

TRANSDISCIPLINARY RESEARCH FOR SUSTAINABLE DEVELOPMENT

illustration
with PRIMA INTEL-IRRIS et PRIMA RESILINK

Workshop Sud-SMART FARMING “New Technologies for Food Security and Sustainable Development”

Bechar University, Algeria, Nov. 5th, 2024

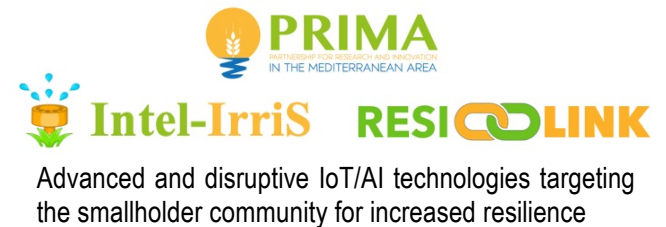
Prof. Congduc Pham
<http://www.univ-pau.fr/~cpham>



Horizon 2020
European Union funding
for Research & Innovation

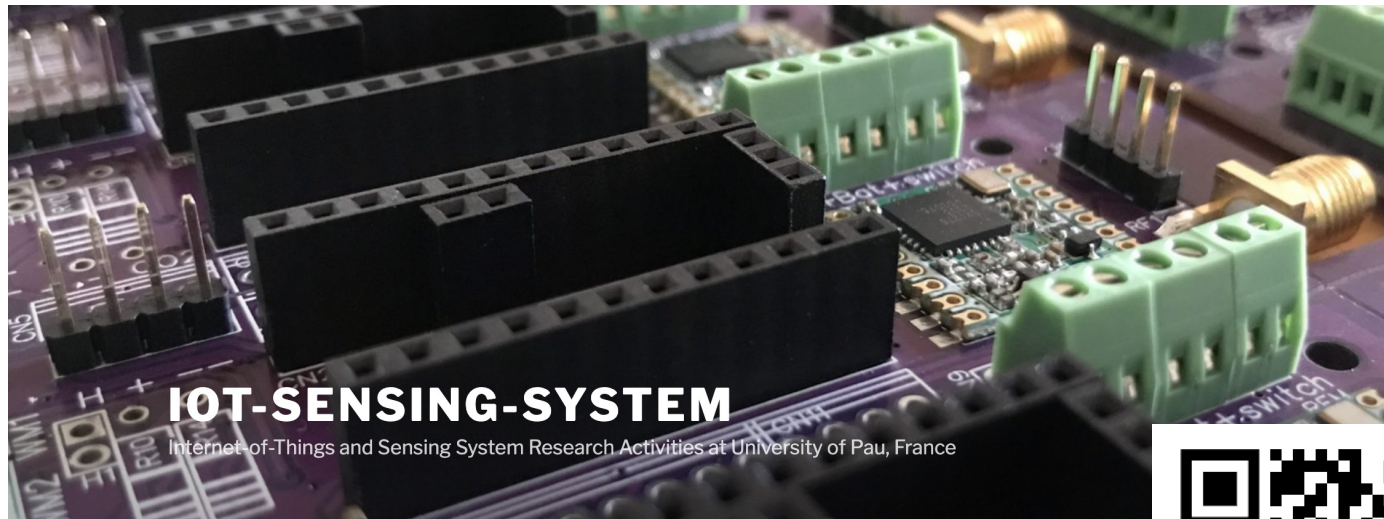


HUBiquitous
Paving for the next 10 years
of innovation in IoT and AI



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

How we moved to more transdisciplinary?



WIRELESS SYSTEMS

PERFORMANCE

EVALUATION

RESOURCE ALLOCATION

**MEDIUM ACCESS
CONTROL**

IOT & SENSING SYSTEMS



How we moved to more transdisciplinary?



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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

How we moved to more transdisciplinary?

**Smarter Agriculture
for Small Farms**



**The more
you scale...
you finally
reach the
users!**

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

More scaling-up
More capacity-building

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

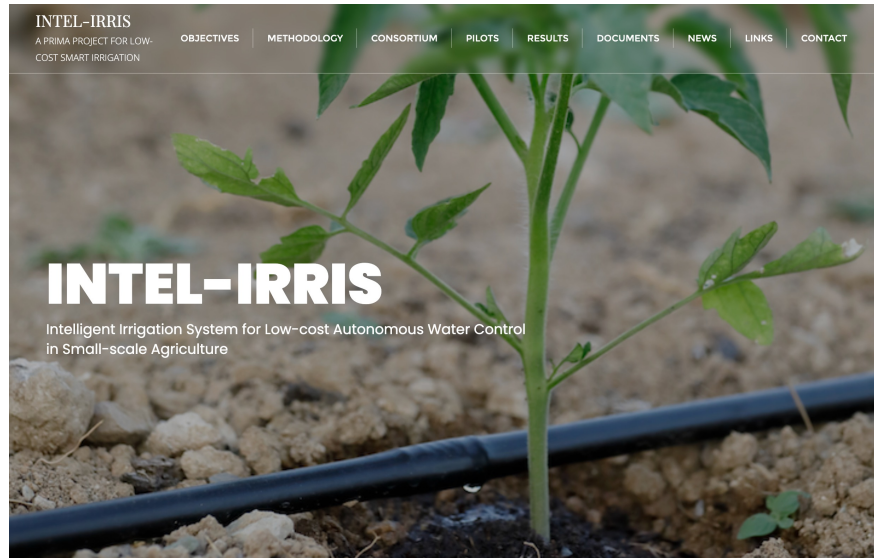
IoT – from idea to reality

Integration &
Technologies

Scaling-up
with DIHs



2 transdisciplinary projects

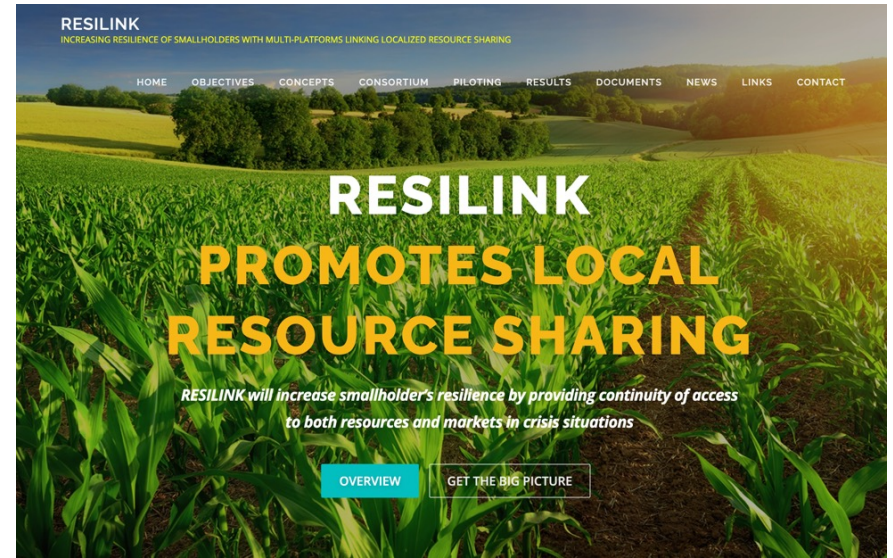


<https://intel-irris.eu>

June 2021-24



Optimize irrigation in small-scale agriculture farms



<https://resilink.eu>

June 2022-26

Resource sharing in smallholder communities in crisis situation





This project is part of the PRIMA Programme supported by the European Union



Intel-Irris



INTEL-IRRIS

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

Optimize Irrigation in Small-Scale Agriculture Farms



Digital Innovation in Agriculture?

🕒 THERE ARE LOT'S OF DIGITAL INNOVATION IN AGRICULTURE!





Digital innovation for all farmers?



Technologies

- Too expensive
- Too integrated
- Highly specialized
- Difficult to customize
- Difficult to upgrade
- Vendor lock-in SW&HW
- Heavily rely on Clouds & Internet servers



Out of reach for smallholders!

Possible for large farms



INTEL-IRRIS's starter-kit

FROM IDEA TO REALITY!



Small-scale farms,
Smallholder Farmers



**NO INTERNET
FULL EDGE
MODE 😊**

Prof. Congduc Pham
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Programme supported by the
European Union



Packaging: 2 versions of the soil device



Volumetric
Water
Content
(VWC)

Soil
Water
Potential
(SWP)

~ 30€

~ 60€

SEN0308
capacitive sensor

Watermark WM200
Water tension sensor



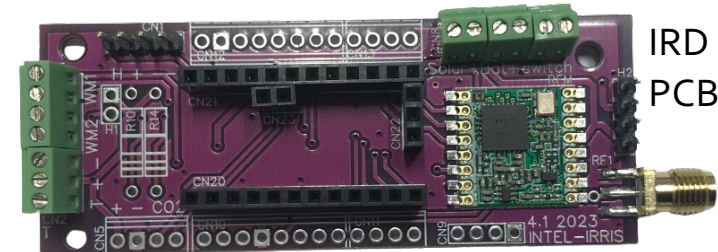
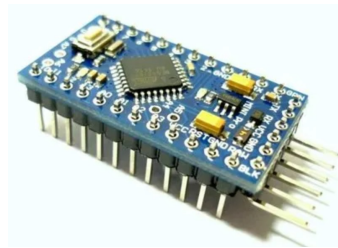
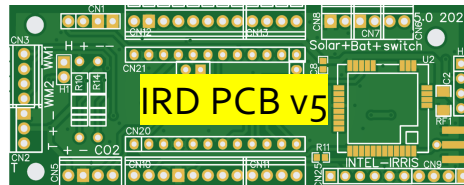
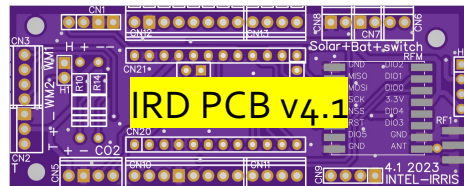
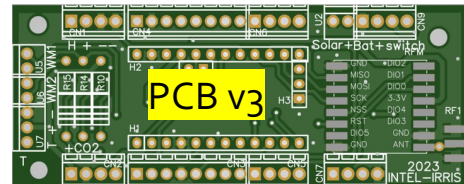
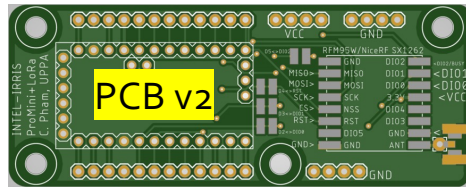
A soil temperature
sensor can be added

Especially for
tensiometer

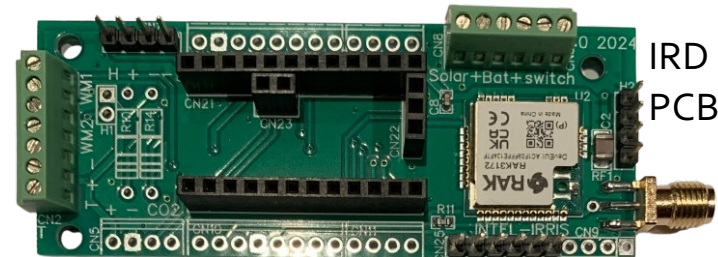


Design of hardware platform

- OPEN SOURCE PCB, VERY MODULAR DESIGN
- EASY WIRING OF PHYSICAL SENSORS, PLACEHOLDER FOR RESISTORS
- LARGER VARIETY OF PHYSICAL SENSORS
- **2 YEARS OF AUTONOMY WITH 2 AA ALKALINE BATTERIES**
- SOLAR CHARGING CAPABILITIES → INFINITE AUTONOMY



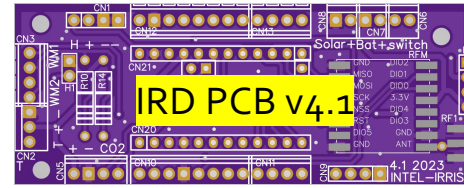
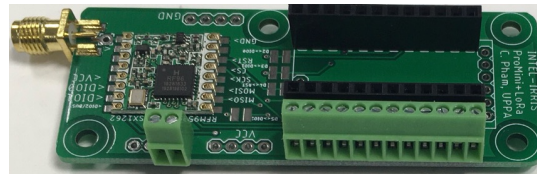
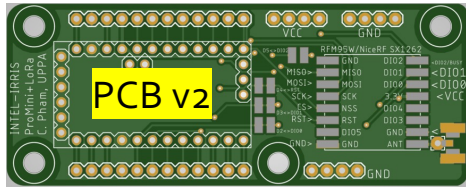
IRD PCBA v4.1



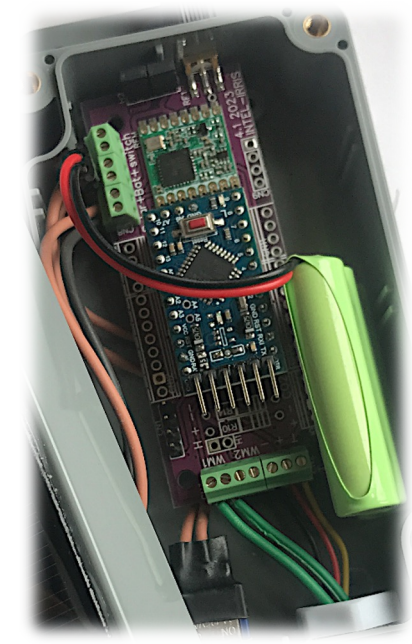
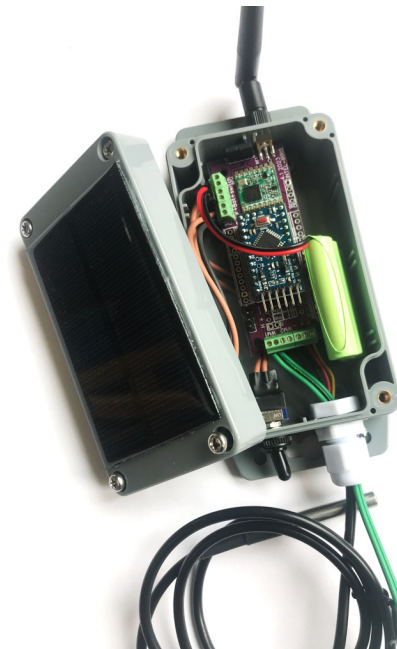
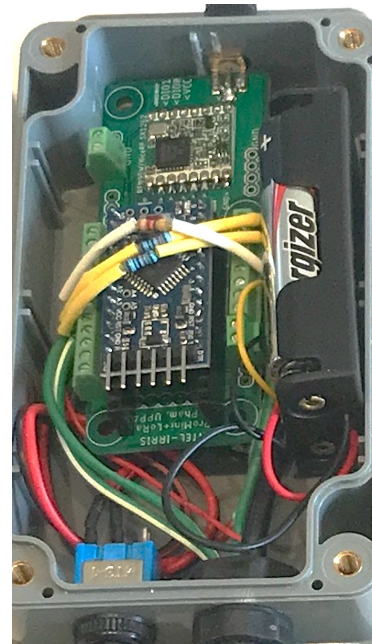
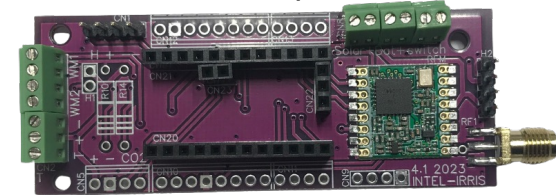
IRD PCBA v5



From v2 to v4.1

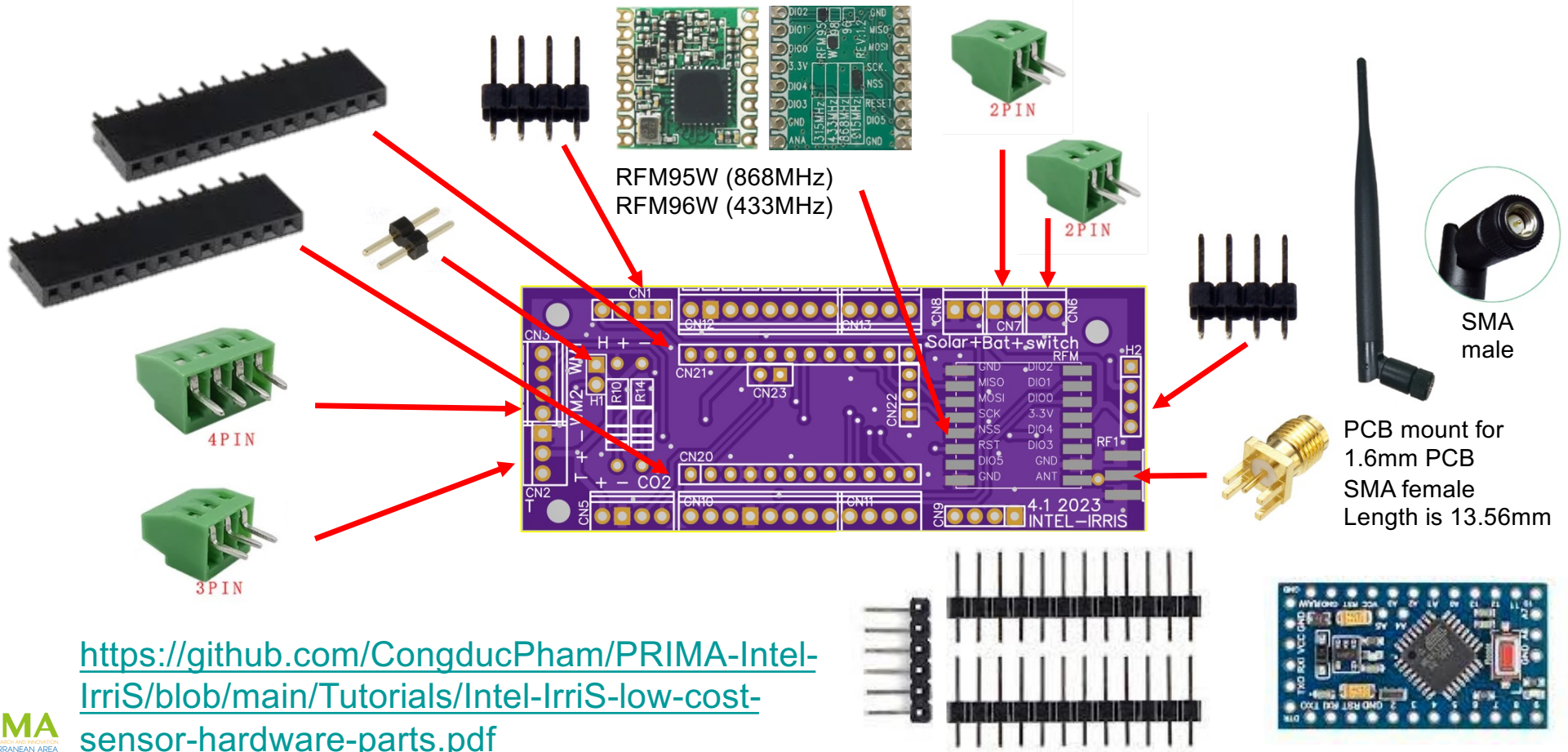


IRD
PCBA v4.1

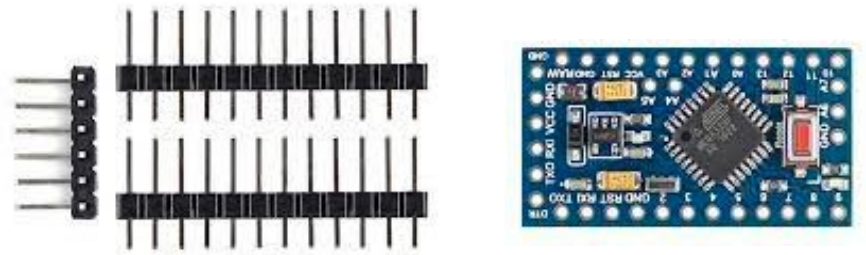




We started with full Do-It-Yourself approach



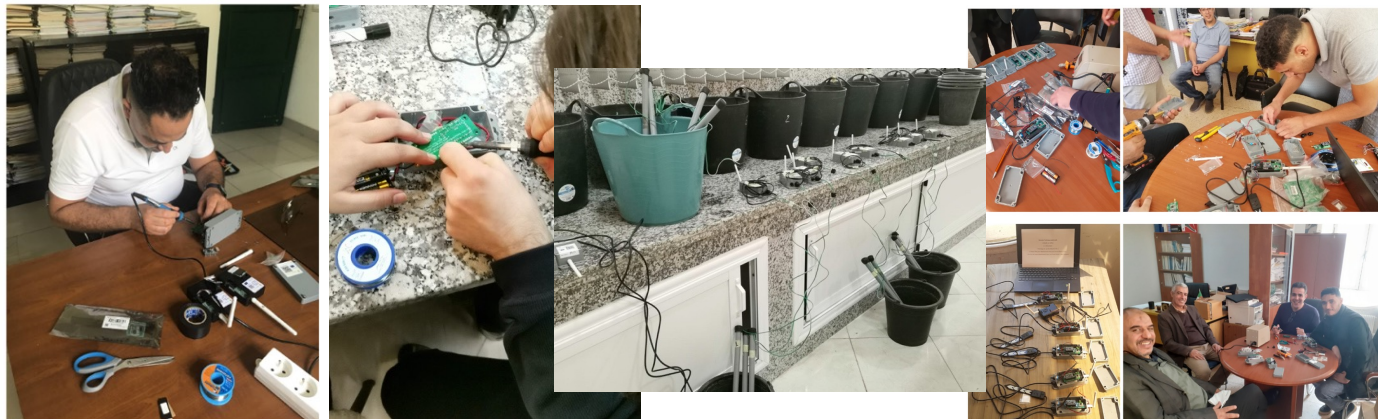
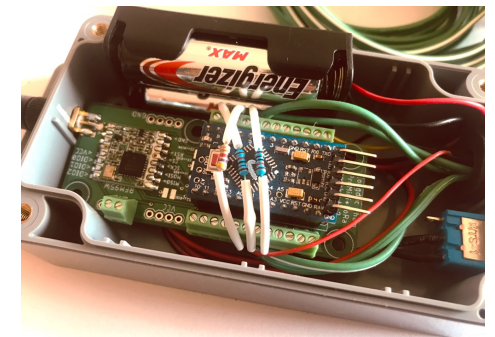
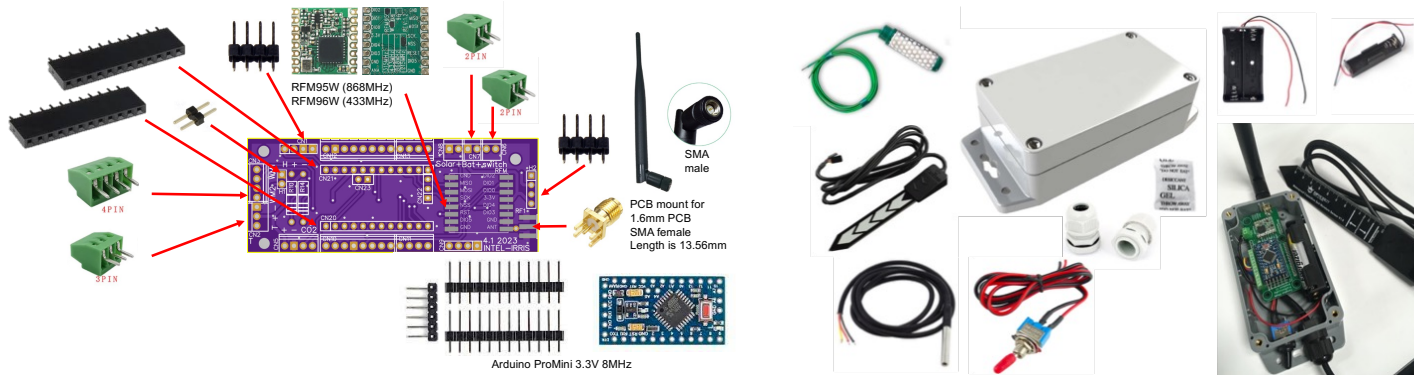
<https://github.com/CongducPham/PRIMA-Intel-IrriS/blob/main/Tutorials/Intel-IrriS-low-cost-sensor-hardware-parts.pdf>



Arduino ProMini 3.3V 8MHz



Great for capacity-building, but ...



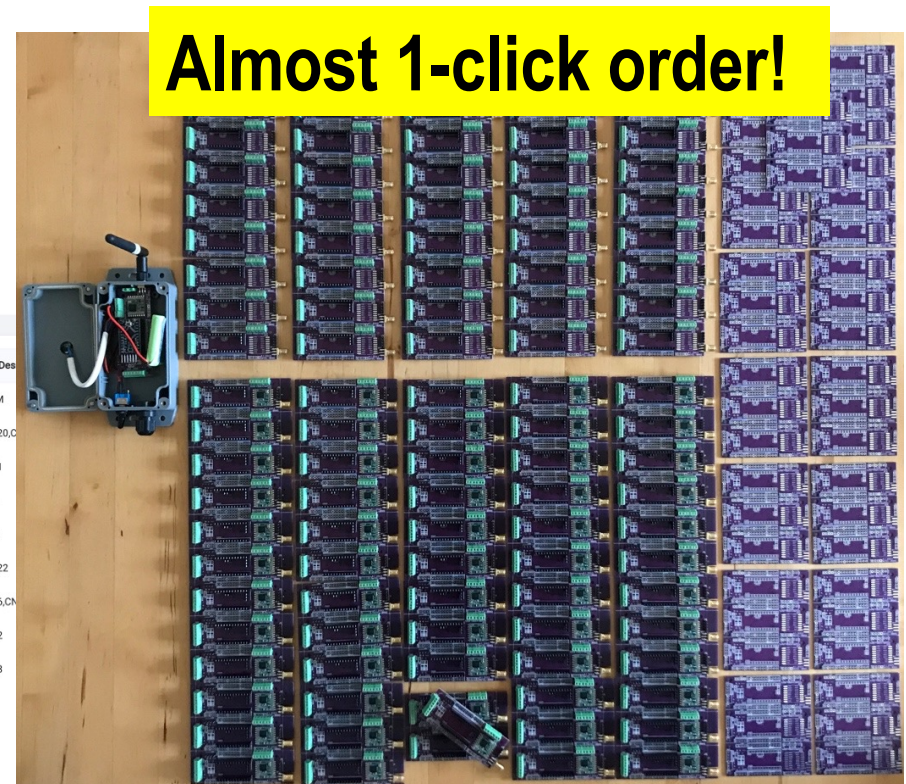


...but we are also working with agronomist! or scientists from other disciplines

- Manufacturing files are freely available
- Ordering the fully assembled PCB is very simple from PCB manufacturers



~ 8€/piece if QT > 100





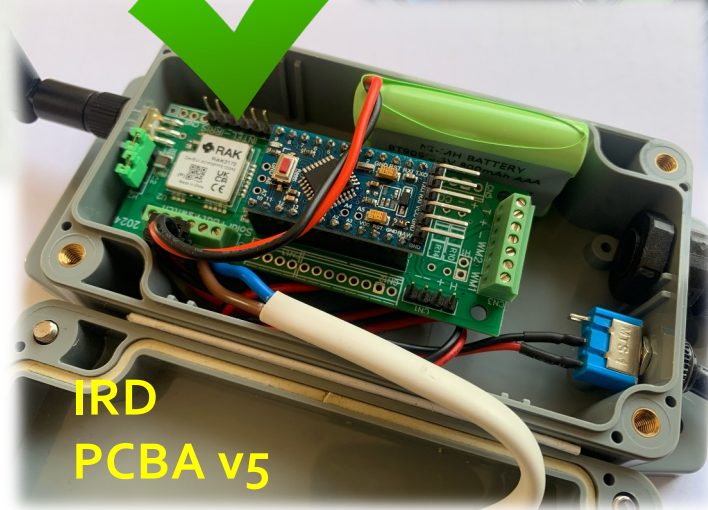
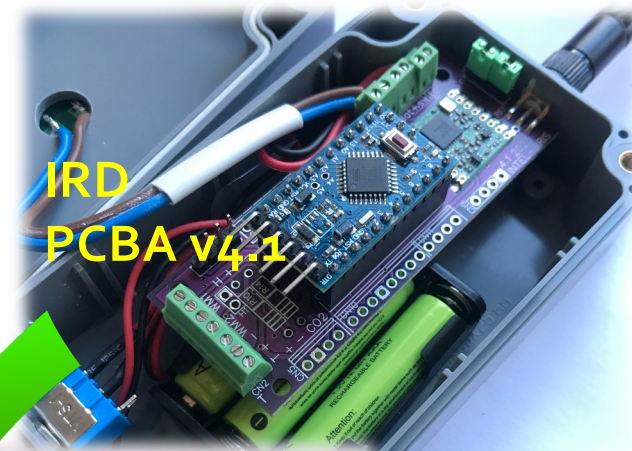
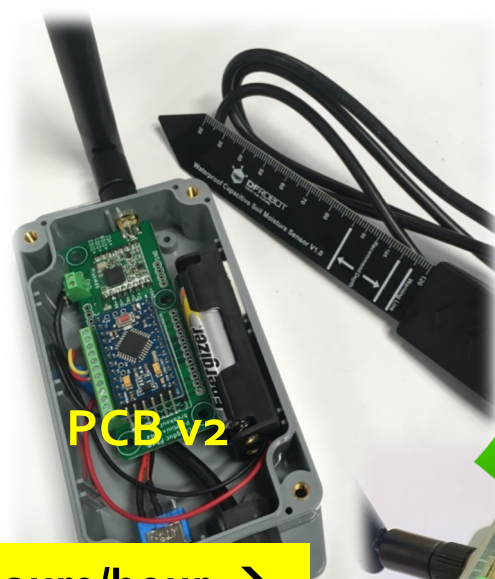
COST-EFFECTIVE, MODULAR & OPEN HARDWARE PLATFORM

EASY & ROBUST INTEGRATION

With 1 measure/hour → ~ 2 years of autonomy on alkaline batteries!



2500mA

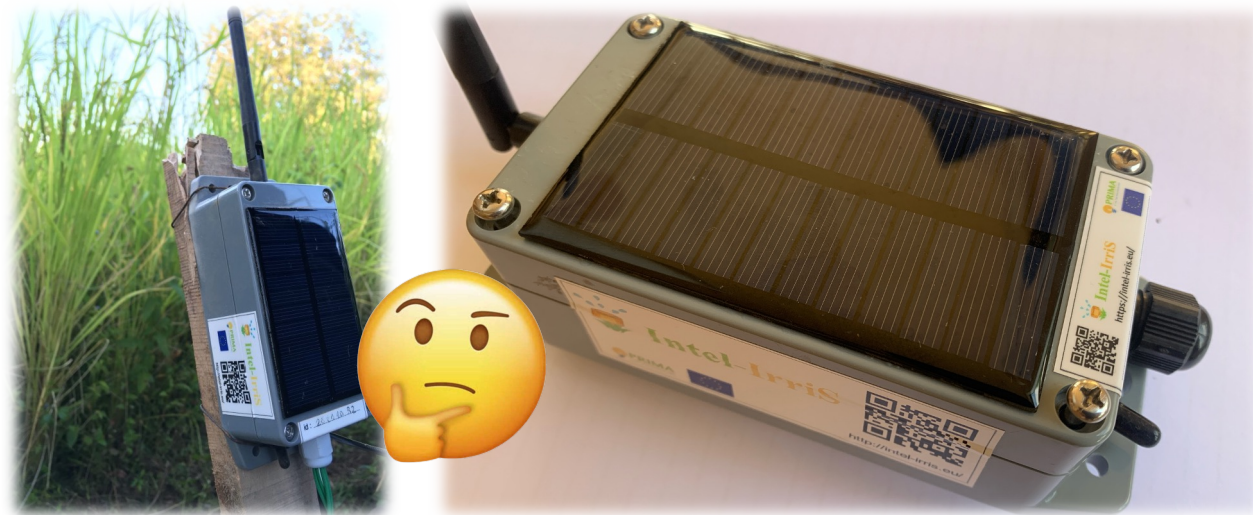




COST-
EFFECTIVE,
MODULAR &
OPEN
HARDWARE
PLATFORM

**SOLAR OR NOT
SOLAR?**

- **FOR FARMERS**, SOLAR PANEL & SOLAR CHARGING CAPABILITY IS NOT CRUCIAL, PROVIDED THAT AUTONOMY CAN BE SEVERAL YEARS
- SOLAR PANEL MAKES DEVICES MORE FRAGILE
- USUALLY, DEVICES NEED TO BE COLLECTED AND STORED WHEN HARVESTING AND PLOUGHING





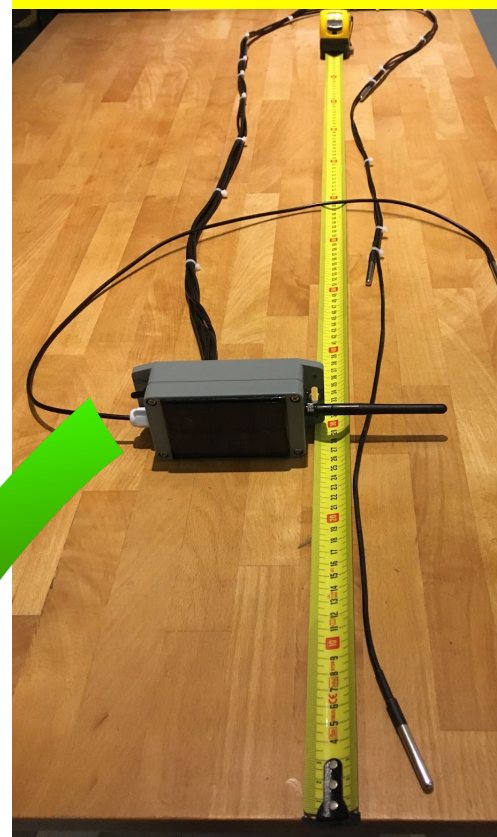
HIGHLY
ADAPTABLE
FOR AD-HOC
DESIGNS

SUITABLE FOR
A LARGE
VARIETY OF
APPLICATIONS

2 WATERMARK SENSORS



6 TEMPERATURE SENSORS



AIR TEMP/HUM





TARGETING THE SMALLHOLDER FARMER COMMUNITIES

OUT-OF-THE-BOX, EASY DEPLOYMENT

- SIMPLE CAPACITIVE SENSOR DEVICE IS EASILY INSTALLED BY SMALLHOLDERS THEMSELVES
- WATER TENSION SENSORS REQUIRE MORE PREPARATION AND NEED ASSISTANCE OF PARTNERS

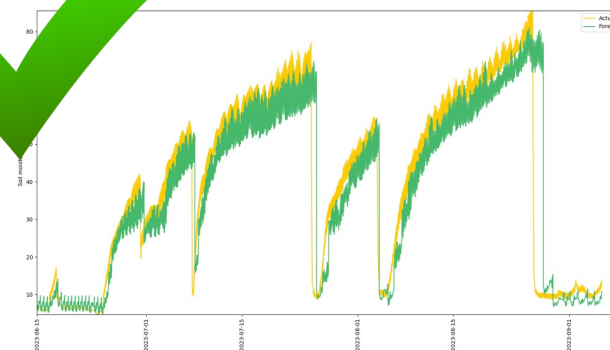




TARGETING THE
SMALLHOLDER
FARMER
COMMUNITIES

FULLY
AUTONOMOUS
NO INTERNET

- FULLY AUTONOMOUS, NO NEED FOR INTERNET CONNECTIVITY, REMOTE SERVERS OR CLOUDS
- ALL SENSOR DATA ARE PROCESSED LOCALLY ON A VERSATILE IOT GATEWAY – FULL EDGE MODE
- PROOF-OF-CONCEPT OF EMBEDDED AI



sliding windows pre-treatment & LSTM

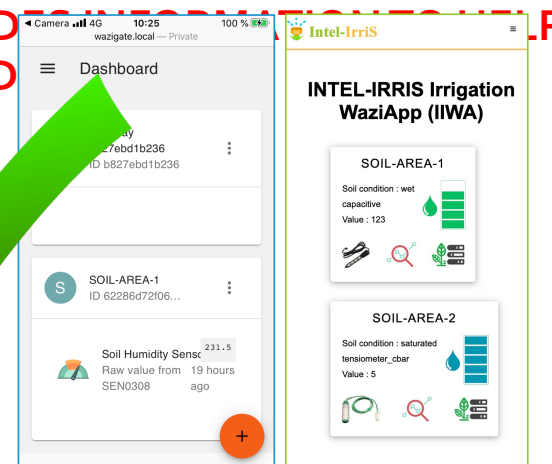
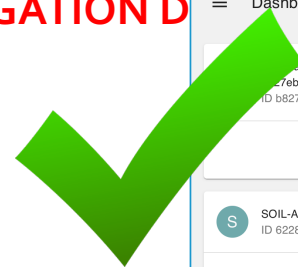


TARGETING THE SMALLHOLDER FARMER COMMUNITIES

USER INTERFACES

MULTIPLE VIEWS ARE AVAILABLE

- FULLY AUTONOMOUS, NO NEED FOR INTERNET CONNECTIVITY, REMOTE SERVERS OR CLOUDS
- ALL SENSOR DATA ARE PROCESSED LOCALLY ON A VERSATILE IOT GATEWAY
- PROOF-OF-CONCEPT OF EMBEDDED AI
- **SIMPLE AND INTUITIVE USER INTERFACE**
- **EMBEDDED APPLICATION PROVIDES SUPPORT TO SMALLHOLDERS IN IRRIGATION DECISION MAKING**

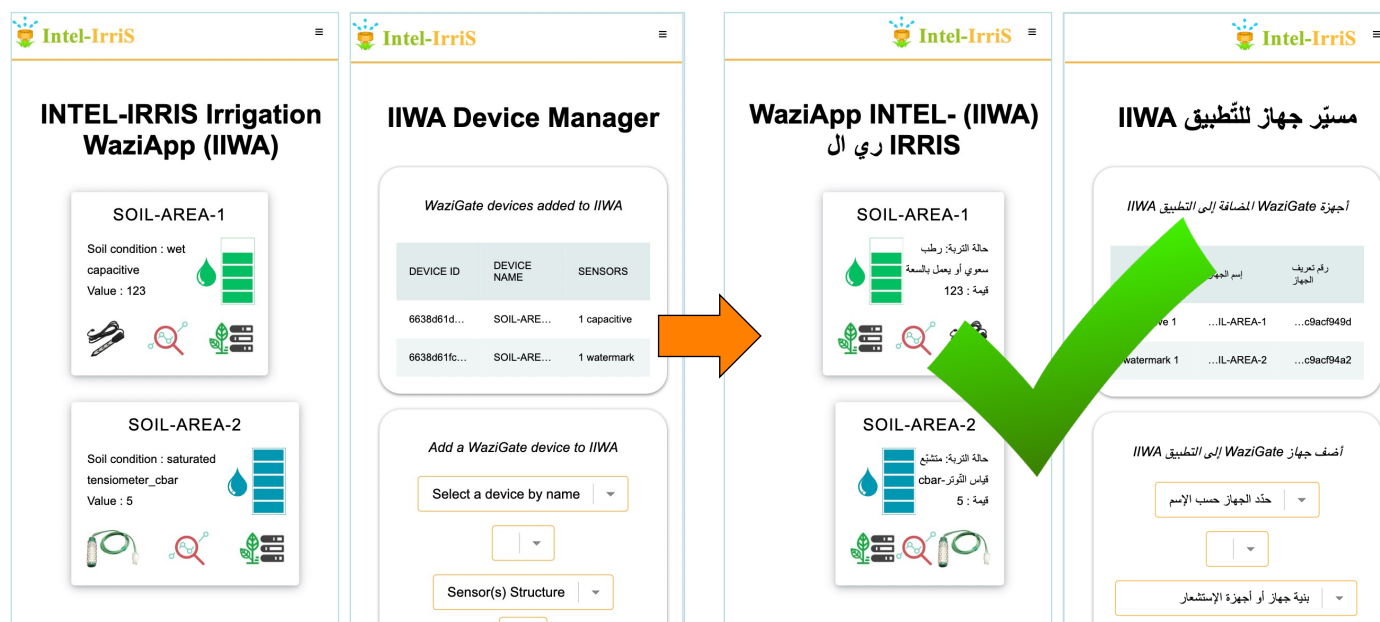




TARGETING THE SMALLHOLDER FARMER COMMUNITIES

USER INTERFACES

LOCAL LANGUAGE!



The figure displays four screenshots of the Intel-Irris user interfaces, arranged from left to right. An orange arrow points from the second screenshot to the third, and a large green checkmark is overlaid on the third and fourth screenshots.

- First Screenshot (English):** Titled "INTEL-IRRIS Irrigation WaziApp (IIWA)". It shows two soil area monitoring cards:
 - SOIL-AREA-1:** Soil condition: wet, capacitive, Value: 123.
 - SOIL-AREA-2:** Soil condition: saturated, tensiometer_cbar, Value: 5.
- Second Screenshot (English):** Titled "IIWA Device Manager". It shows a table of "WaziGate devices added to IIWA":

DEVICE ID	DEVICE NAME	SENSORS
6638d61d...	SOIL-ARE...	1 capacitive
6638d61f...	SOIL-ARE...	1 watermark

 Below the table is a section "Add a WaziGate device to IIWA" with a dropdown menu "Select a device by name" and a "Sensor(s) Structure" dropdown.
- Third Screenshot (Arabic):** Titled "WaziApp INTEL- (IIWA) ري ال IRRIS". It shows two soil area monitoring cards:
 - SOIL-AREA-1:** حالة التربة: رطب, سعوي أو يعمل بالسمعة, قيمة: 123.
 - SOIL-AREA-2:** حالة التربة: مشبع, قياس التوتر-cbar, قيمة: 5.
- Fourth Screenshot (Arabic):** Titled "مسير جهاز للتطبيق IIWA". It shows a section "أجهزة WaziGate المضافة إلى التطبيق IIWA" with a table:

رقم تعريف الجهاز	اسم الجهاز
...c9ac949d	...IL-AREA-1
...c9ac94a2	...IL-AREA-2

 Below the table is a section "أضف جهاز WaziGate إلى التطبيق IIWA" with a dropdown menu "حدد الجهاز حسب الاسم" and a dropdown menu "بنية جهاز أو أجهزة الاستشعار".



RAISE
AWARENESS
EVENTS

CAPACITY
BUILDING

PILOTING WITH
FARMERS

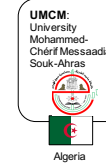
KNOWLEDGE
SHARING

- BIG SUPPORT & ENGAGEMENT FROM LOCAL PARTNERS
- **NOTHING WOULD HAVE BEEN POSSIBLE WITHOUT THE CONTINUOUS SUPPORT FROM LOCAL RESEARCH TEAMS!**





This project is part of the PRIMA Programme supported by the European Union



RESILINK

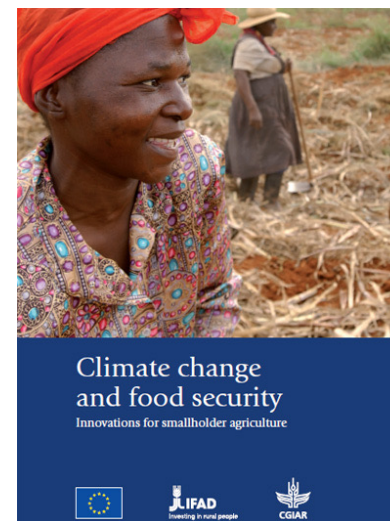
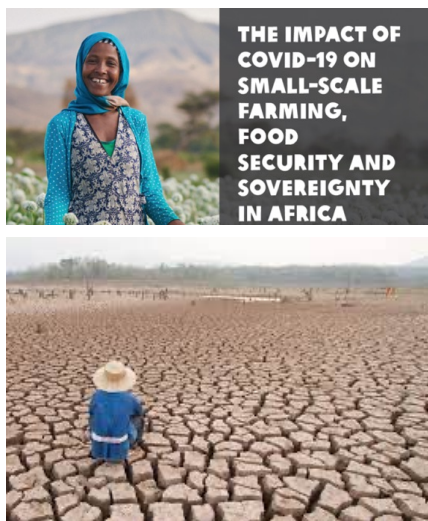
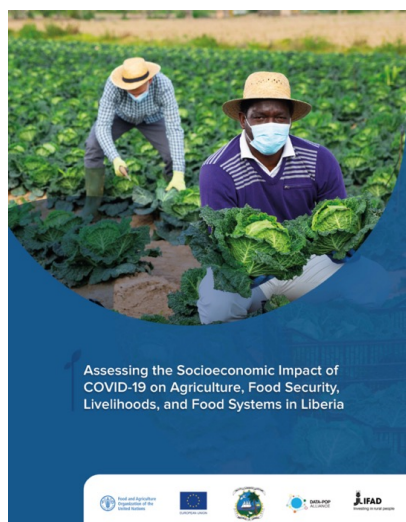
INCREASING RESILIENCE OF SMALLHOLDERS WITH MULTI-PLATFORMS LINKING LOCALIZED RESOURCE SHARING

RESOURCE SHARING IN SMALLHOLDER COMMUNITIES IN CRISIS SITUATION



Motivations

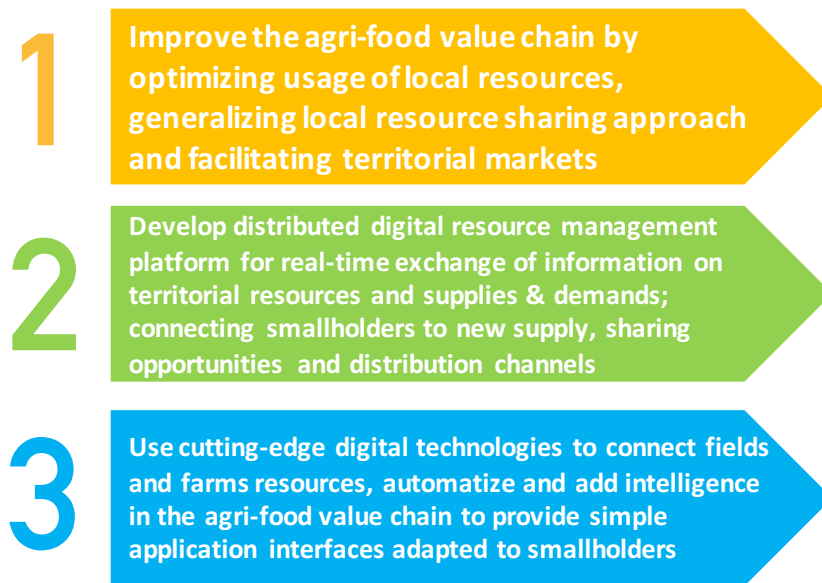
- Smallholders are more likely to suffer from crisis or disasters. They are the first to be impacted by climate change, unexpected crises. They are very economically fragile!
- RESILINK** aims to increase smallholder's resilience by providing continuity of access to both resources and markets in crisis situations
- It promotes localized use of resources with **digital platforms**





The 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**, keeping them informed of **news/alarms/regulations** from government agencies

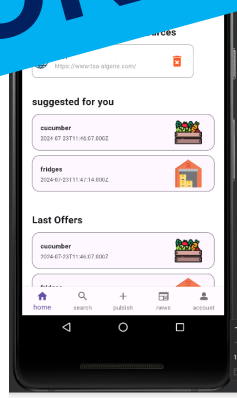




The RESILINK mobile application

- The RESILINK mobile application connects to the RESILINK digital platform to **publish & search for resources**
- It **connects smallholders to new supply opportunities & distribution channels**, keeping them informed of **risks/alerts/regulations** from...

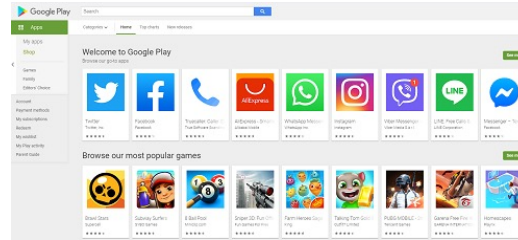
OK – WHAT'S NEW?





Are we going the right way?

- There are already a lot of digital platforms, they are already **key element of the digital transformation**



- BUT**, usually, **each new digital platform or solutions will try to create its own community!**
- Sharing between communities is usually not proposed in traditional platforms. Rather, the main objective is competition and isolation to other communities



No "one app fits all"

- Competition → isolation → fragmented ecosystems



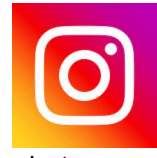
LinkedIn



Facebook



AirBnB



Instagram



WhatsApp



YouTube

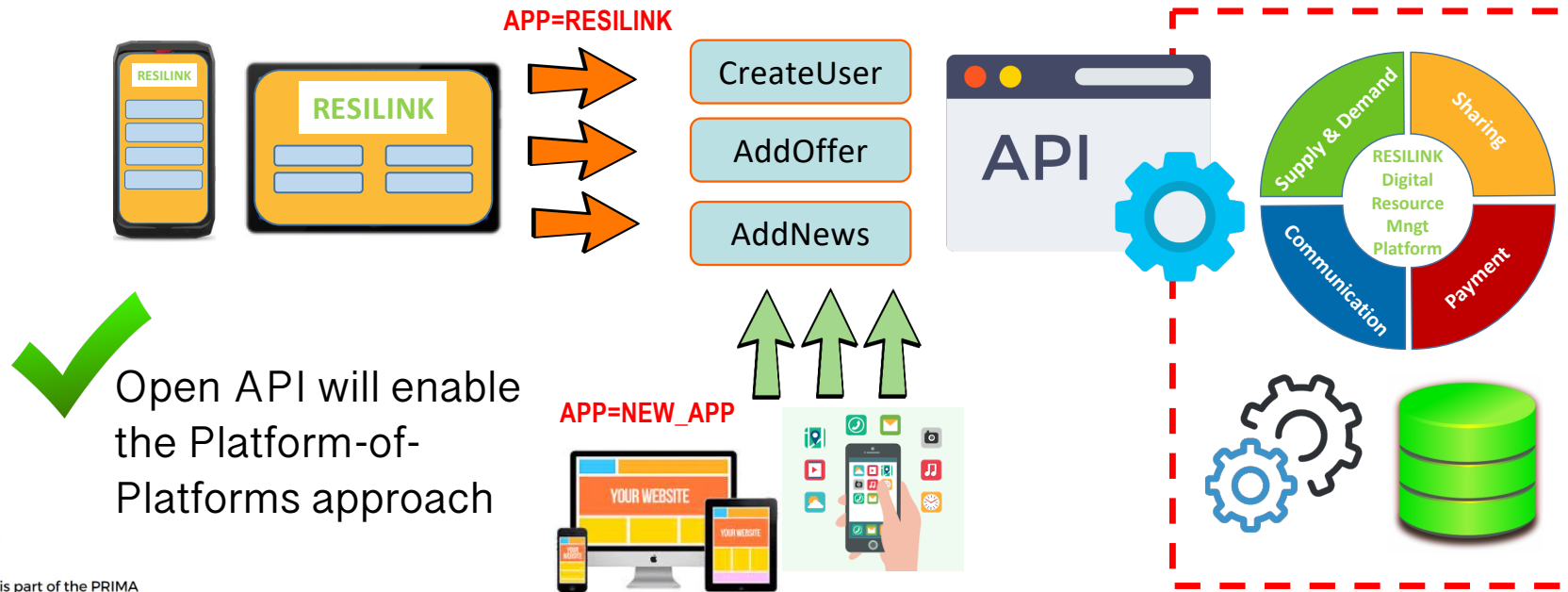


- Platform-of-Platforms!
- Enabling a platform-of-platforms approach will promote a much wider and appealing ecosystem
- Specialized platforms to better manage specific agricultural sectors
- Discover resources/services from other platforms → no isolation



API: key to large adoption!

- API: **Application Programming Interface**
- Digital platforms better than Applications thanks to API-oriented design
- All functionalities/actions are accessible through an API call

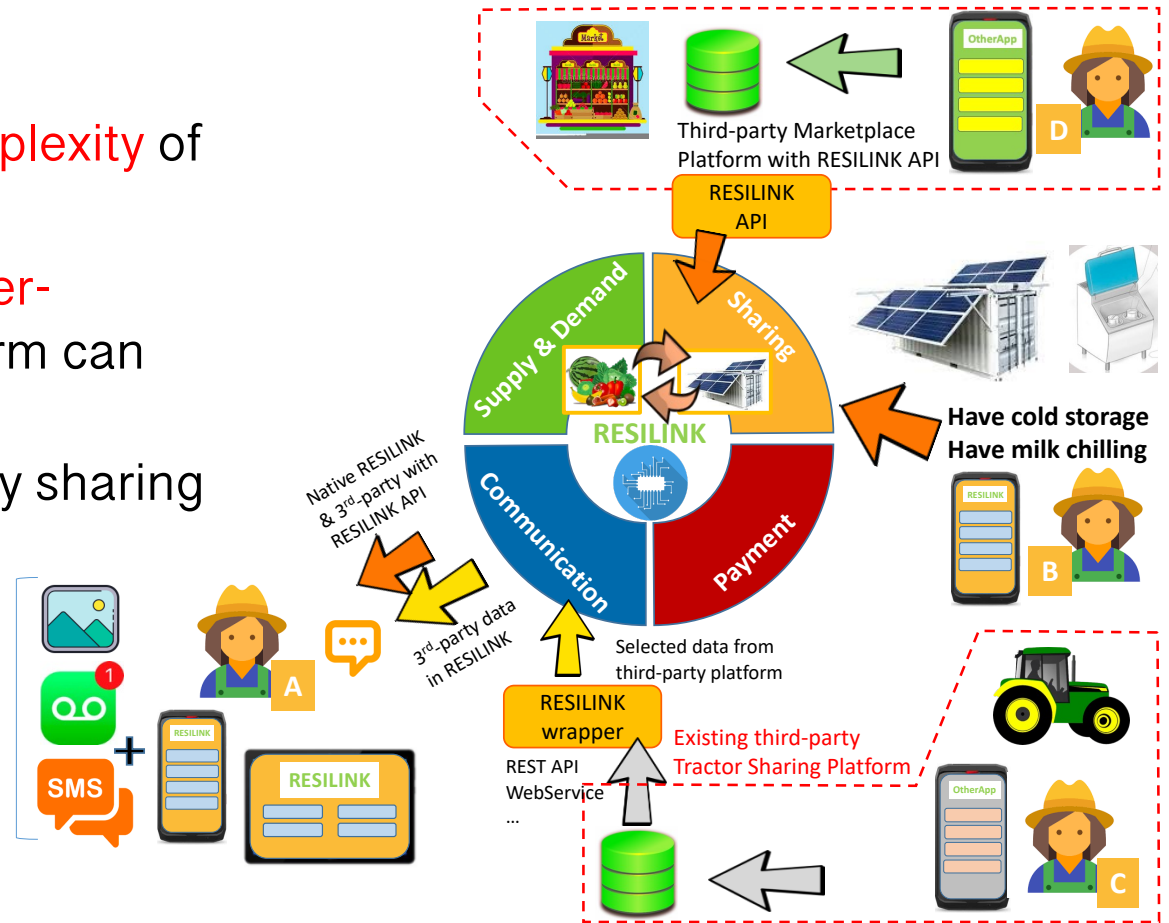


✓ Open API will enable the Platform-of-Platforms approach



Stimulating local innovation?

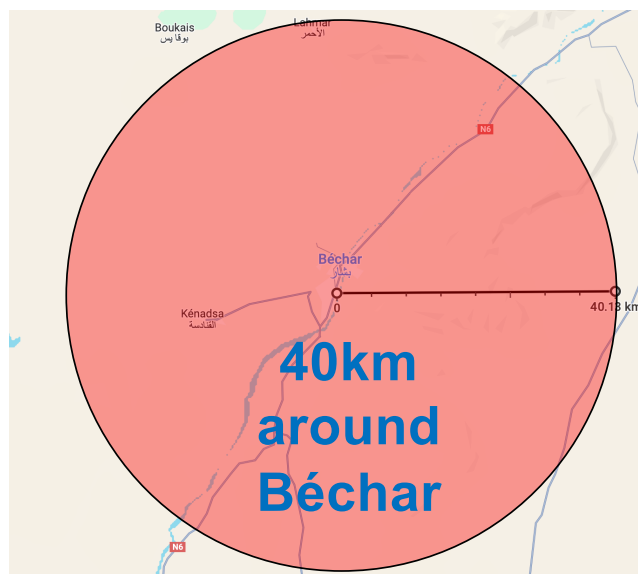
- The open API will **reduce development time & complexity** of new platforms
- All platforms **can fully inter-operate** and a new platform can benefit from all the other platforms' communities by sharing users & contents
- RESILINK develops a consistent API to **enable fast development and deployment** platforms





Now, where are local resources?

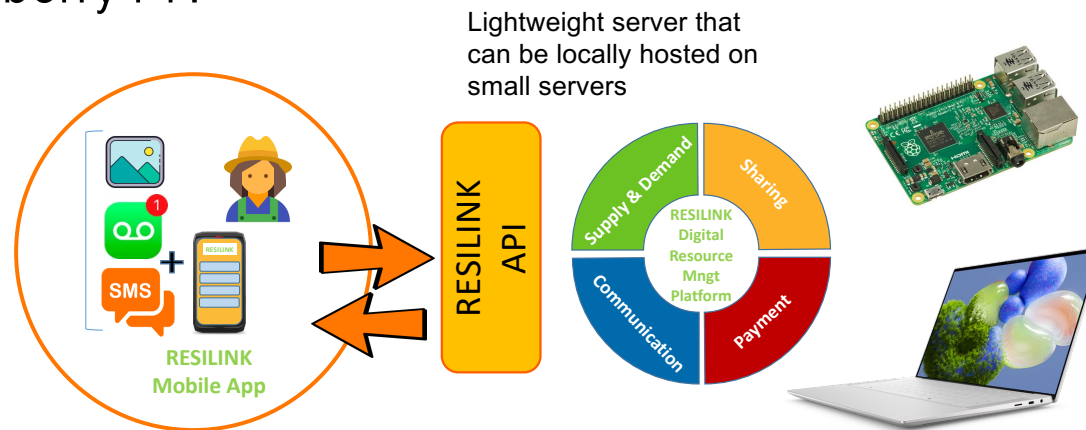
- Local resources are... **local!**
- In crisis situation, the objective is to rely & discover resources linked to a small geographical area





Light-weight servers & fast deployment

- The RESILINK digital platform server can run on a small server, even on a Raspberry Pi!



- A RESILINK server can be **locally deployed** by local city government agencies, agriculture cooperatives, agriculture services, ... in 1 hour!



Incremental deployment

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



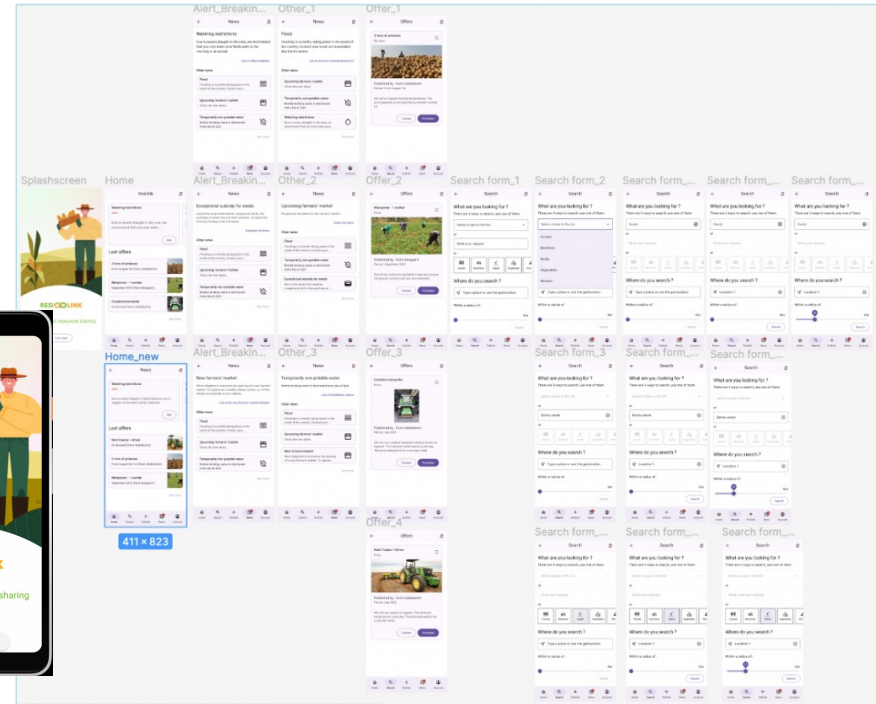
This project is part of the PRIMA Programme supported by the European Union



Increase/ensure acceptability!

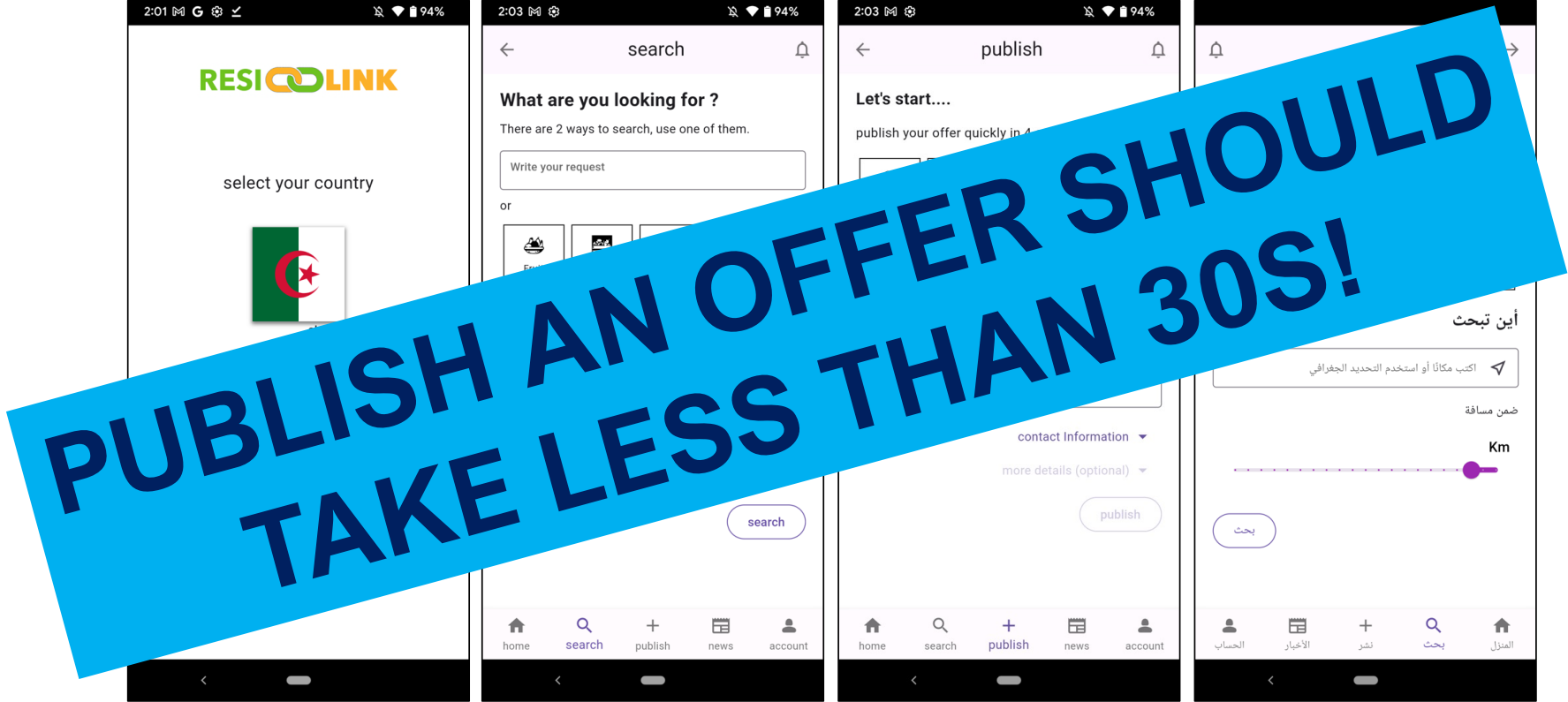
- Test & validate the new & innovative functionalities
- Test & validate User Experience & User Interface (UX/UI)

From March 2023 to May 2024. A series of workshops and interviews with questionnaires and then with the RESILINK mobile application mockup have been conducted by our Algerian, Egyptian and Moroccan research teams to ensure that proposed functionalities meet the farmers' needs and expectations. It was a great source of information to prepare the piloting in Living-Lab mode. Congrats to UMCM (Algeria), ARC (Egypt), INRA & USMS (Morocco) for their hard work!





User Interface / User Experience



At first run, you need to select your country

The "Search" screen

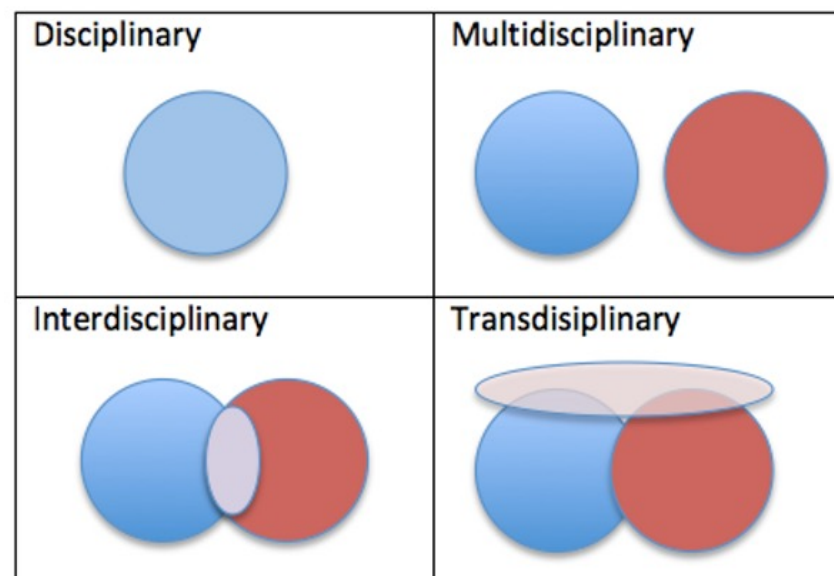
The "Publish" screen

You can switch to Arabic in the Account/Language menu

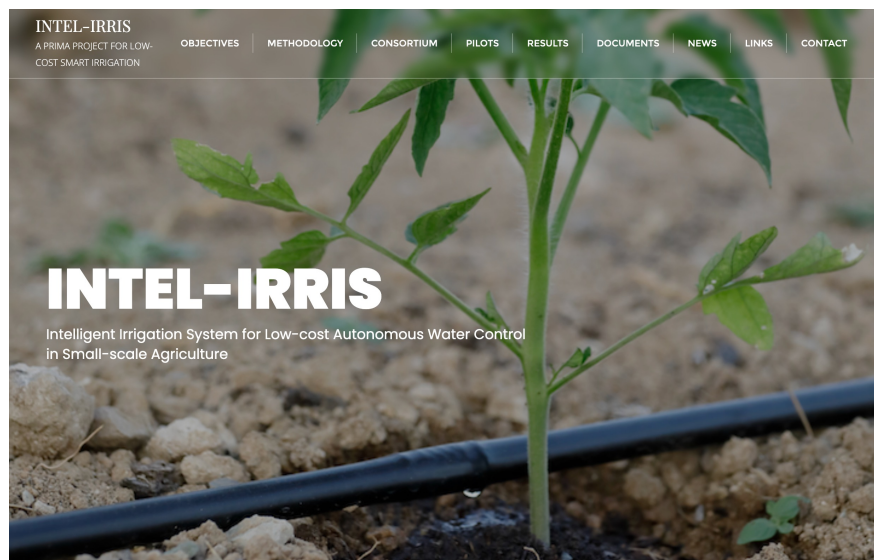


Conclusions

- Going to more transdisciplinary takes a lot of efforts and a lot of time!
- You need do **more than listen** to other colleagues!
- But, at the end, it is very rewarding!
- And, most importantly, you can discover **new research challenges, you would not have considered!**



Want to know more?



<https://intel-irris.eu>

June 2021-24



Optimize irrigation in small-scale agriculture farms



RESILINK

<https://resilink.eu>

June 2022-26

Resource sharing in smallholder communities

