XX OIL PALM International Conference

THE TRANSFORMATIVE POWER OF OIL PALM

Interdependence of precision agriculture, smart agriculture and digital agriculture as a means to boost agronomic efficiency in oil palm

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ISPA International Society of Precision Agriculture

ATB Leibniz-Institut für Agrartechnik und Bioökonomie

ADAPTIVE AGROTECH

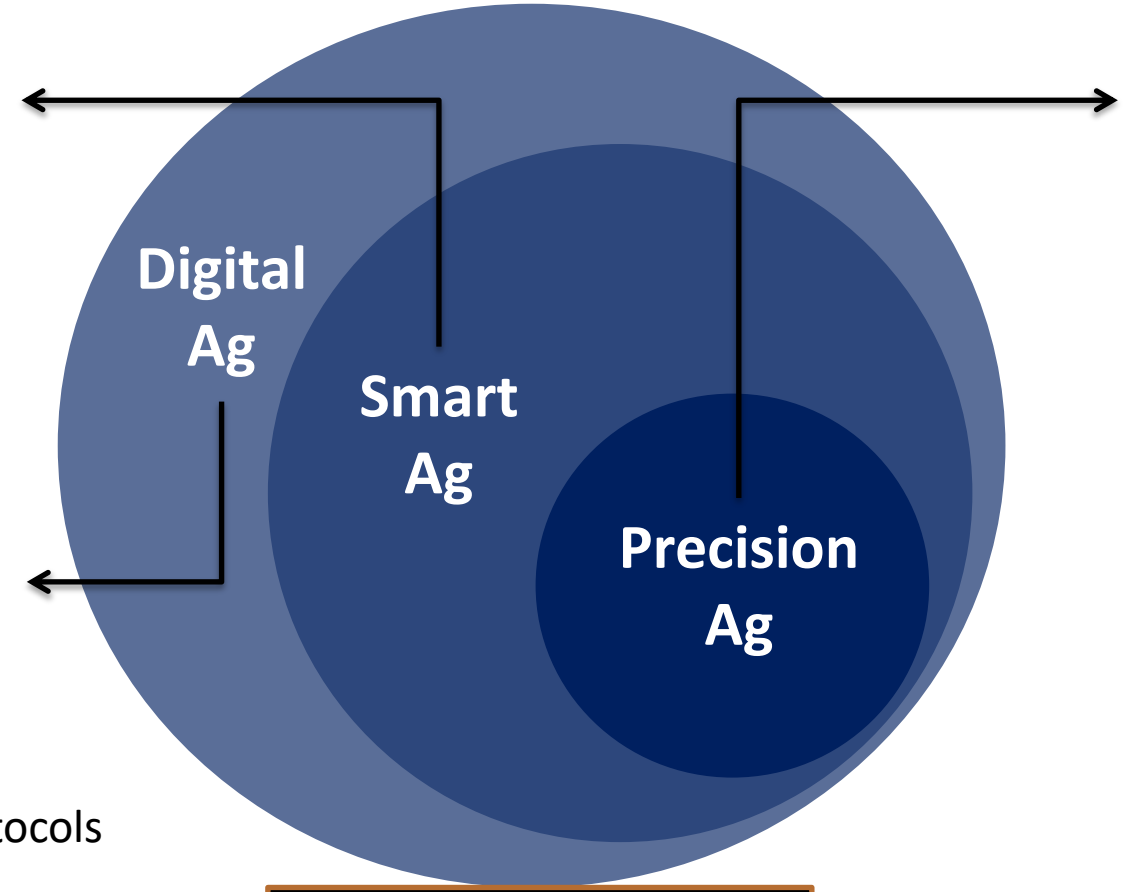
The ‘holy trinity’ of modern agriculture

Real-time

- AI
- IoT
- Robotics
- Sensors
- Telemetry
- Drones

Connectivity

- AI
- IoT
- Big data analytics
- Communication protocols



Optimization

- Spatio-temporal modeling
- Remote/proximal sensing
- GPS
- GIS
- AI
- Management zoning
- Decison support systems

How much have we progressed with precision agriculture in oil palm?

S.K Balasundram - Selected Precision Agriculture Studies in Oil Palm: A 10-year Summary.
18th International Oil Palm Conference | Cartagena, Colombia | September 22-25, 2015

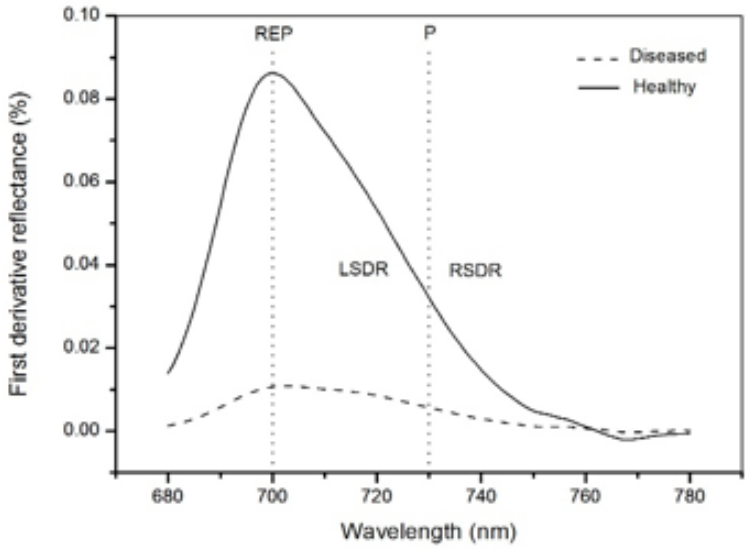
Technological domain	Scope of investigation	Keywords
Geo-spatial modeling	FFB yields Leaf and soil nutrients Fertilizer trials Soil organic carbon	Spatial variability, management zones, nearest-neighbor analysis, operational zones
Decision support system	Oil yield Oil quality	FFB harvesting, image processing, surface color, degree of bleachability index
Remote and proximal sensing	FFB yields Disease detection Oil quality Stand density	Vegetation indices, spectral reflectance, sensor, geographical information system, Google Earth

How much have we progressed with precision agriculture in oil palm? … (2)

S.K Balasundram *et al.* - Non-invasive approaches for plant disease assessment and monitoring.

19th International Oil Palm Conference | Cartagena, Colombia | September 26-28, 2018

Development of Orange Spotting Disease Index (OSDI)



REPRfpi – Red edge position determined from four point linear extrapolation

The ratio of right side-peak area within REPRfpi-780 nm to left side-peak area within 680-REPRfpi nm

OSDI = RSDRfpi/LSDRfpi

$$\text{OSDI} = \int_{REP}^{780} \frac{dR\lambda}{d\lambda} d\lambda \Big/ \int_{680}^{REP} \frac{dR\lambda}{d\lambda} d\lambda$$

Available at www.sciencedirect.com

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A review of neural networks in plant disease detection using hyperspectral data

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ABSTRACT

This paper reviews advanced Neural Network (NN) techniques available to process hyperspectral data, with a special emphasis on plant disease detection. Firstly, we provide a review on NN mechanism, types, models, and classifiers that use different algorithms to process hyperspectral data. Then we highlight the current state of imaging and non-imaging hyperspectral data for early disease detection. The hybridization of NN-

How much have we progressed with precision agriculture in oil palm? … (3)

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Abstract

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Article

Using SPOT-7 for Nitrogen Fertilizer Management in Oil Palm

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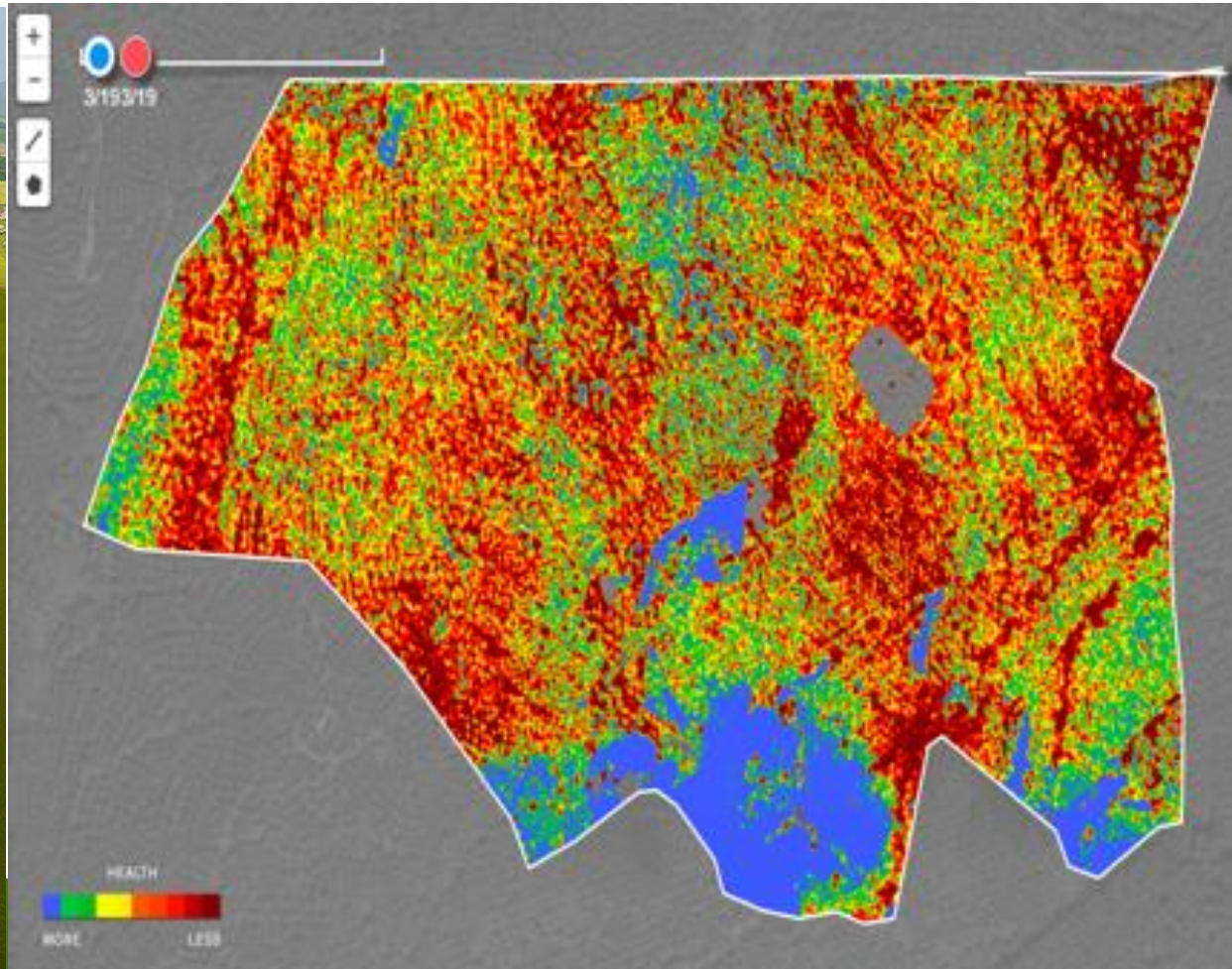
check for updates

Hot topics for precision oil palm research

- Mapping of carbon sequestration potential in different oil palm ecosystems
- Development of sustainability indicators that accounts for spatial and temporal variability
- Development of appropriate spatial scale to monitor shifts in yield maxima
- Geospatial modeling of water flow in sloping land
- Improvement of data processing methods, e.g. drone data should be in sync with spatio-temporal data

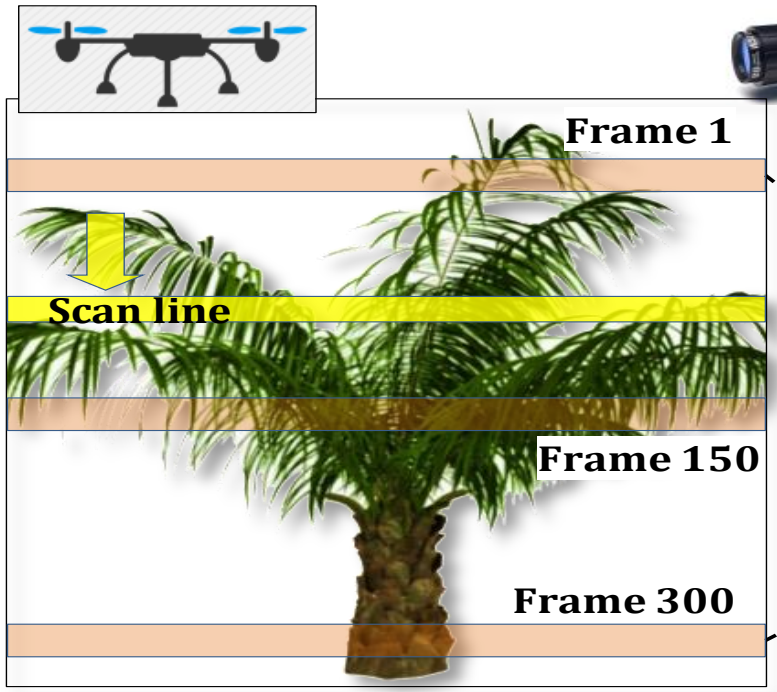
How much are we progressing with smart agriculture in oil palm?

- Use of drone for mapping agronomic variables



How much are we progressing with smart agriculture in oil palm? … (2)

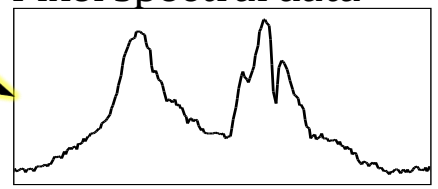
- Use of drone for early disease detection



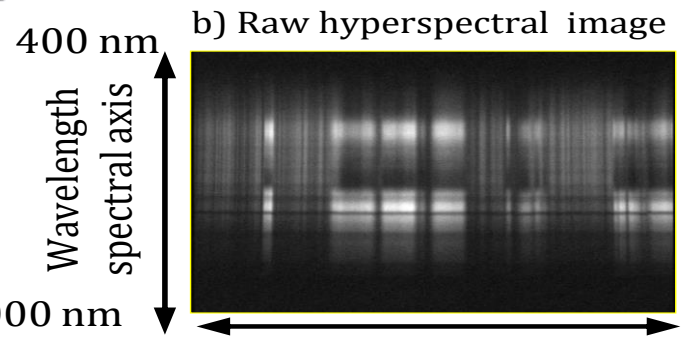
a) Oil Palm tree scene

Line-scan or Snapshot Mosaic

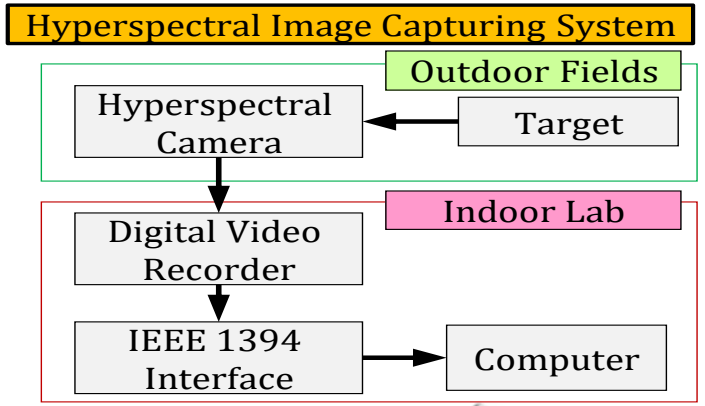
Snapshot imager with high temporal resolution



Pixel spectral data



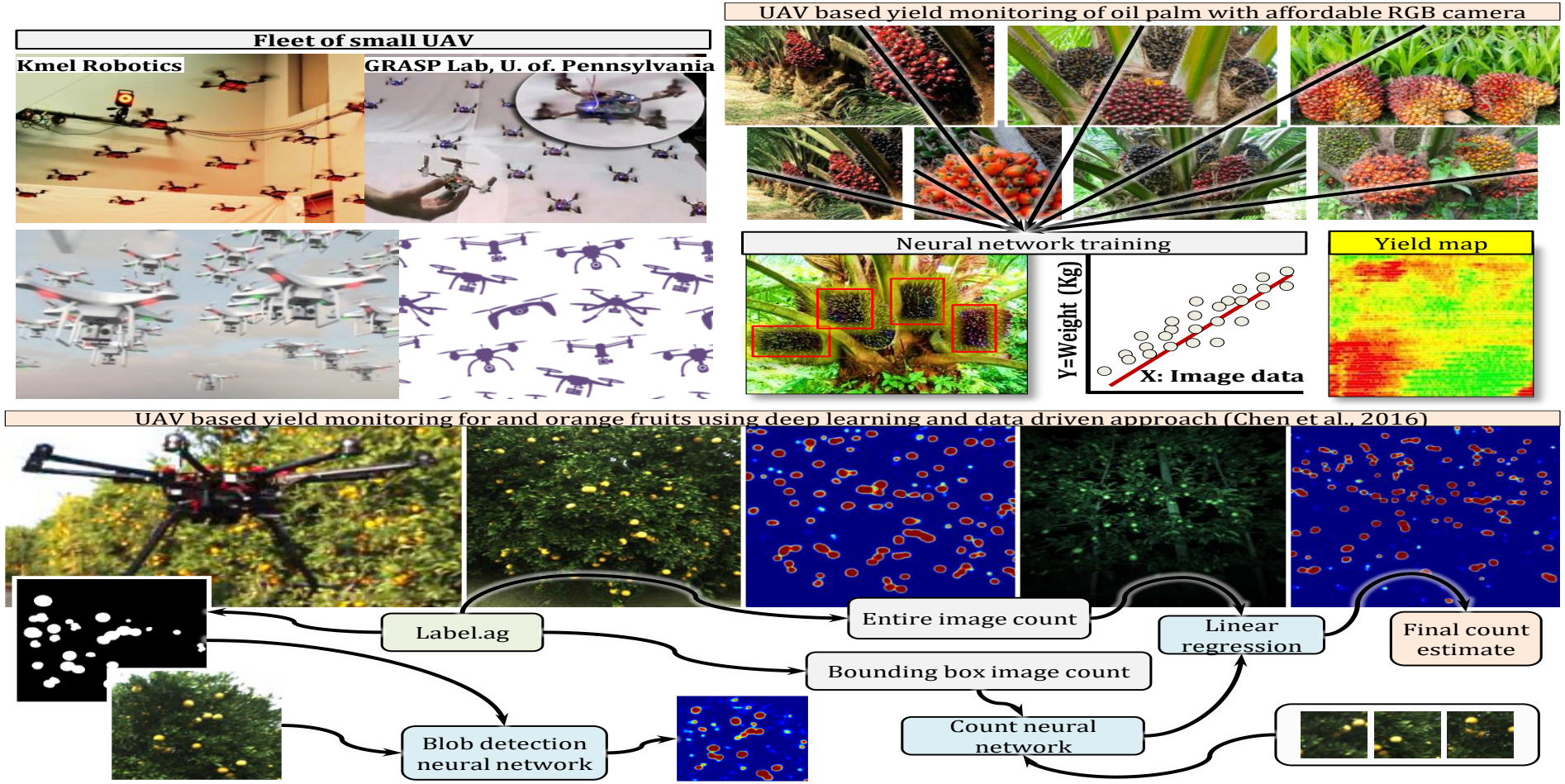
b) Raw hyperspectral image



c) Image generated at a specific wavelength

How much are we progressing with smart agriculture in oil palm? … (3)

- Use of drone for yield monitoring



The rise of digital agriculture

- Real-time sensing using long range wireless data acquisition systems
- AI and information processing tools for enhancing data accuracy
- Cloud storage for data sharing
- Mobile applications to make data useful for growers

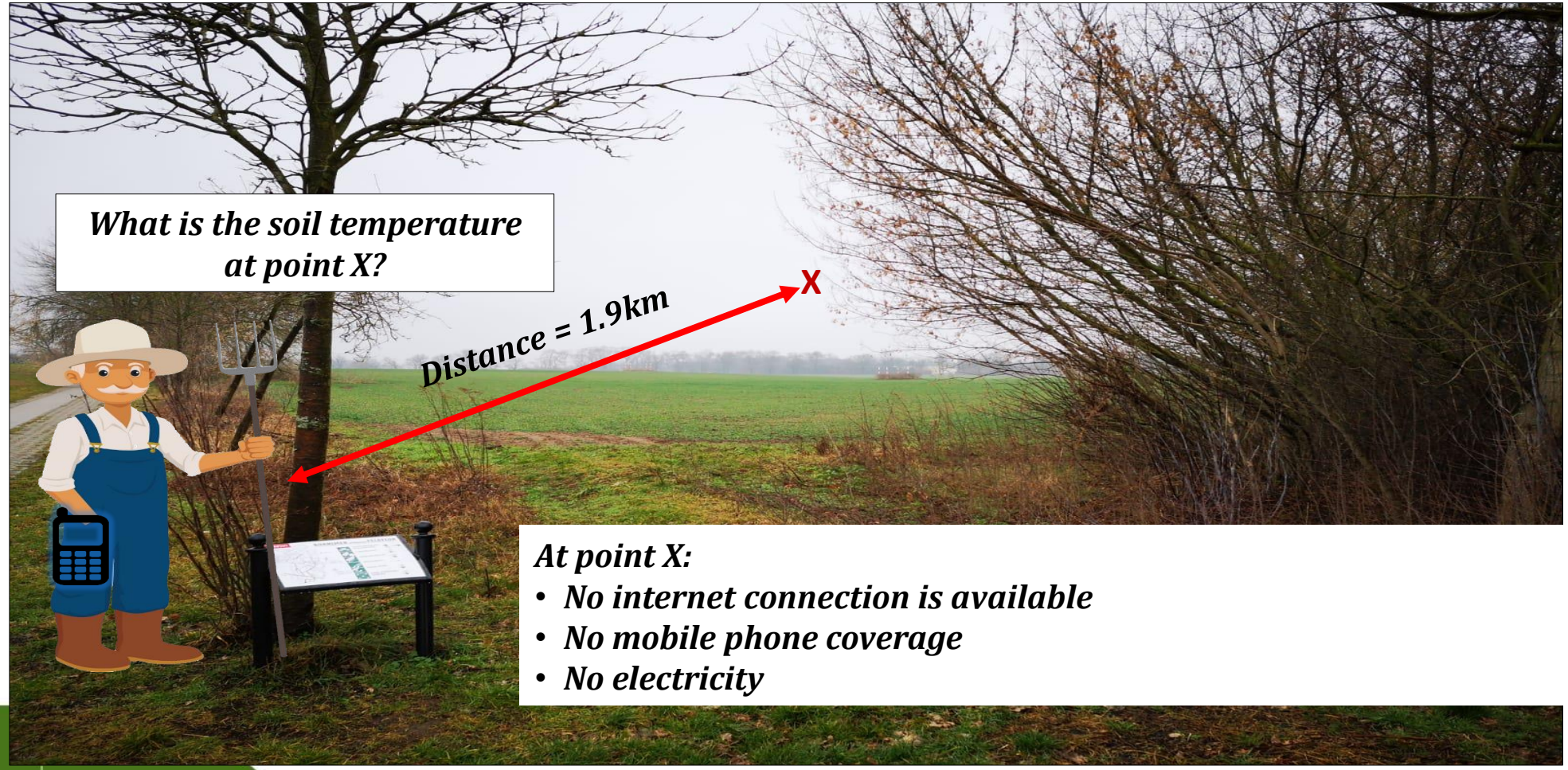
Building blocks of digital agriculture

Classic response to higher yield was larger machinery

- Smart Sensors
- Artificial Intelligence
- Virtual Farms
- Automation & Control
- Internet of Things
- Big Data
- Unmanned Aerial Vehicles
- Agricultural Robotics
- Deep Learning
- Wireless Sensors
- Precision Management

Modern response to higher yield is smarter machinery

The problem in simple words ...

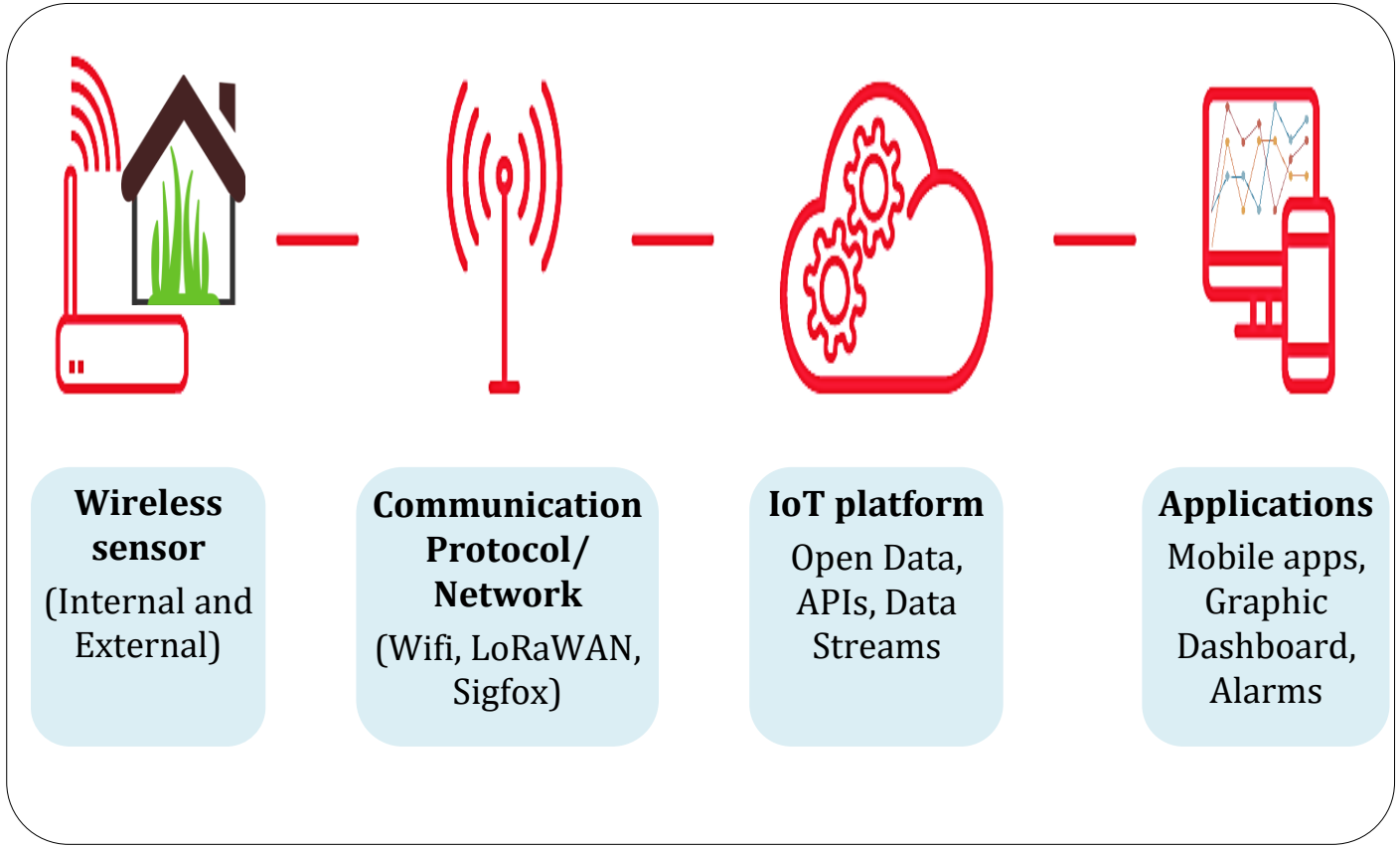


At point X:

- *No internet connection is available*
- *No mobile phone coverage*
- *No electricity*

The solution: Real-time measurement

- **Wireless Sensors Network (WSN)**
- **Low power wide area networks (LPWAN)**
- **Internet of Things (IoT) platform**
- **Application software (mobile apps, web-based apps, dashboards)**

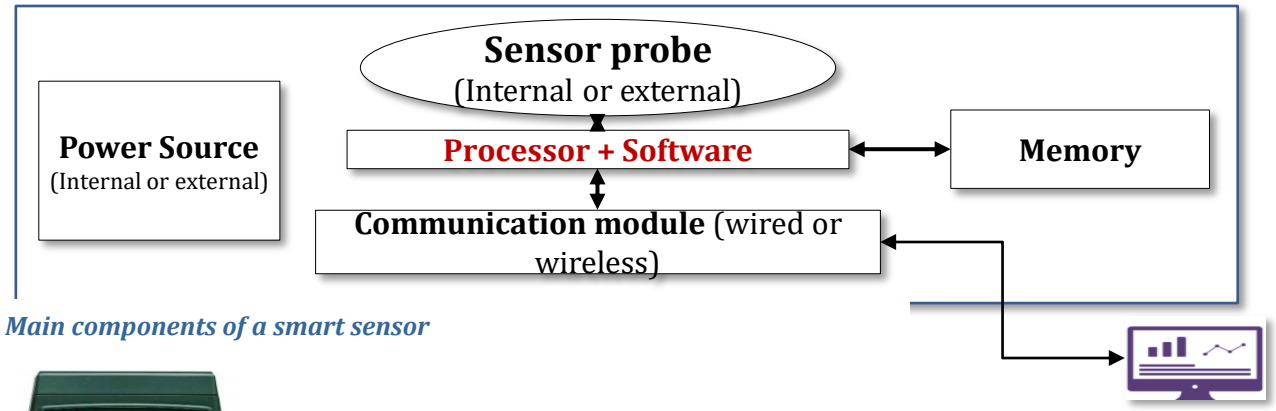


Key concepts

Smart sensor?

A device that can:

- sense changes in the physical world using different sensor probes
- perform data conversion, data processing and data logging
- communicate with external devices via wired or wireless protocols



Main components of a smart sensor

Datalogger?

A device that:

- logs data on an onboard memory (e.g. SD card)
- uses wired communication (e.g. Serial or CANBUS) to send out information

1-channel datalogger with internal battery and sensor probe

Wireless sensor?

A device that:

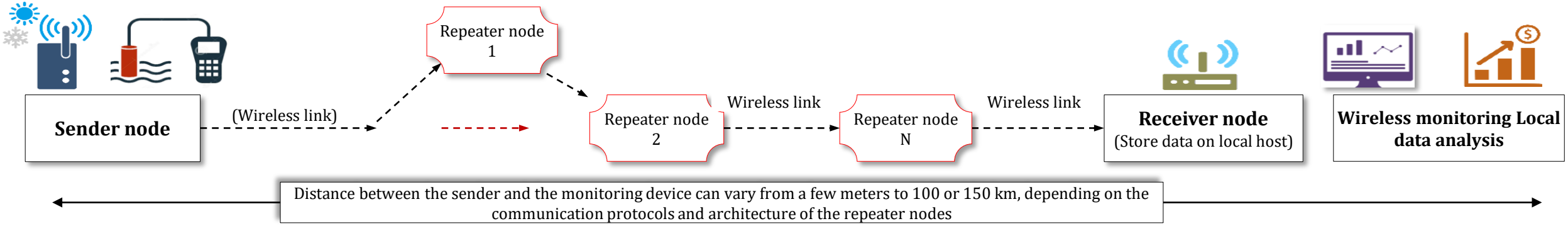
- saves data on an onboard memory (e.g. SD card) or cloud storage
- uses wireless communication modules such as Bluetooth, WiFi or LoRa to send out information

5-channel wireless sensor with external battery and different sensor probes

Real-time monitoring (≤ 1 min): Wireless vs. IoT

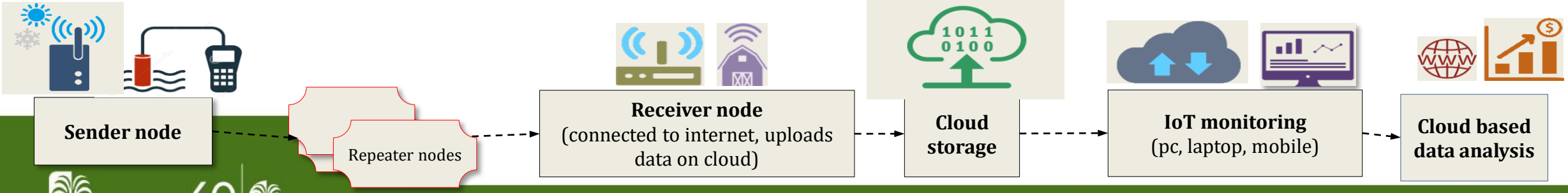
Wireless monitoring:

In a wireless monitoring system, the receiver node stores data on a local host, therefore data access is limited



(Internet-of-Things) IoT monitoring:

In an IoT monitoring system, the receiver node uploads data on a web-server, so data is accessible by any device that is connected to the world-wide-web



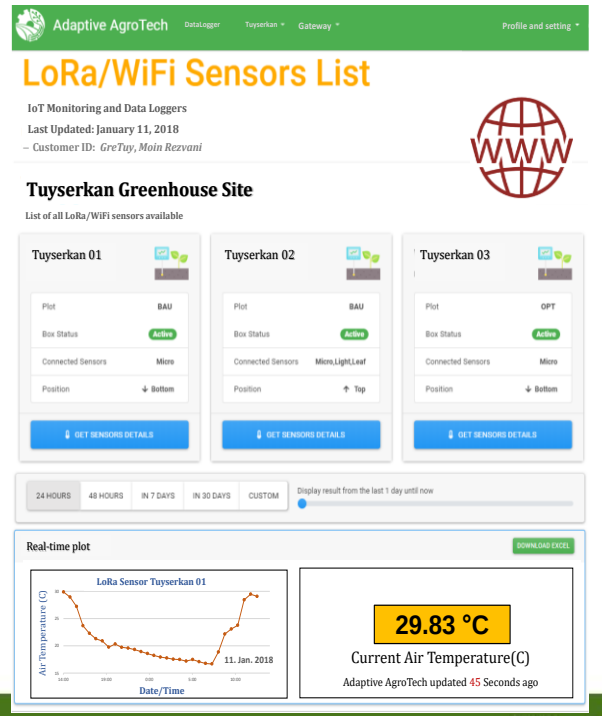
Advantages of IoT over wireless

1. IoT monitoring provides real-time information about the field and crop even in isolated locations. Data can be downloaded from any location
2. Data can be shared with unlimited number of users
3. Sensor data can be used for adjusting parameters of IoT-control devices (e.g. smart irrigation control over the internet)

Wireless Monitoring: Bluetooth

Cannot be accessed via WWW

IoT monitoring of Greenhouse in Iran with LoRa connectivity

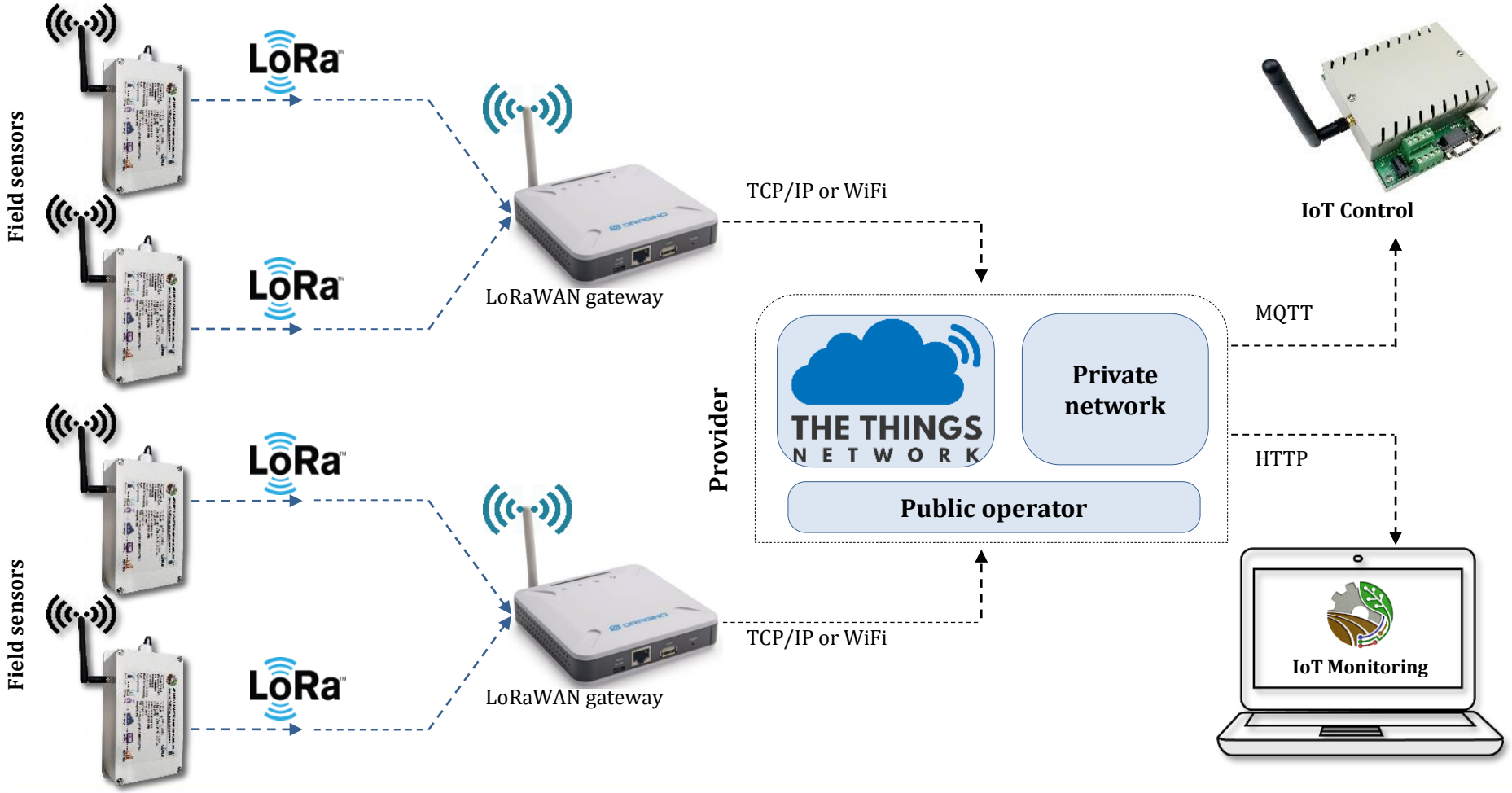


Can be accessed via WWW

Rezvani SME, HZ Abyaneh, RR Shamshiri, **SK Balasundram**, V Dworak, M Goodarzi, ... & B Mahns (2020) IoT-based Sensor Data Fusion for Determining Optimality Degrees of Microclimate Parameters in Commercial Greenhouse Production of Tomato. *Sensors*, *20*(22): 6474.

IoT for oil palm: A work in progress

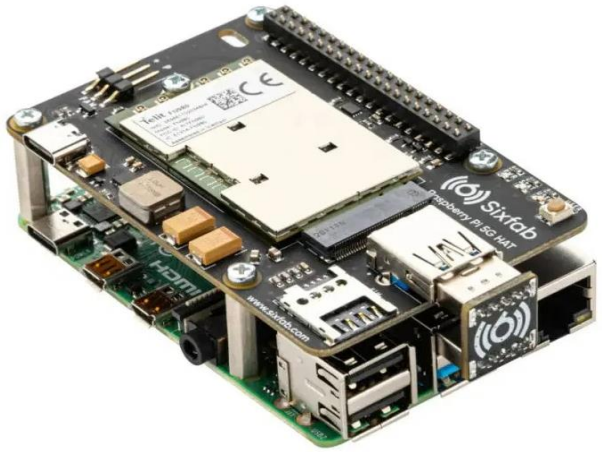
LoRaWAN not suitable for delivering data with high bandwidth

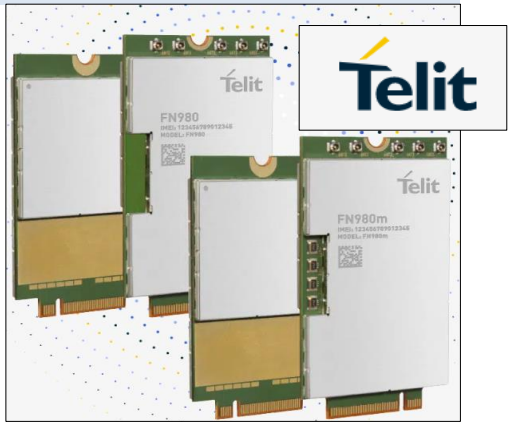


IoT for oil palm: A work in progress … (2)

5G Solution for high-bandwidth limitation (using LoRaWAN)
Project: Evaluation of RPi for 5G connectivity with **Telit FN980** for Agriculture
(A collaborative project)

HAT: SixFab, based on Quectel RM50xQ OR Telit FN980





HAT: Waveshare SIM8200EA-M2 5G, based on SimCOM SIM8200EA

Will they work in oil palm fields?

✓Data throughput of up to 5.0 Gbps (download) and 1.0 Gbps (upload), Can be used in IoT gateways, high bitrate video streaming, real-time sensor data broadcasting, high-speed mobile 5G hotspot

IoT for oil palm: A work in progress … (3)

IoT monitoring technology needs evaluation …

Does the board work under harsh field conditions?

SENSING	Data Management	Data Processing	Data Enhancement	Realization/Actuation
Sensor Platform Single or multiple Data Communication Wireless or IoT Coverage area	Data filtering, hybrid storage (onboard or cloud), Data Access, Over the air program	Quality Control Geo-processing Outlier Removal	Simulation Modeling Model Inversion Prediction/Estimation	Mobile application Ag-Robotics Autonomous systems Decision support sys

Sensor transmitter

Multi-sensor platform with redundant storage

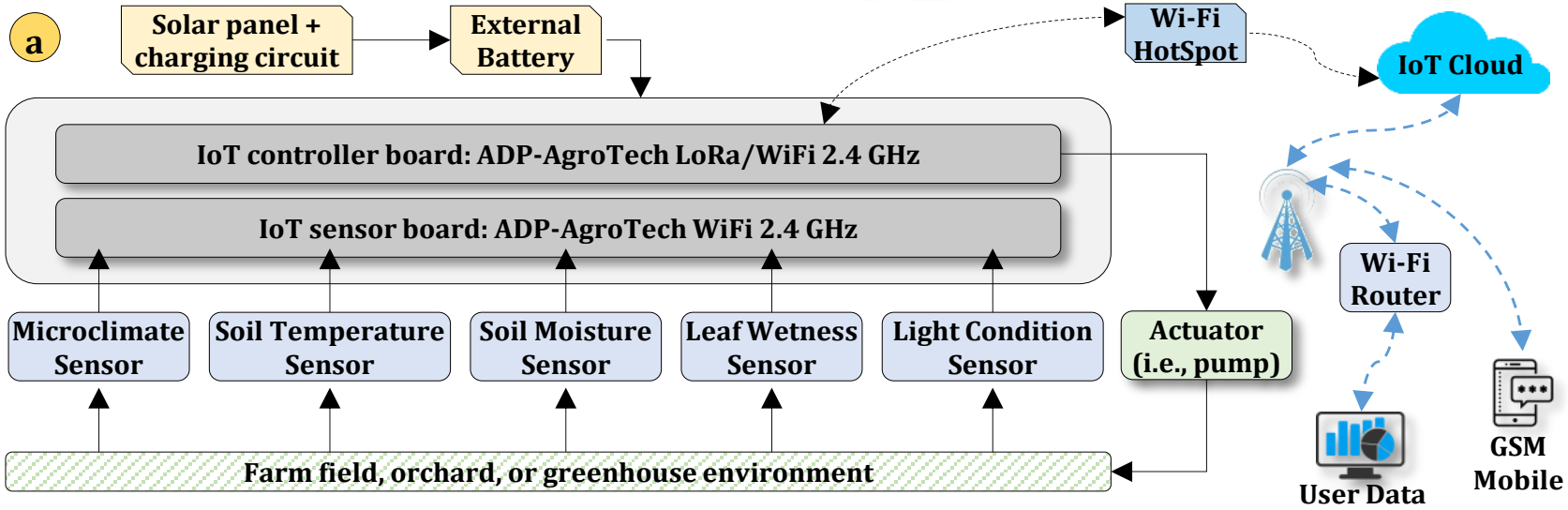
Over the air programming

IoT for oil palm: A work in progress … (4)

IoT controller scheme for smart irrigation

Is it reliable?

a



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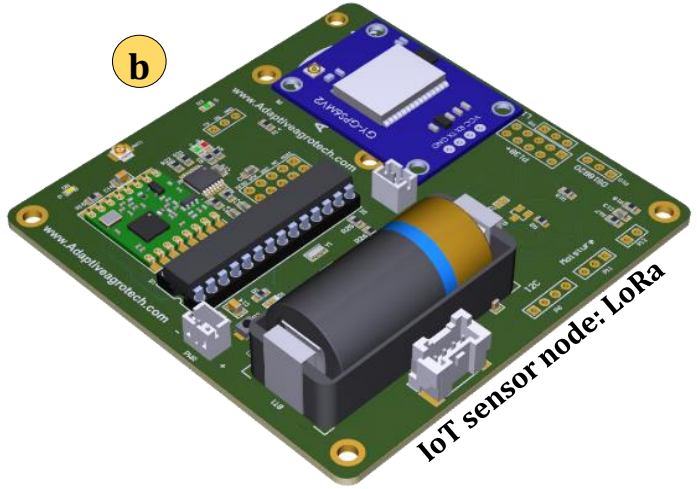


IoT sensor node: LoRa

c

IoT for oil palm: A work in progress … (5)

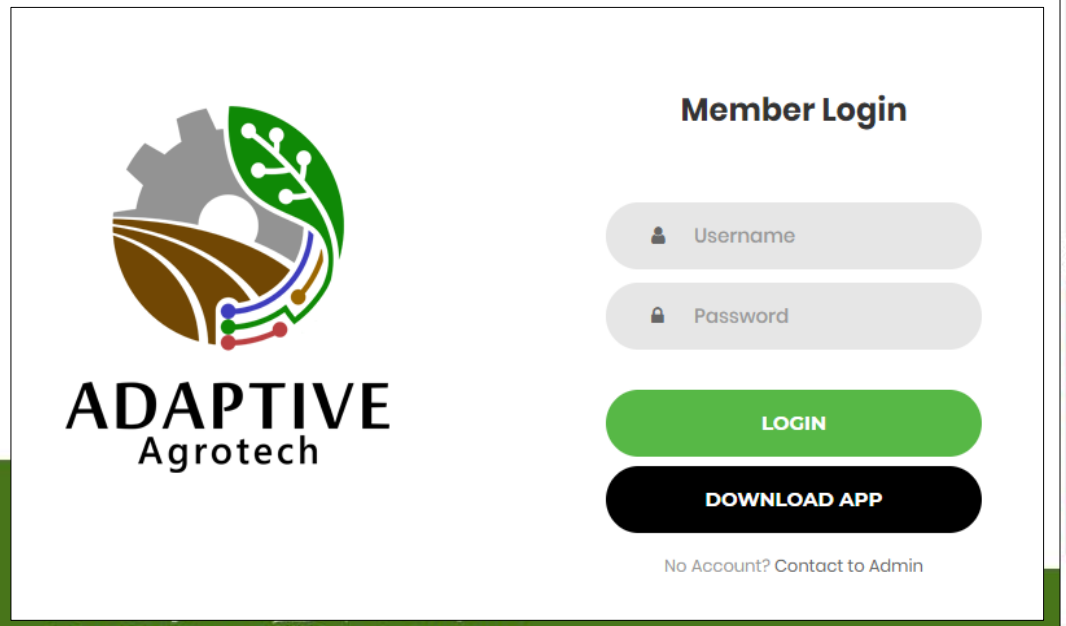
Lessons learnt?

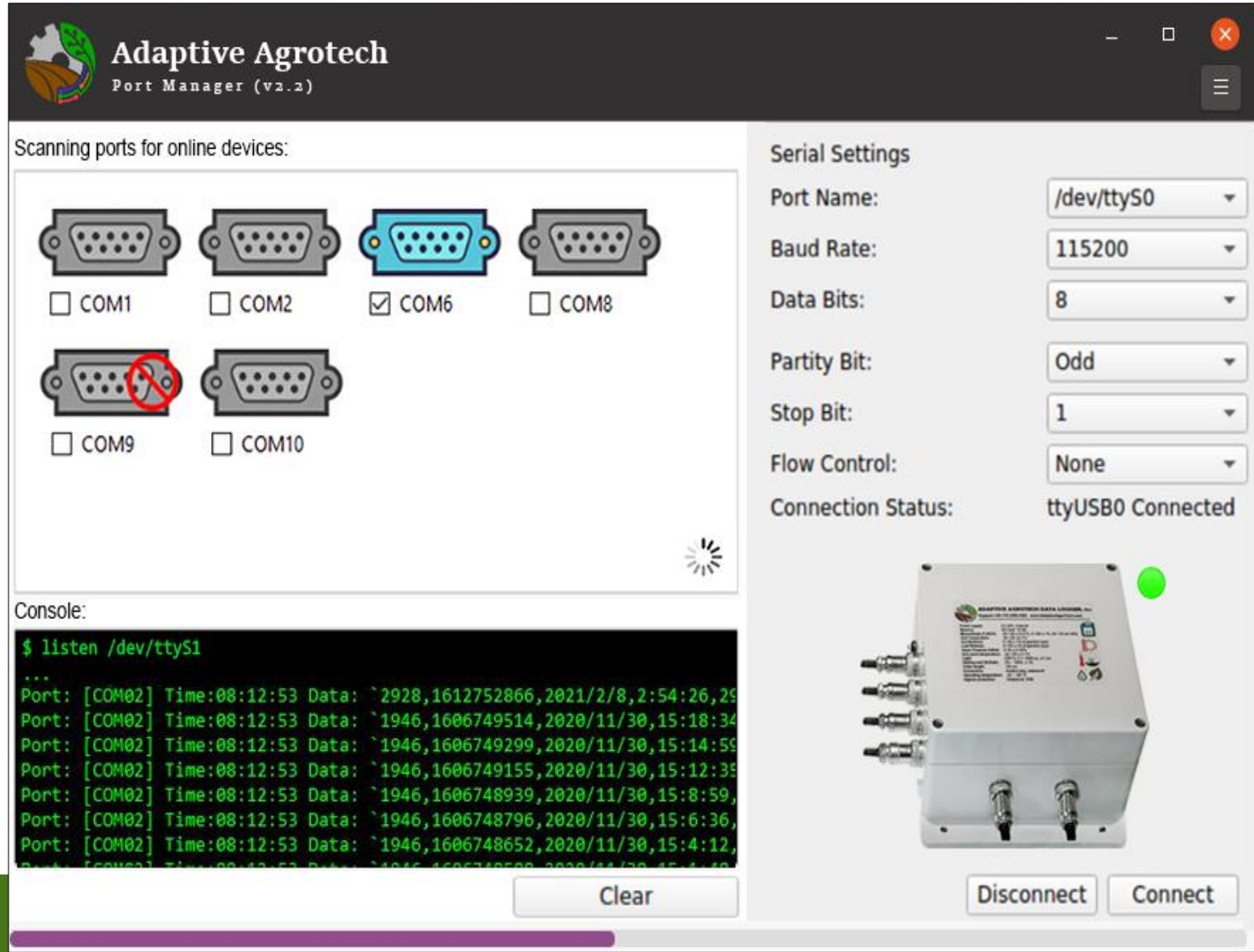
- ✓ Hybrid: datalogger+LoRa+ WiFi
- ✓ Modular
- ✓ Plug and sense
- ✓ High quality battery

IoT for oil palm: A work in progress … (6)

IoT needs custom-designed software and mobile app

eg. customized dashboard and private cloud for users





Good things take time !

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Thank you very much

Muchas gracias