IoT and DSS solutions for <u>Rural</u>: Smart-Agri & Smart-Water
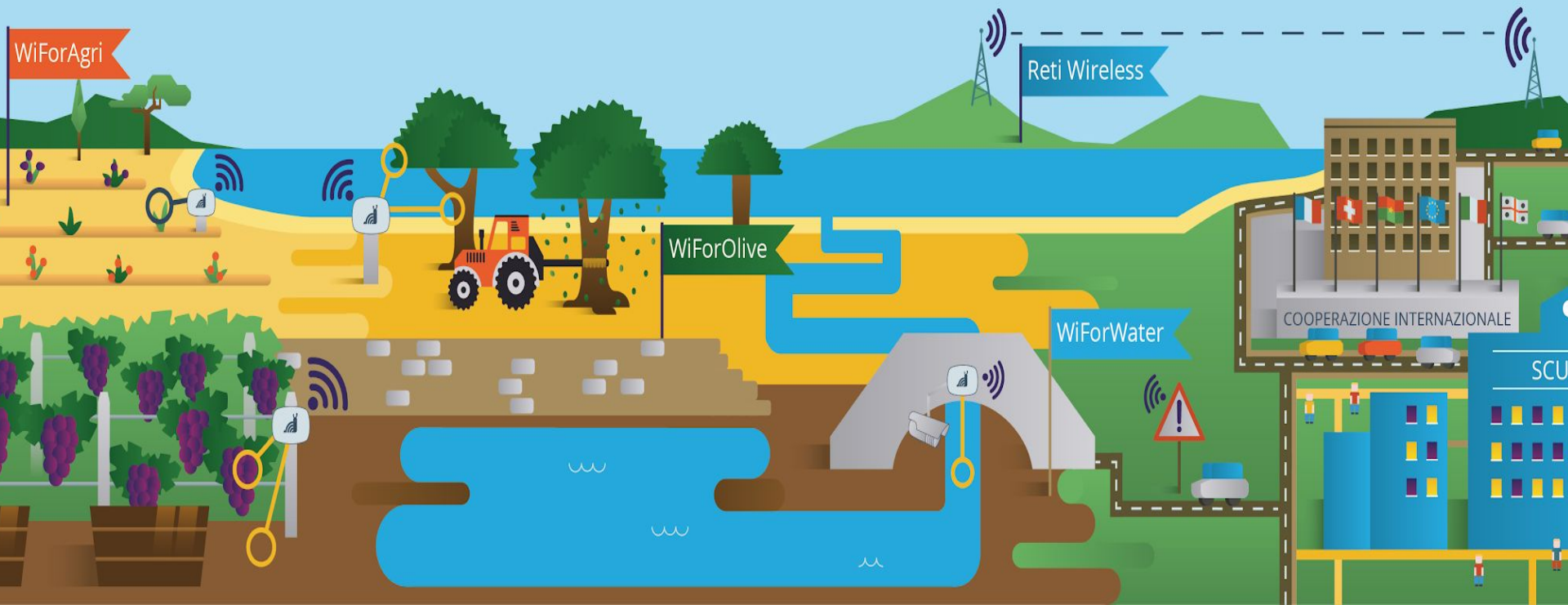
PRIMO PRINCIPIO

Trieste, 20/01/2019
Federico Longobardi
CTO - Primo Principio
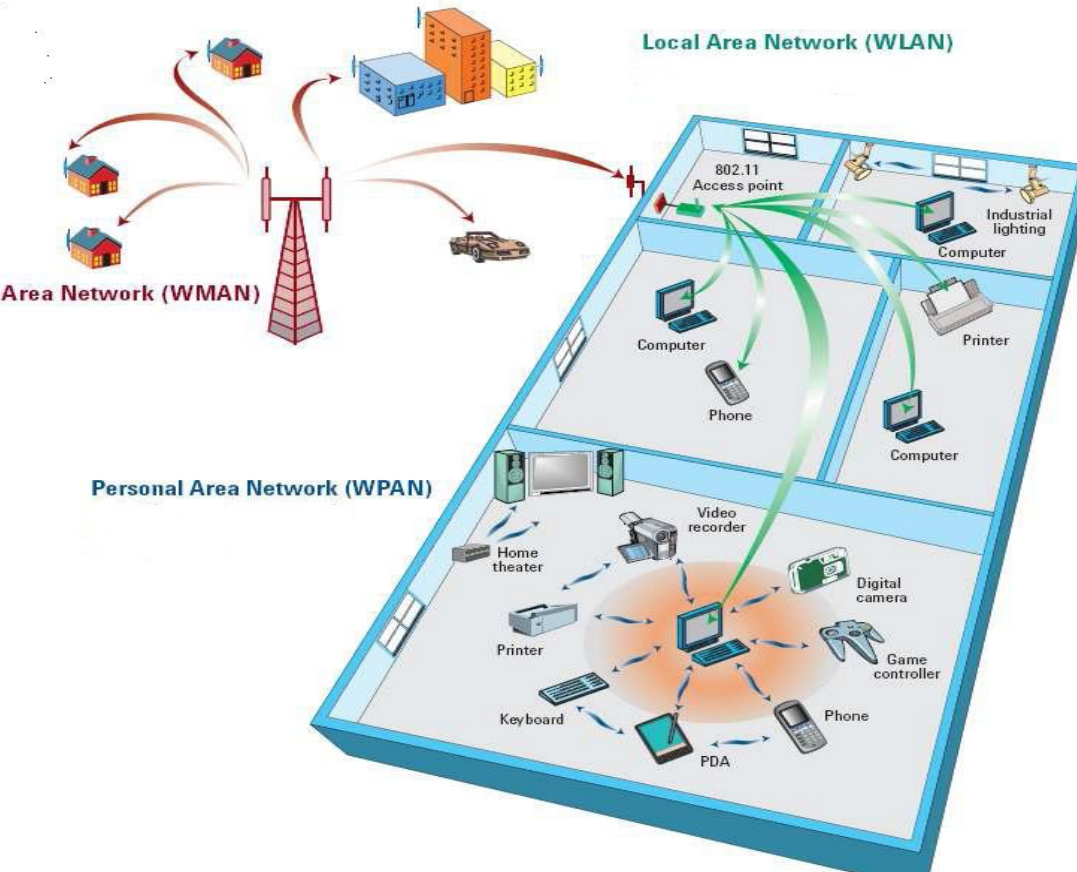*www.PrimoPrincipio.it*

AREA SCIENCE PARK

Smart-City vs Smart-Technology for the rural world

Smart-City vs Smart-Technology for the rural world

Rural → constraints:

1. **Stand-alone energy** management (no power-grid):
   - mini-wind system
   - mini-solar system
   - only battery (deep-sleep is needed)

2. **Stand-alone and/or long-range TLC system**:
   - transport data toward the nearest Internet Gateway...saving your battery;
   - local data backup;

3. Almost **zero-maintenance**:
   - remote monitoring
   - rock-solid hardware

Let's listen to this story: *"Sensor application from Libelium"*

IoT Working Areas → Agriculture

SMART AGRICULTURE

41 **Wine Quality Enhancing**
Monitoring soil moisture and trunk diameter in vineyards to control the amount of sugar in grapes and grapevine health.

42 **Green Houses**
Control micro-climate conditions to maximize the production of fruits and vegetables and its quality.

43 **Golf Courses**
Selective irrigation in dry zones to reduce the water resources required in the green.

44 **Meteorological Station Network**
Study of weather conditions in fields to forecast ice formation, rain, drought, snow or wind changes.

45 **Compost**
Control of humidity and temperature levels in alfalfa, hay, straw, etc. to prevent fungus and other microbial contaminants.

IoT Working Areas → Environment
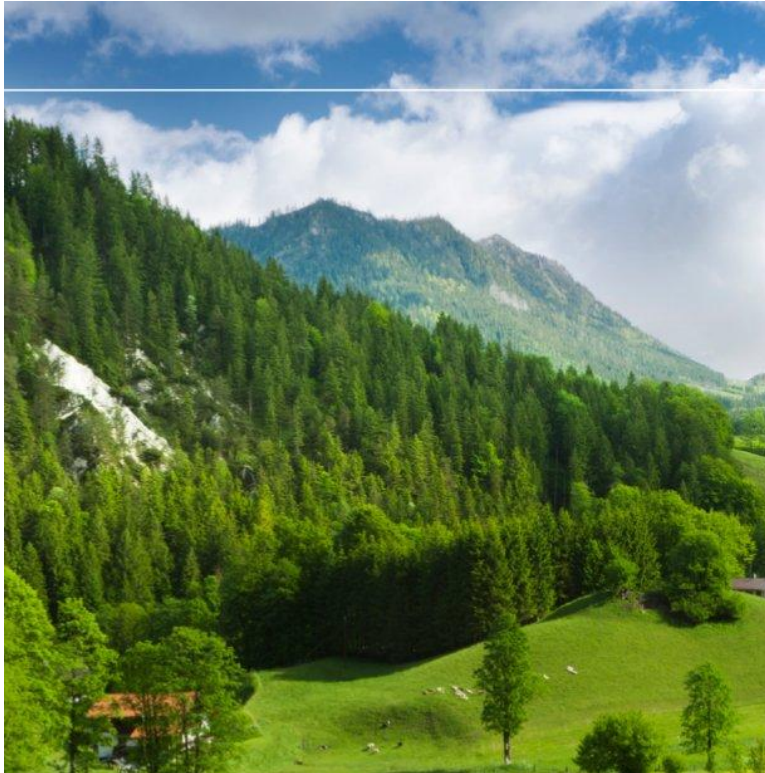
SMART ENVIRONMENT

10 Forest Fire Detection
Monitoring of combustion gases and preemptive fire conditions to define alert zones.

11 Air Pollution
Control of CO_2 emissions of factories, pollution emitted by cars and toxic gases generated in farms.

12 Snow Level Monitoring
Snow level measurement to know in real time the quality of ski tracks and allow security corps avalanche prevention.

13 Earthquake Early Detection
Distributed control in specific places of tremors.

14 Landslide and Avalanche Prevention
Monitoring of soil moisture, vibrations and earth density to detect dangerous patterns in land conditions.

IoT Working Areas → Breeding

SMART
ANIMAL FARMING

46 Offspring Care
Control of growing conditions of the offspring in animal farms to ensure its survival and health.

47 Animal Tracking
Location and identification of animals grazing in open pastures or location in big stables.

48 Toxic Gas Levels
Study of ventilation and air quality in farms and detection of harmful gases from excrements.

IoT Working Areas → hydro-risk
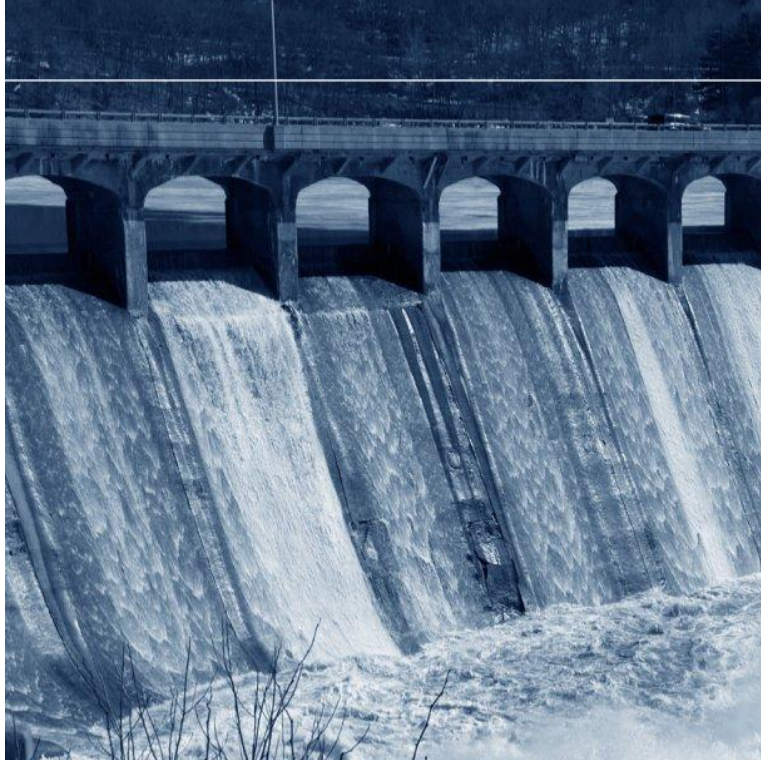
SMART WATER

15 Water Quality
Study of water suitability in rivers and the sea for fauna and eligibility for drinkable use.

16 Water Leakages
Detection of liquid presence outside tanks and pressure variations along pipes.

17 River Floods
Monitoring of water level variations in rivers, dams and reservoirs.

IoT Working Areas → Pollution and Security

SECURITY & EMERGENCIES

23 Perimeter Access Control
Access control to restricted areas and detection of people in non-authorized areas.

24 Liquid Presence
Liquid detection in data centers, warehouses and sensitive building grounds to prevent break downs and corrosion.

25 Radiation Levels
Distributed measurement of radiation levels in nuclear power stations surroundings to generate leakage alerts.

26 Explosive and Hazardous Gases
Detection of gas levels and leakages in industrial environments, surroundings of chemical factories and inside mines.

INDUSTRIAL CONTROL

35 **M2M Applications**
Machine auto-diagnosis and assets control.

36 **Indoor Air Quality**
Monitoring of toxic gas and oxygen levels inside chemical plants to ensure workers and goods safety.

37 **Temperature Monitoring**
Control of temperature inside industrial and medical fridges with sensitive merchandise.

38 **Ozone Presence**
Monitoring of ozone levels during the drying meat process in food factories.

39 **Indoor Location**
Asset indoor location by using active (ZigBee) and passive tags (RFID/NFC).

*"**Human Technologies**
turning information into Values"*

- data measurement provide only **information (necessary but not sufficient**)
  - we are still far away from problem-solving;

- **IoT** technologies are a good **instrument** to measure and achieve data of interest (nowadays we can measure and monitor almost everything)

- We need to "**turn informations into values**"...

→ IoT technologies are not enough → **design and develop ad-hoc and user-friendly** (Web)Services **supporting** users in **decision making**

Moral of the story...

We need to **turn informations into values**:
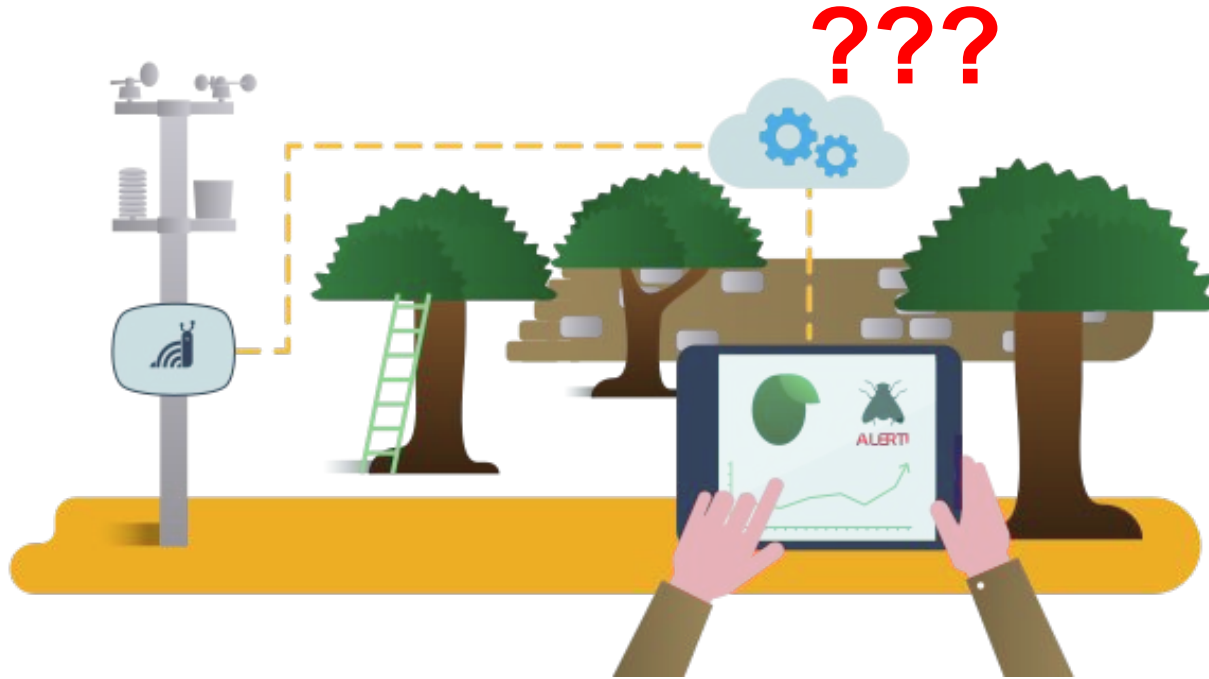
- observe and analyze the specific <u>NEED</u> you want to fulfill;

- <u>study</u> the problems related to this need (<u>multidisciplinary approach</u>);

- create a <u>mathematical-model</u> of each problem/process (analyze causes and processes which evolve into problems);

- use <u>measured data</u> and third-party data <u>to feed your models</u>

- develop a <u>software (DSS Decision Support System)</u> which is able to simulate the main problems of interest supporting stakeholders in decision making

→ IoT technologies are not enough → **we need to design and develop ad-hoc (Web)Services with a DSS approach**
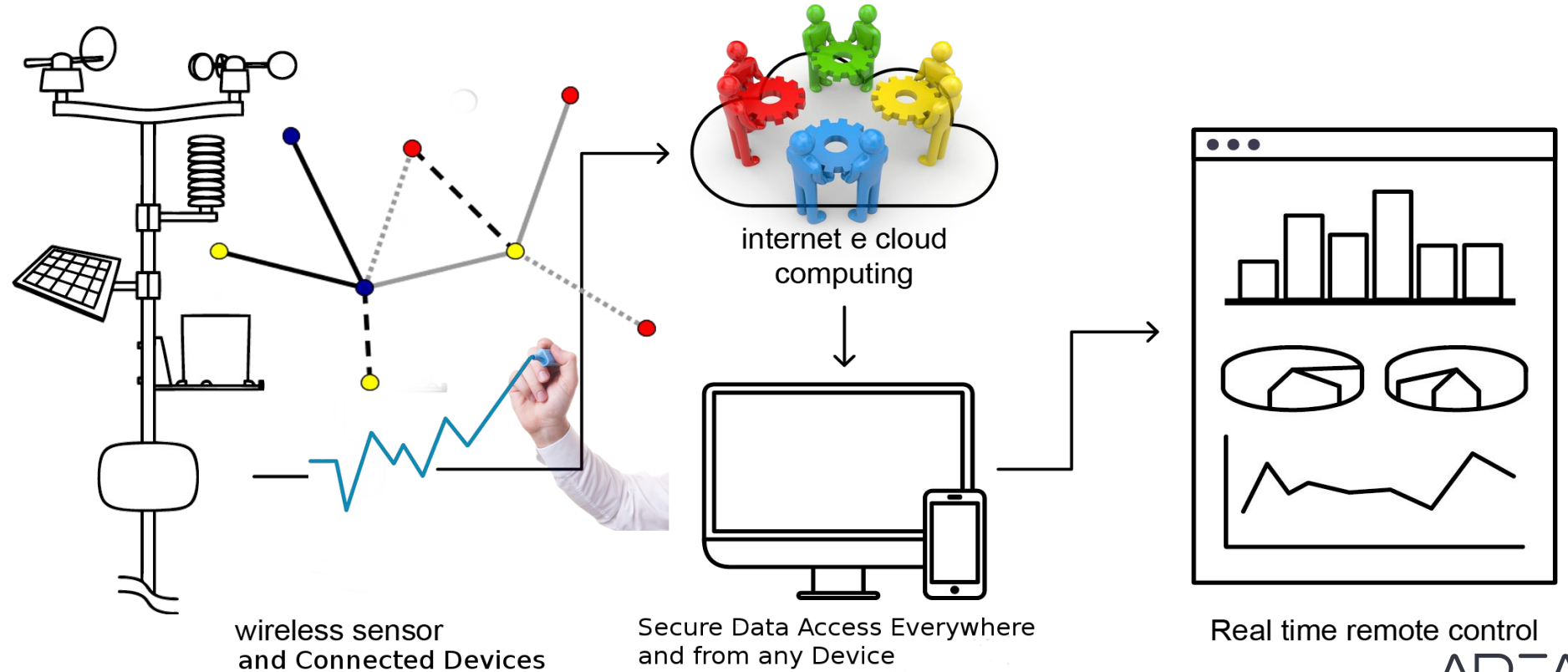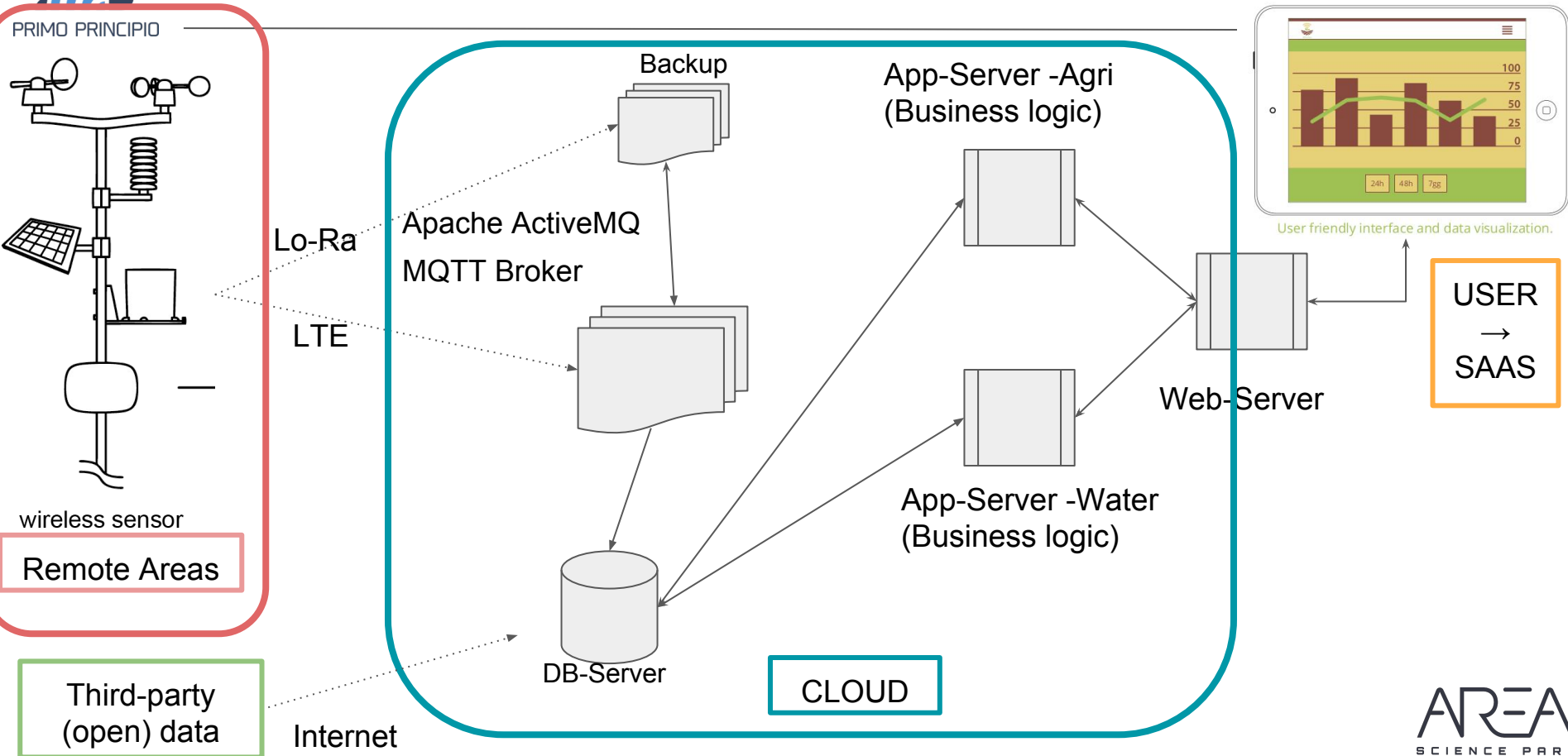
"Technical" moral of the story...

"Technical" moral of the story...

wireless sensor
and Connected Devices

internet e cloud computing

Secure Data Access Everywhere and from any Device

Real time remote control

"Technical" moral of the story...

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wireless sensor

Remote Areas

Third-party (open) data

Internet

Lo-Ra

LTE

Apache ActiveMQ
MQTT Broker

Backup

App-Server -Agri
(Business logic)

App-Server -Water
(Business logic)

DB-Server

CLOUD

Web-Server

User friendly interface and data visualization.

USER
→
SAAS

AREA
SCIENCE PARK

DSS and Smart Technology
for Agricultural Crops monitoring and Water Risk management

- starting point: **technology transfer** (necessary but not sufficient)

- now we can measure (better "monitor") accurate **field-information (data)**

Goal → "Value from Information "

WIFORWINE

WIFORAGRI

WIFORWATER

WiForAgri Solution: Smart-Service for Agri

Features

Possibility of setting SMS/e-mail alarms

Data visualization through intuitive diagrams

Forecast models of diseases and risky situations
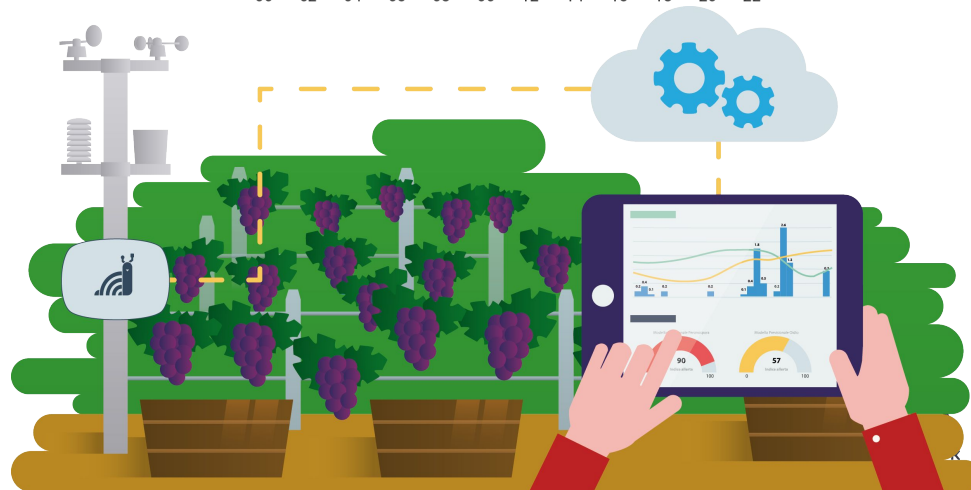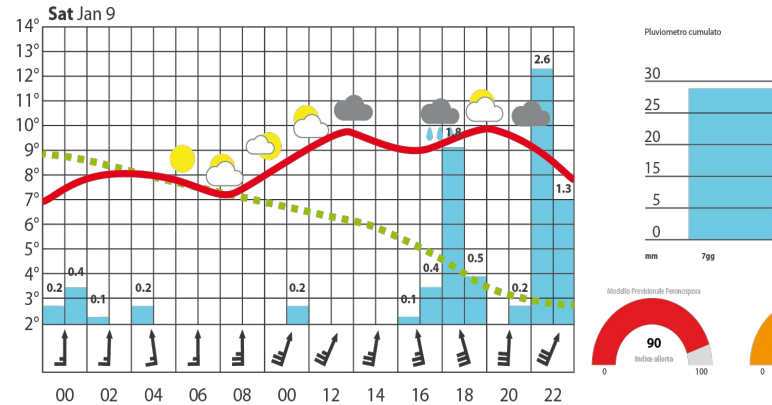
Management of field data and logbook

Historical data storage and possibility to export data in tabular form

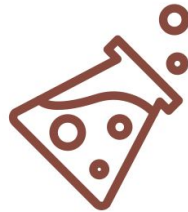**Possibility to create ad hoc customizations**

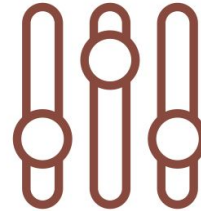*"Value from Information"*

WiForAgri Solution: Value and Benefits

→ Rationalization of pest management and herbicides, **pesticides and fungicides saving**

→ **Irrigation and fertilizers optimization** and **savings in labor costs** and rising labor efficiency due to remote monitoring e control

→ **Guidance to the farmer** about the optimal time for harvesting and improvement in the average **product quality**

→ reduction in **environmental impact** due to the reduction and rationalization of operations

Qualitative and quantitative growth

Reduce pesticide use and saving water

Optimization of crop management
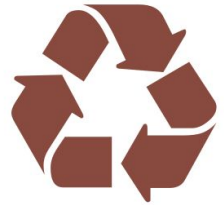
Reduction of the environmental impact

WiForAgri Solution: Value and Benefits

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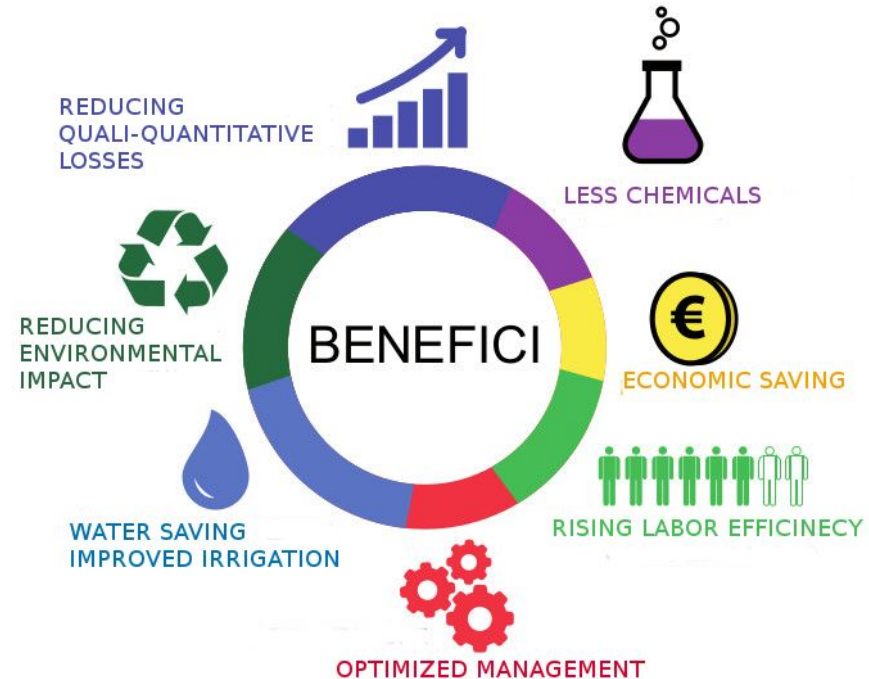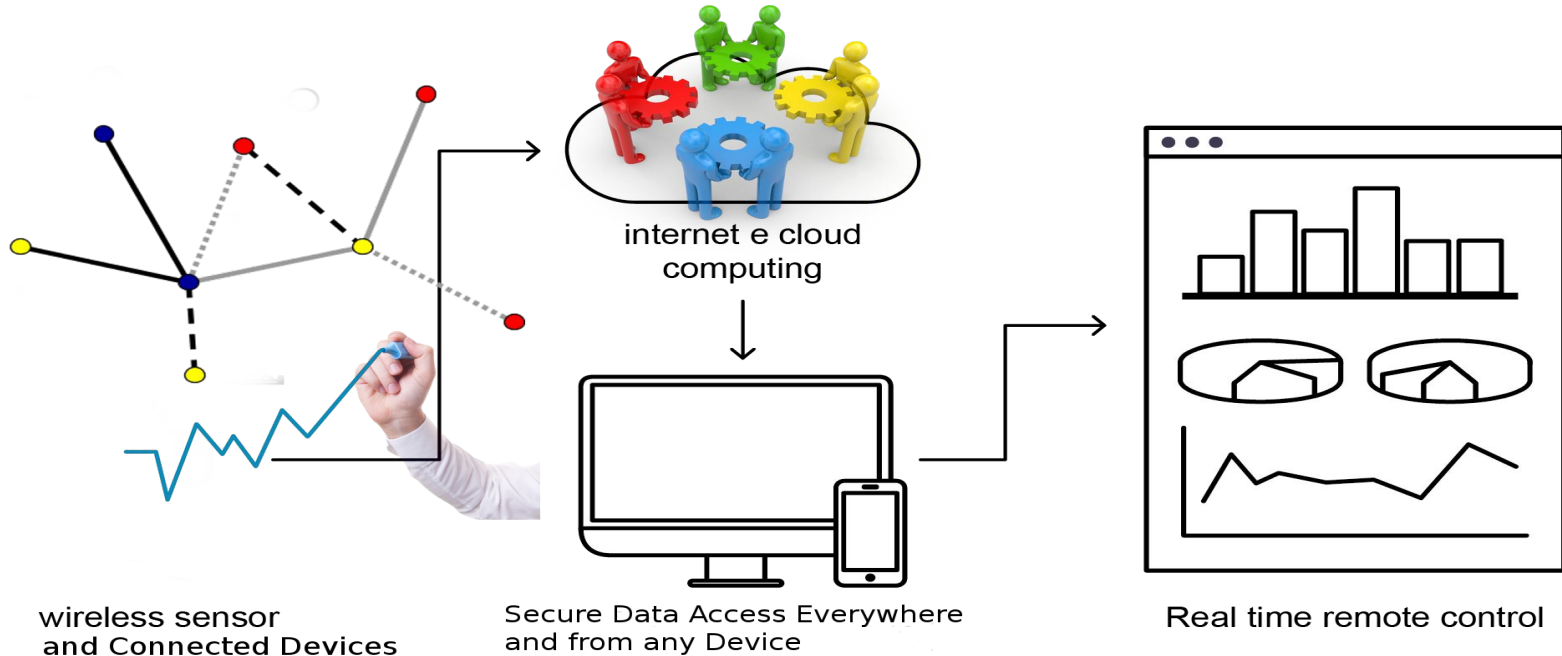
The Complexity is fully managed by **Cloud Computing Platform** with **easy/auto scale options** → you can **Up/Down-Scale your IoT network** (number of devices and device's sensors) preserving full functionality of old devices and central software infrastructure

internet e cloud
computing

wireless sensor
and Connected Devices

Secure Data Access Everywhere
and from any Device

Real time remote control

Case-Study SUSGRAPE: sustainability viticolture

Where: Italia (Region of FVG) and Slovenia

When: 2017-2020 (funded Interreg ITA-SLO Project) - <u>duration: 3 years</u>

Target: cross-border wine-producers (more than <u>10.000 farmers</u>)

Budget: about <u>300.000 Euro</u> (budget related to the following challenge)

Challenge: **- develop and validate innovative forecasting models**
         (downy mildew and powdery mildew);
      - optimize field management;

Goal: - efficient integrated defense **reducing chemicals** ;
     - researching about **bio-pesticides** and **bio-fertilizers;**

17 → Private Company
2 → Producer Consortium
1 → ICT innovative SME
1→ University
2 → Research Centers
1 → Chamber of Commerce

Case-Study SUSGRAPE: actions and solutions

→ cross-border monitoring network : **42 monitoring stations** totally wireless and energetically self-sufficient

→ Development **innovative ad-hoc prediction SW** for "downy mildew and powdery mildew"

→ **Validation of prediction model** on field

→ **Training** of technical staff of farmers-partner

→ Using the tablets provided within the project, the WiForAgri platform will enabled partners to **upload field data**

→ **Tuning prediction model to the local microclimate**: Agrometeo and field data feed the prediction model which **provides DSS** (decision support system) to producers
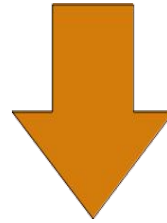
Case-Study SUSGRAPE: expected results

Innovative **prediction models** which will be **location-based** and **tunable** by farmers

Innovative **DSS for local production ecosystem** (and not for single farmers)

chemical reduction above 30% as an average for local ecosystem

toward **bio-pesticides in viticulture** for further **chemical reduction**

Potential Target (final users) → more than 10.000 farmers

"We want to show that when agriculture invests in appropriate technologies, it gets results of excellence"

economical and environmental sustainability

market success funding capabilities

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Case-Study LAORE: Sardinia Agro-Meteo Network

Where: Sardinia Region (25.000 km² - 1,5M people)

When: 2014-2015 <u>duration: 2 years</u> - **Budget:** about <u>0.5M Euro</u>

Customer: LAORE - Regional Agency for Agriculture Development

Target: regional farmers (more than <u>60.000 farmers</u>)

Challenge: D.L.vo 150/2012 in the field of **mandatory integrated defense** (CE Directive 128/2009 on the sustainable use of plant protection products) → the use of all **practices that can minimize the use of pesticides** including prevention techniques and meteorological and epidemiological monitoring

Goal: allow our customer (**Sardinia Region) to provide tools for farms** to adopt a wise and sustainable use of pesticides

Laore

Agenzia regionale
per lo sviluppo in agricoltura

REGIONE AUTONOMA DELLA SARDEGNA

AREA SCIENCE PARK
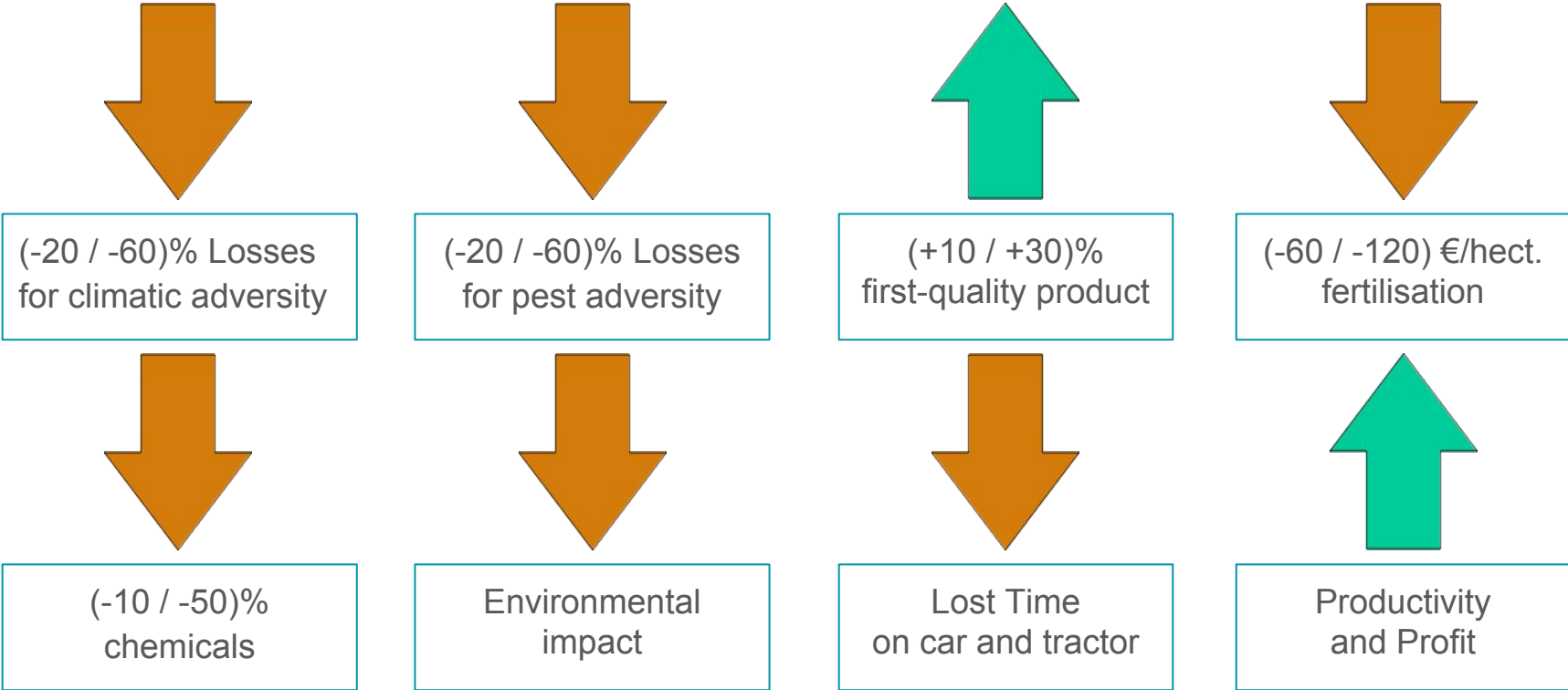
Case-Study LAORE: WiForAgri actions and solutions

→ Primo Principio has developed an agrometeorological monitoring network of Sardinia. The network consists of **62 monitoring stations** totally wireless and energetically self-sufficient → **Appropriate Technology**) distributed throughout the regional territory and on various agricultural branches **(vine, olive, citrus, horticulture, rice ...)**

→ **Training** of Laore technical staff (→ **Technology Transfer**)

→ Using the tablets provided within the project, the WiForAgri platform has enabled Laore Agency staff to **upload field data on phenological and epidemiological aspects, detecting pathogens and the occurrence of adversity directly in the field (→ enhance information and know-how)**

→ Agrometeo data and field data provided the basis for compiling **alert bulletins** on climate or plant health risks (→**value from information**)

Case-Study LAORE: benefits and results

(-20 / -60)% Losses for climatic adversity

(-20 / -60)% Losses for pest adversity

(+10 / +30)% first-quality product

(-60 / -120) €/hect. fertilisation

(-10 / -50)% chemicals

Environmental impact

Lost Time on car and tractor

Productivity and Profit

Target (final users) → more than 60.000 farmers

Case-Study AIPO: olive-fly Prediction Model

Where: Veneto - Garda lake (Region of Veneto and Lombardia)

When: 2015-2016 <u>duration: 2 years</u> - **Budget:** about <u>100.000 Euro</u>

Customer: AIPO - Interregional Consortium of high-quality (DOP)

Target: olive-oil producers (more than <u>2.500 farmers</u>)

Challenge:
- **mandatory integrated defense** (focused on "*olive fly*");
- **optimize irrigation;**

Goal: allow our customer (**AIPO) to provide tools for farms** to adopt a wise and **sustainable use of pesticides** and to **reduce water and hydric-stress** on olive plants

Case-Study AIPO: WiForAgri actions and solutions

→ agro-meteorological monitoring network for AIPO in Sud-Garda (pilot area): **4 monitoring stations** totally wireless and energetically self-sufficient

→ Development **ad-hoc prediction SW** for "olive-fly"

→ **Validation of prediction model** with a pilot-project on field

→ **Training** of AIPO technical staff

→ Using the tablets provided within the project, the WiForAgri platform has enabled AIPO staff to **upload field data**

→ Agrometeo and field data feed the **prediction model which provides DSS** (decision support system) to producers **(→value from information)**
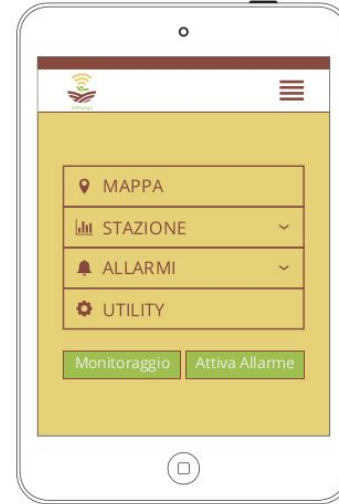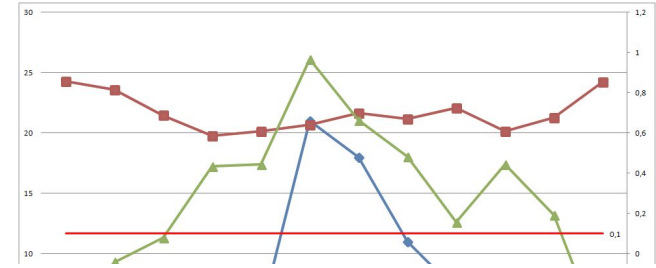
Alarms on customised risk thresholds via SMS / email to users or user groups.
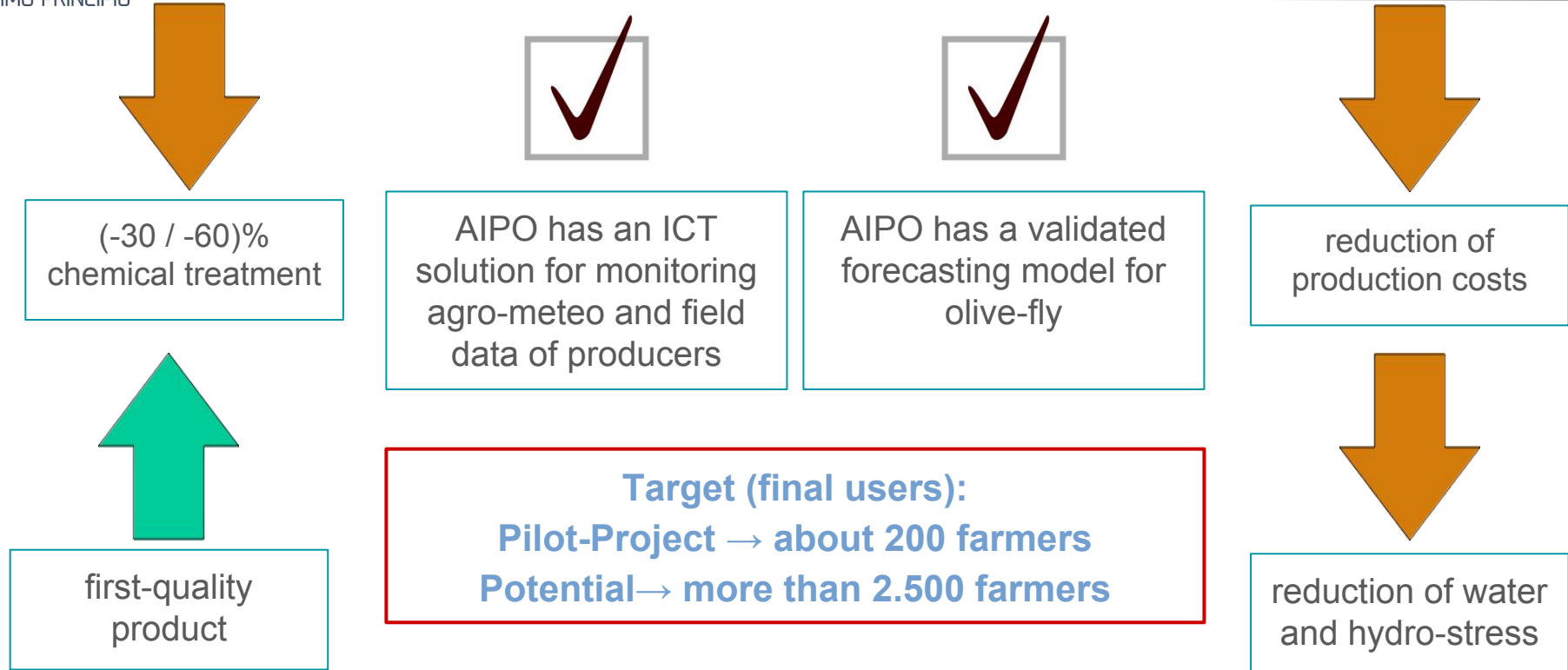
Import and management of crop data (phenologies, pathologies, irrigation, threatments...)

Case-Study AIPO: benefits and results

(-30 / -60)% chemical treatment

AIPO has an ICT solution for monitoring agro-meteo and field data of producers

AIPO has a validated forecasting model for olive-fly

reduction of production costs

first-quality product

Target (final users):
Pilot-Project → about 200 farmers
Potential→ more than 2.500 farmers

reduction of water and hydro-stress

Case-Study Smart-Cheese: cheese maturation v4.0

Where: Italy - Sardinia

When: 2017-2018 duration: 1 year - **Budget:** about 100.000 Euro

Customer: Pinna SPA - Producer and exporter of "Pecorino Brigante":

Target: 100.000 quintals of cheese for a turnover of 65M Euros

Challenge: design, develop and test an innovative wireless system able to   itoring of the cheese maturation; this means to measure the cheese humidity with   stand-alone technology which works without any human intervention

Goal: reducing the weight loss during the maturation process in order to inc   lue on the market

Case-Study Smart-Cheese: cheese maturation v4.0

→ Design and develop of **different IoT prototypes** able to **measure the internal cheese humidity**;

→ **Comparative study** between different technologies;

→ Set-up of the **final prototype in the maturation rooms**

→ Development **ad-hoc SW** for smart-phone and Tablet

→ **Training** the customer

→ Using the SW in order to **find the optimal time for the cheese to move from one camera to another**

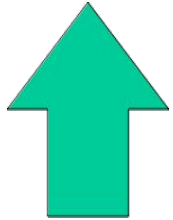→ **Increase the final weight of the cheese**

Case-Study Smart-Cheese: cheese maturation v4.0
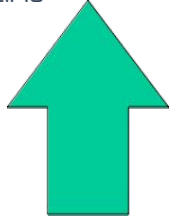
+3% final weight of the standard cheese

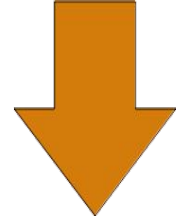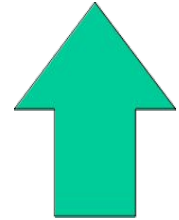Pinna has an IoT solution for monitoring in real-time the maturation of cheese

The SW alert when is optimal time for the cheese to move from one camera to another

reduction of production costs

first-quality product

Resume:
Pilot-Project costs → about 100.000 Euros
Economical results→ +1M euros /year

→ appropriate technologies → excellence

+1 Million Euro final annual turnover

Primo Principio and Area Science Park: IT Consultancy Solutions and Services for Rural

WIFORWINE   WIFORAGRI   WIFORWATER

Smart IoT Solutions
for **development and innovation**
in **Agriculture**, **Agri-Food Industry**
and **Smart-Water management**

turnkey HW and SW
for **private and public
sector** (from local to
national scale

IoT **Project Design
Consultancy
Pilot** Project
**Training
Support**

improving economical and
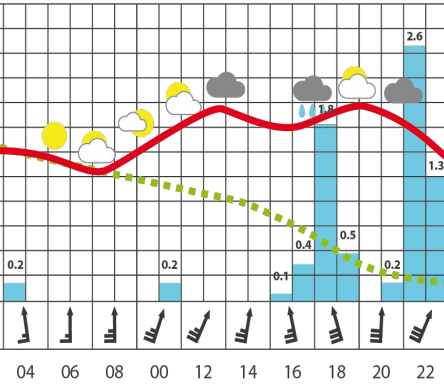environmental **sustainability**
of agri-producers

improving **funding capability** and
competitiveness
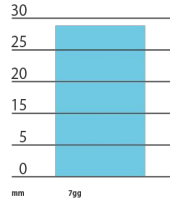of **agri-producers** and **public bodies**
operating in the Agro sector

Federico Longobardi federico@PrimoPrincipio.it – Technical and Marketing Officer – www.PrimoPrincipio.it

Let's try our DEMO: servizio.WiForAgri.com

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www.PrimoPrincipio.it