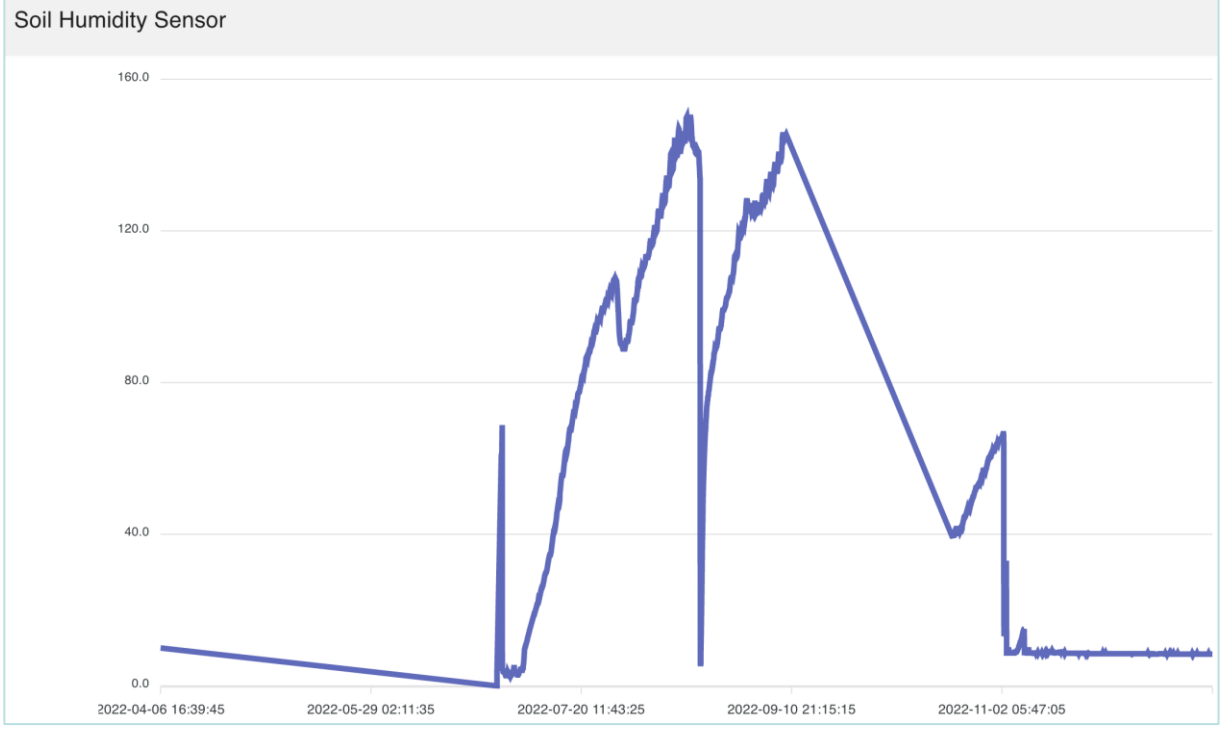
**AI/ML**



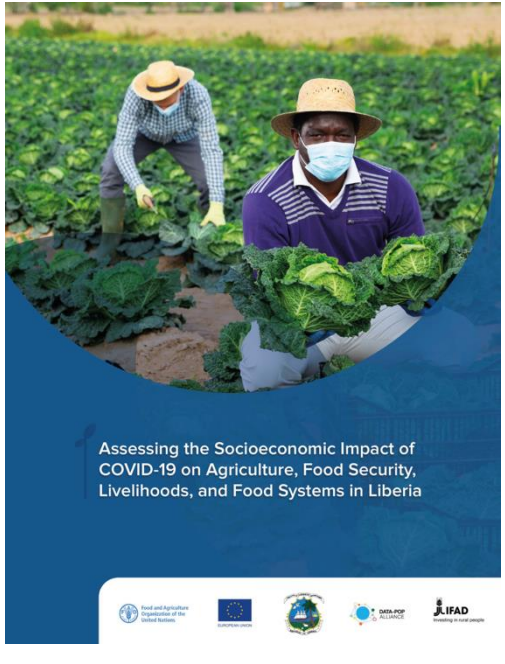
# How to build irrigation datasets?

- Soil type, plant type, evaporation, weather condition,…
- Where to apply IA, how to handle irrigation cycles, …?

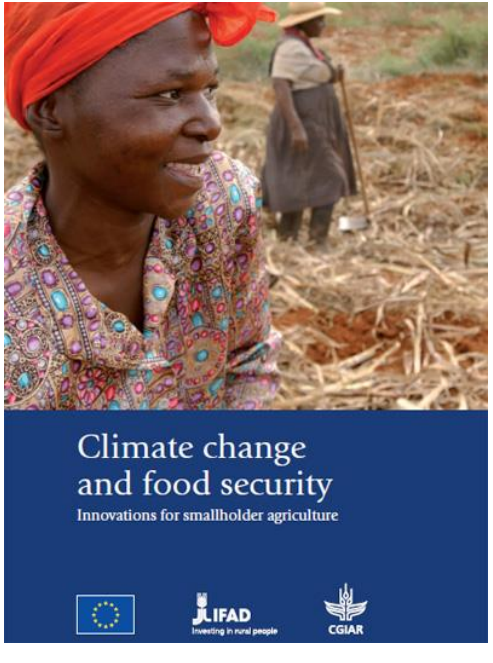


# Increase smallholder's resilience?

- RESILINK will increase smallholder's resilience by providing continuity of access to both resources and markets in crisis situations

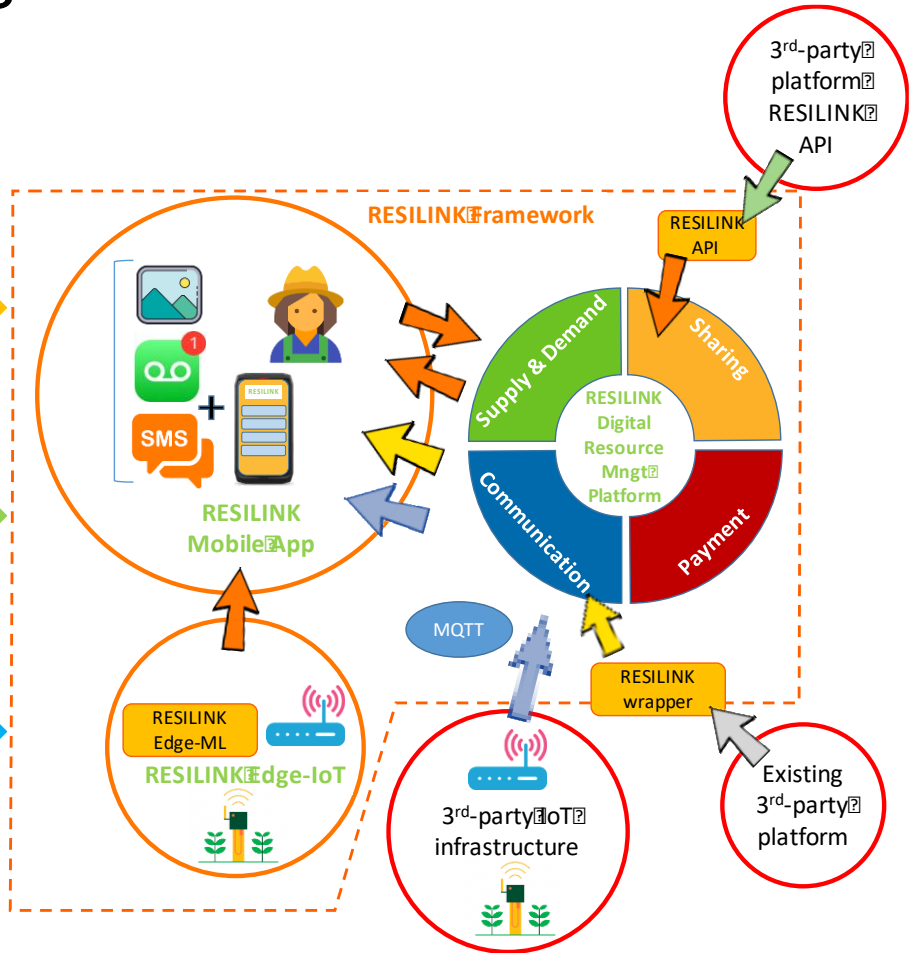






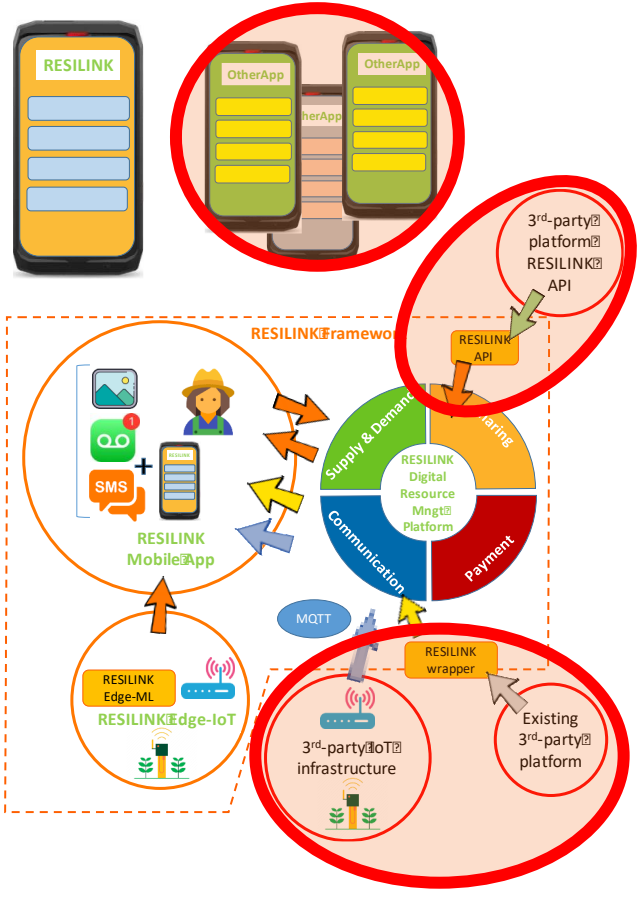
# RESILINK's objectives

1. Improve the agri-food value chain by optimizing usage of local resources, generalizing local resource sharing approach and facilitating territorial markets
2. Develop distributed digital resource management platform for real-time exchange of information on territorial resources and supplies & demands; connecting smallholders to new supply, sharing opportunities and distribution channels
3. Use cutting-edge digital technologies to connect fields and farms resources, automatize and add intelligence in the agri-food value chain to provide simple application interfaces adapted to smallholders

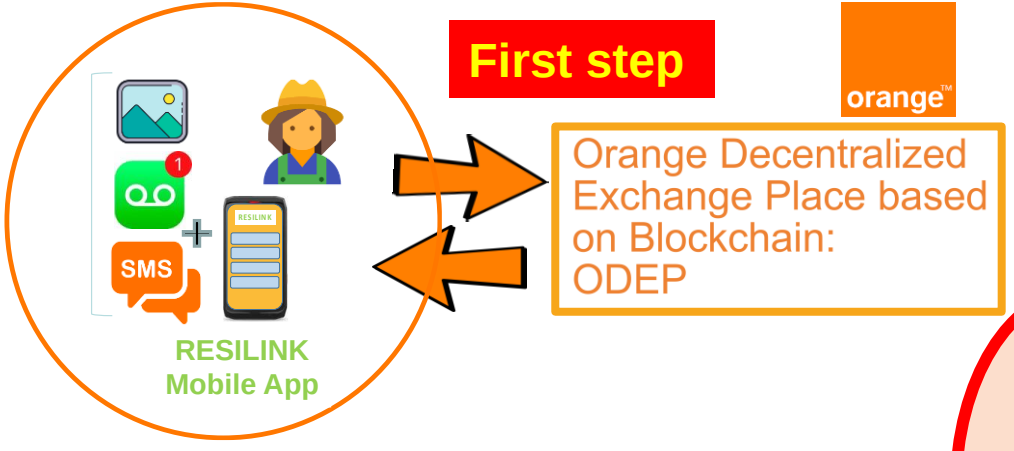


# RESILINK digital platform

- will enable real-time exchange of information on territorial resources and supplies & demands; connecting smallholders to new supply, sharing opportunities and distribution channels
- will provide an open architecture and API to seamlessly integrate third-party platforms into comprehensive dashboards/portfolios
- The open API will enable the platform-of-platforms approach for promoting a much wider and appealing ecosystem
- Incrementally add disruptive technologies such as Internet-of-Thing (IoT), Edge Computing, Linked-Data and AI-based clustering & recommendation system

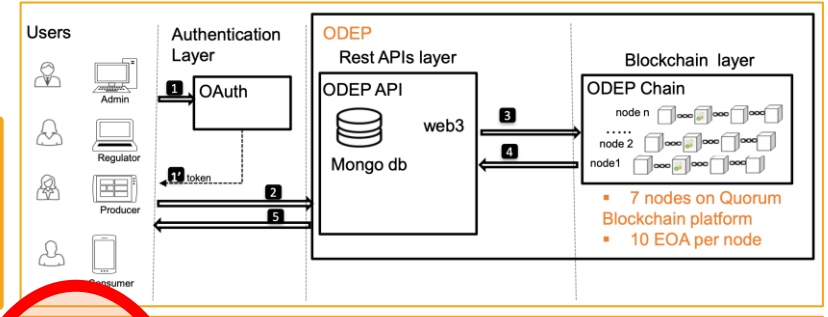


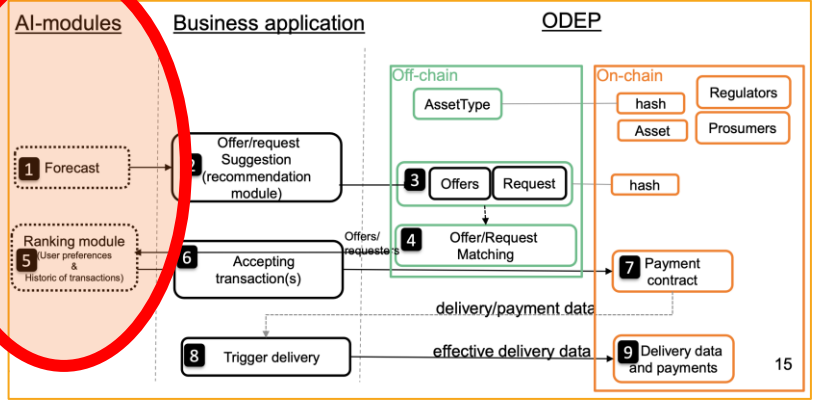
# RESILINK & Orange ODEP platform




**First step**

Orange Decentralized Exchange Place based on Blockchain: ODEP



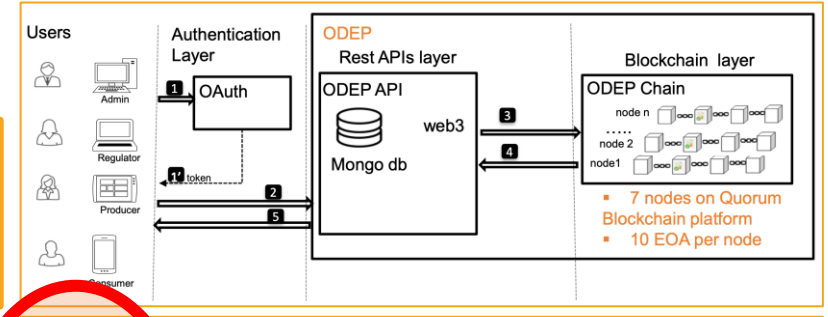


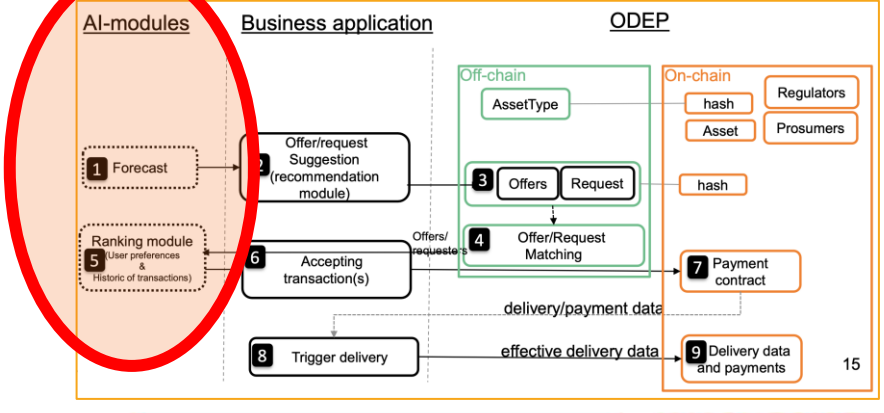


From Orange ODEP presentation. Salma Bradai, Sofrecom

# RESILINK & Orange ODEP platform

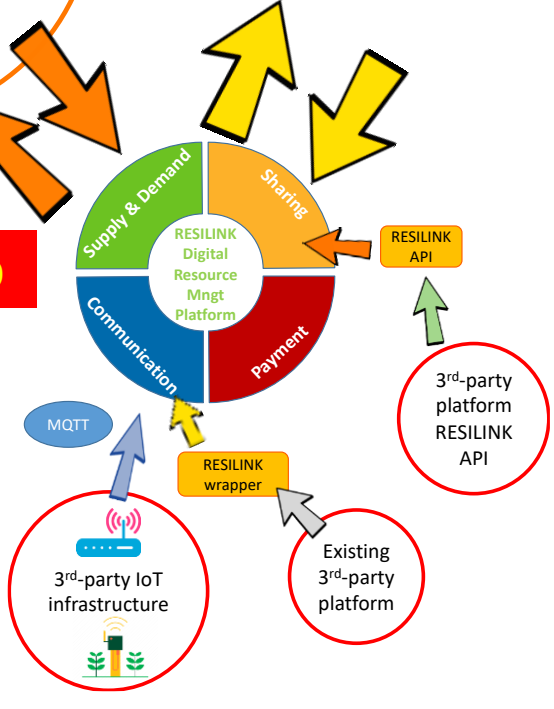

Orange Decentralized Exchange Place based on Blockchain: ODEP




**Second step**

Lightweight platform to be run on Single-Computer-Board that could be locally hosted





From Orange ODEP presentation. Salma Bradai, Sofrecom

# Beyond technology!

Intel-IrriS

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


RESILINK

5 Provide a long-term and sustainable crisis management in the agri-food value chain

6 Improve local innovation capacity and facilitate technology appropriation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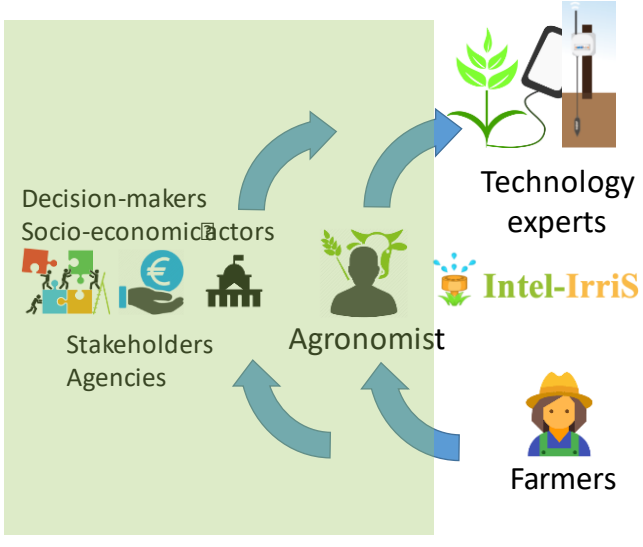
# Collaboration with local actors

- **INSID** (Institut National des Sols et de l'Irrigation et du Drainage, Algeria)
- **INRAA** (Institut National de la Recherche Agronomique, Algeria)
- **National Institute of Vegetable Protection** (Institut National de la protection des végétaux, Algeria)
- **Direction of Agricultural Services of Oran** (Direction des Services Agricoles d'Oran, Algeria)
- **Direction of Agricultural Services of Mostaganem** (Direction des Services Agricoles de Mostaganem, Algeria)
- **Chamber of Agriculture of Mostaganem** (Chambre d'Agriculture de Mostaganem, Algeria)
- **National council of vegetable crop farmers** (Conseil National Interprofessionnel de la Filière des Cultures Maraîchères, Algeria)
- **ORMVAT** (Office Régional de Mise en Valeur Agricole du Tadla, Morocco)
- **ONCA** (Office National du conseil Agricole, Morocco)
- **Association of Irrigation Water Users** (AUEA, Association d'Usagers de l'Eau Agricole, Morocco)




# 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

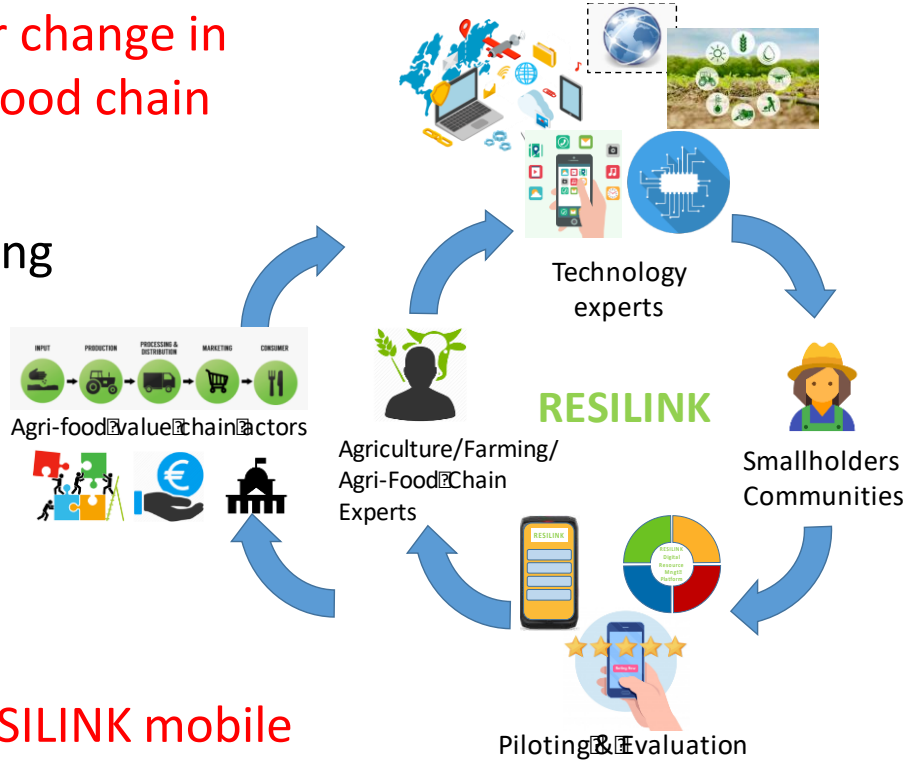
UMAB farm #1, Algeria

INRA farm #1, Morocco

INRA farm #2, Morocco

# Living-Lab piloting program

- RESILINK's approach is a major change in smallholder's traditional agri-food chain
- The RESILINK "living-lab" piloting program will maximize smallholder's acceptability of these new technologies that may imply radically new practices & interaction model
- The sharing principle & the RESILINK mobile app user interface will be extensively tested for more than 2 years



# Conclusions

**Transdisciplinary research for a healthy planet**

- 2 projects targeting smallholder farmer communities with digital platforms and embedded AI
- Although different objectives, some issues are recurrent
  - Technology readiness
  - Technology cost
  - Technology simplicity
  - Technology acceptability & trust
- Transdisciplinary research needs a lot of meetings & discussion!
  - May be obvious remarks but was definitely taking much more time than expected!
- Transdisciplinary research may lead to frustration!
  - Tradeoff in complexity & accuracy
  - Tradeoff in results & impacts

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# Digital platforms and embedded AI to target the smallholder communities


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PRIMA PARTNERSHIP FOR RESEARCH AND INNOVATION IN THE MEDITERRANEAN AREA

Intel-IrriS RESILINK

Advanced and disruptive IoT/AI technologies targeting the smallholder community for increased resilience