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Transitioning from Precision Agriculture to Digital Agriculture: A Case for Oil Palm

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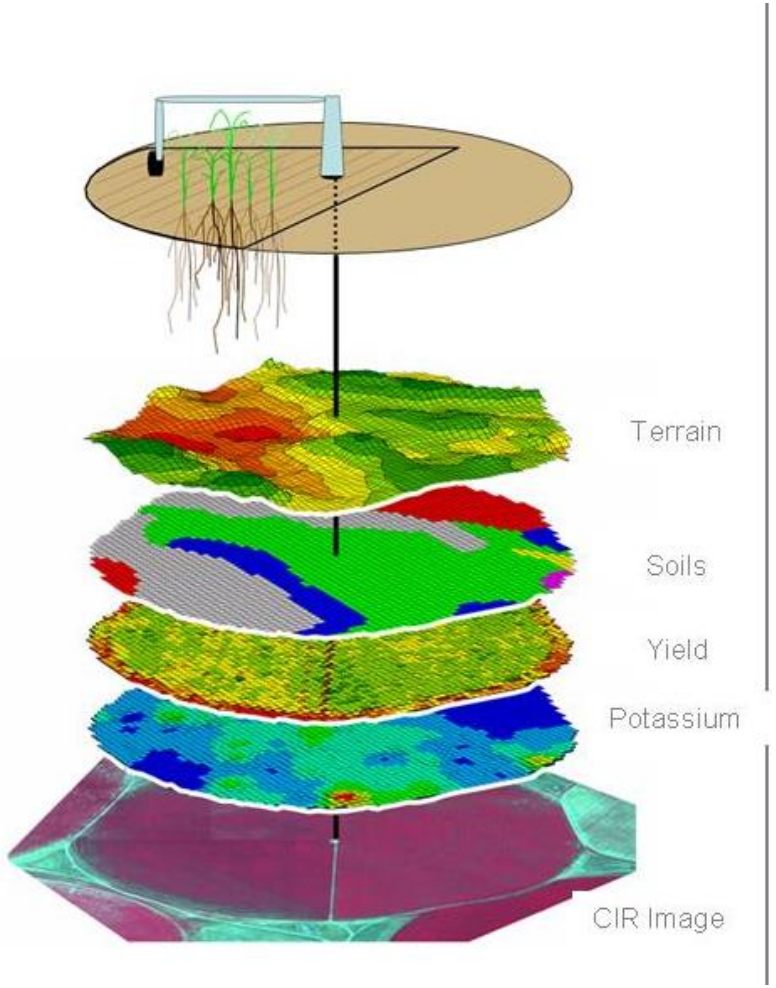
Precision agriculture

- A management practice applied at the **right rate**, **right time** and the **right place**

- Field sub-region management
  - nutrients
  - drainage/irrigation
  - pests and diseases
  - tillage and seeding

Individual field focus
➡ spatial variability
➡ temporal variability



Key agenda for precision oil palm management

1. Crop nutrition
   - Nutrient balance index
2. Pest and disease control
   - Early detection in a non-destructive way
3. Harvesting/Crop recovery
   - Optimum ripeness detection protocol
   - Optimized quality

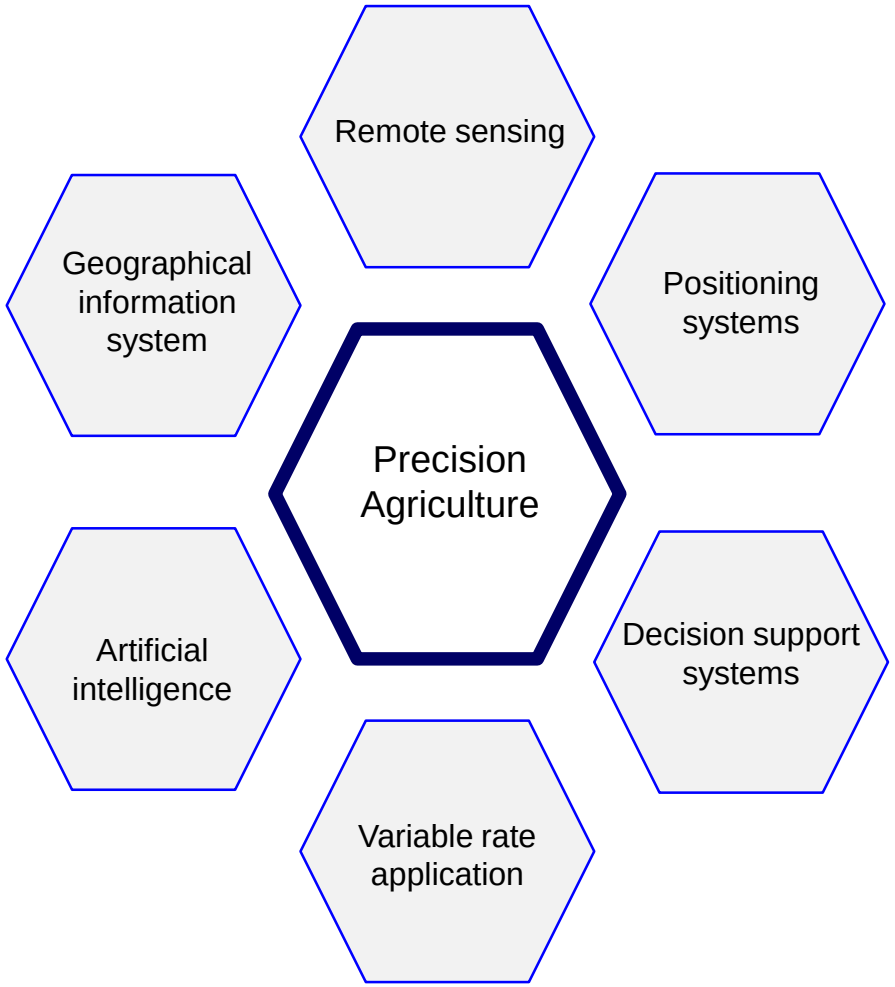
Other priority areas that require further work

- Mapping of carbon sequestration potential in different oil palm ecosystems
- Development of sustainability indicators that include 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

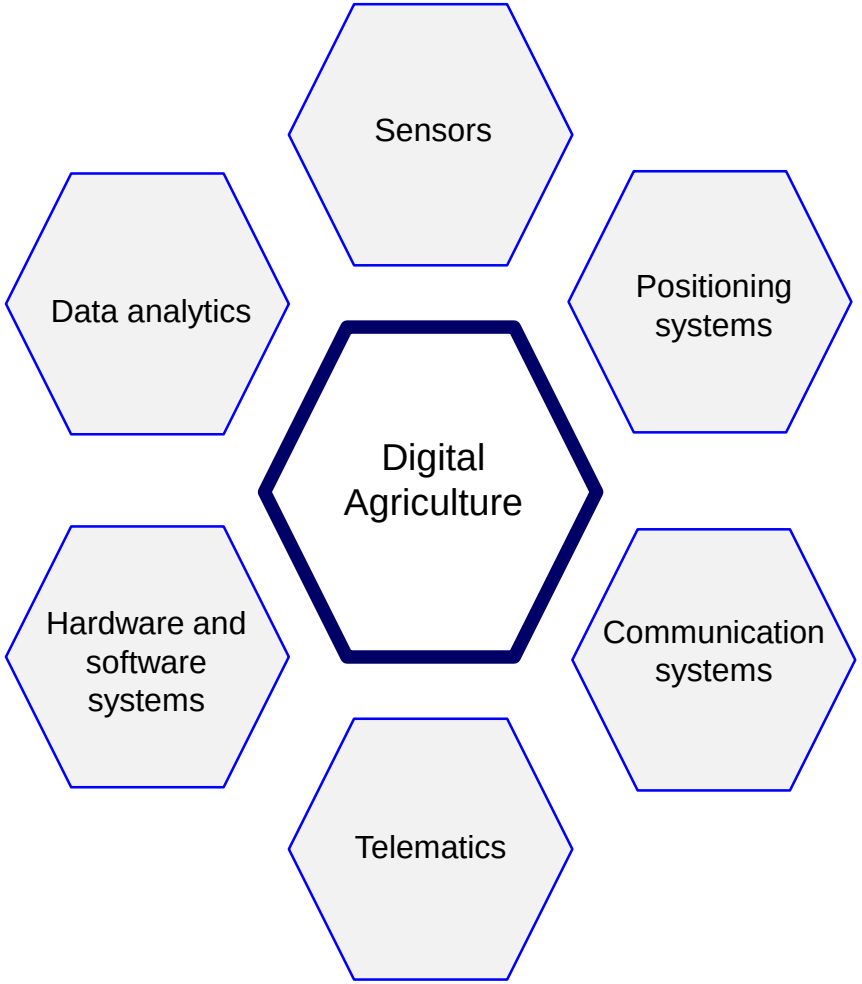
Balasundram, S.K. 2016. Selected precision agriculture studies in oil palm: A 10-year summary. *Revista Palmas*, 37(1): 243-266. (In Spanish)

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

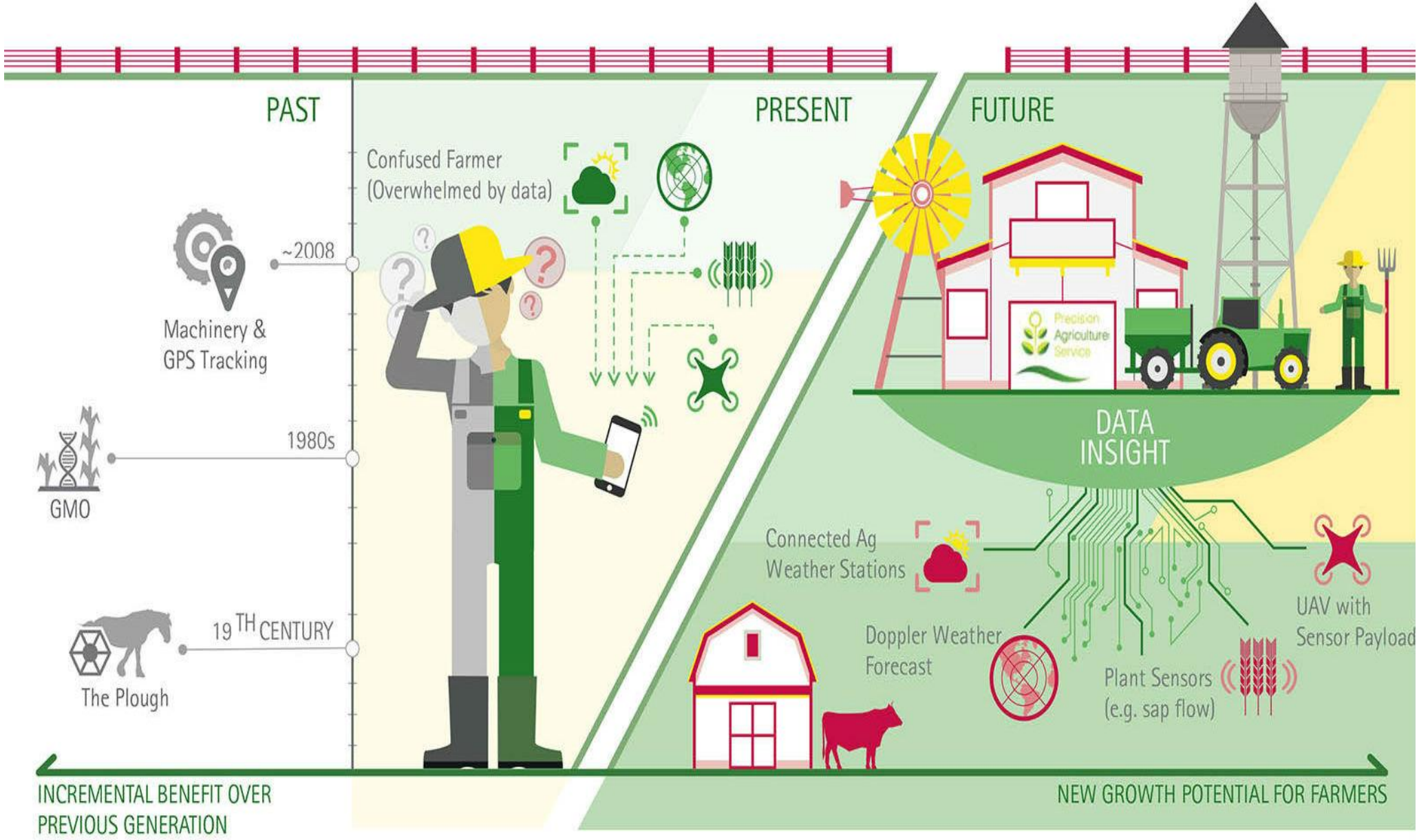
The first 25 years (1990-2015): **Efficient farm**



The next several years (2015-?): **Connected farm**



Towards a connected farm …



Source: Accenture (2015)

Where are we going with all these?

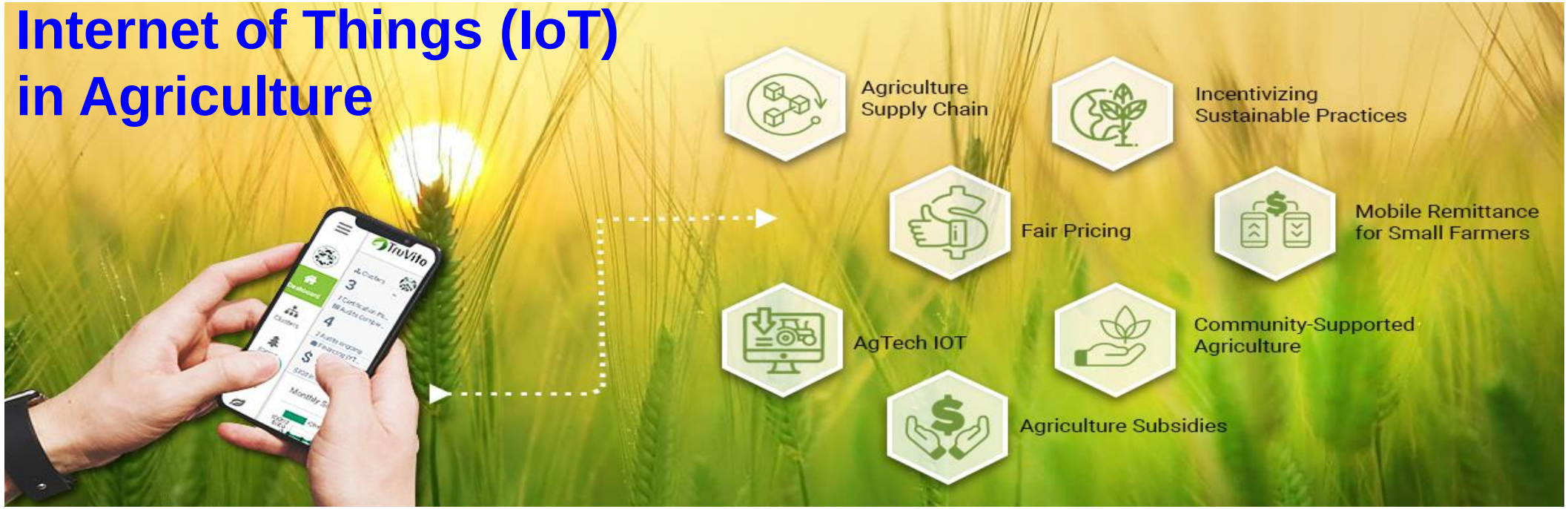
Climate-smart agriculture

▪ Efficient ▪ Cost-effective ▪ Practical ▪ Pollution free

Making the crop fit the environment (always changing)
→ resilience

❖ Instead of the old way of changing the environment to fit the crop

Where are we going with all these? … (2)



A means of connecting systems so as to allow an **integrated, multidimensional view** of farming activities, enabling deeper <u>understanding on how the whole ecosystem works</u>

- Smart devices than can collect and send data in real time to increase speed for decision making
- Big data

Our digital agriculture initiative for oil palm …

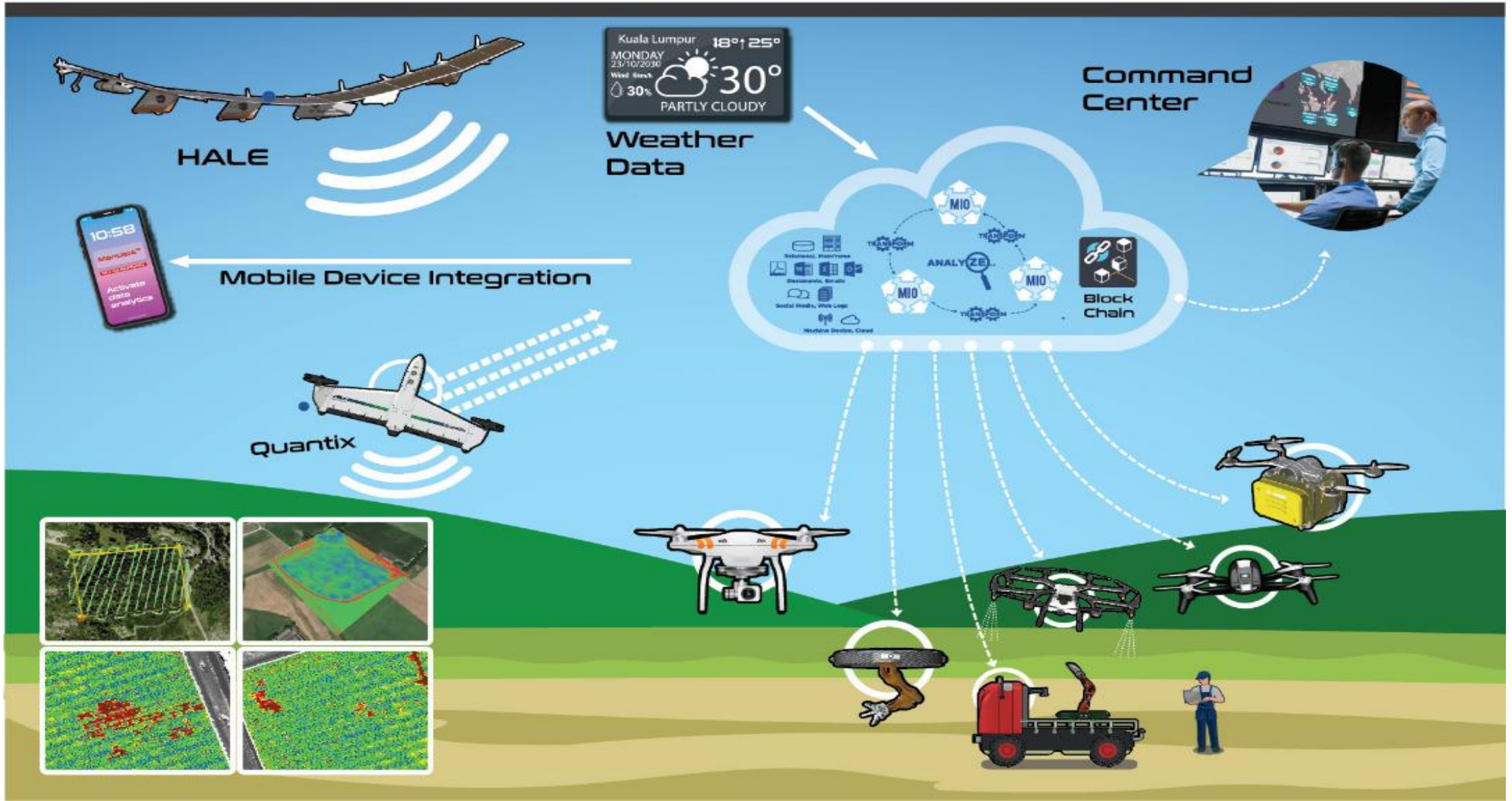
Artificial Intelligence (AI) platform

ManUsIA™

Man Using Intelligent Applications

ManUsIA™

Digital Agriculture



Our digital agriculture tech menu …

- Wireless Technology
- Sensing Technology
- Positioning Technology
- Data analytics solutions
- Mobile applications
- Web-based applications

Modular and flexible design for multi-purpose applications:


Sensor-based field mapping


Wireless crop monitoring


Climate monitoring and forecasting


Stats on farm production

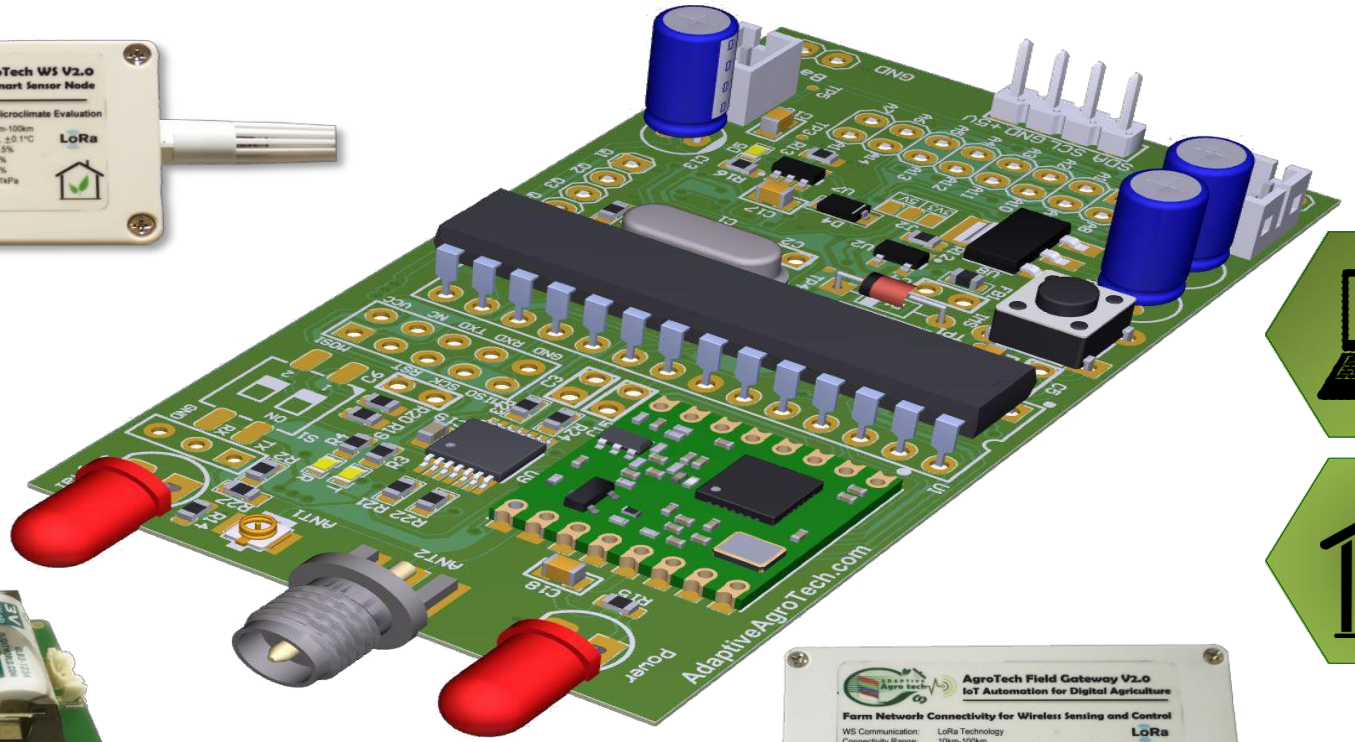

Wireless equipment monitoring


Predictive analytics for crop and livestock


Livestock tracking and Geo-referencing


Smart logistic and warehousing

IoT sensing and data sharing for open-field and closed-field crop production



Kambyan sensor node for digital agriculture

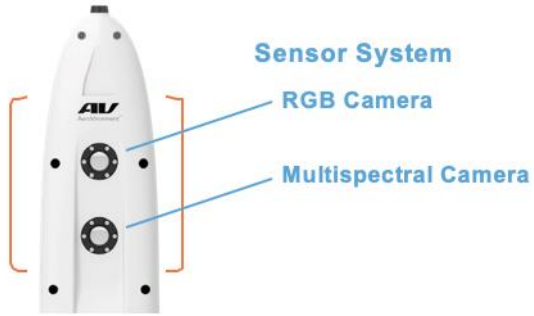
WS Communication:	LoRa Technology, over 10 km in rural areas, extendable to +100 km with repeater
Air Temperature:	-40 °C to +125 °C, ±0.1 °C, Typical consumption 1 µA
Relative humidity:	0 ~ 100 %, ±3 %, Typical consumption 1.8 µA
Air Pressure:	30 ~ 110 kPa, ±0.1 kPa , Typical consumption 2.8 µA
Soil Temperature	DS18B20 probe: -55 °C +125 °C, ±0.5 °C, Adjustable resolution, Stainless Water Proof
Soil Moisture:	Capacitive type, Output Voltage: 0 ~ 3.0 VDC, Interface: PH2.0 - 3P
Vapor Pressure Deficit:	0 – 35 kPa, 0.01 kPa
Dew point temperature:	-40 °C to +125 °C, ±0.1 °C
Light Sensor:	ORP12, 0.1 ~ 1000 Lux, ±1 Lux, Resistance: Day light 5kΩ, Dark night: 20MΩ
GPS:	NEO6MV2 GNSS modules , accuracy 2.5 m, NMEA protocols, Max Current : ~67mA
OptDeg and Cft-Ratio:	0% ~ 100%; ±1%, (Valid for Greenhouse Crop Production)
Battery type and life:	Olight CR123 CR123A 3.0V 1600mAh Primary Lithium, Over 1 year at 6 readings/hour
Ingress protection:	IP65

Current commercially operational drones (payload < 20 kg)

- Agras
- Joyance
- Mavis
- Quantix

COMPLETE END-TO-END ECOSYSTEM

Everything you need right out of the box to begin scouting fields and scaling your business



1 Quantix Hybrid Drone

- Takes-off and lands like a multi-rotor
- Range, reliability, and efficiency of a fixed-wing aircraft—up to 400 acres per 45 minute flight
- **NEW** Quality data capture in wind speeds up to 20 mph
- Allows for a safe launch and soft landing to protect sensors

2 Integrated Sensor System

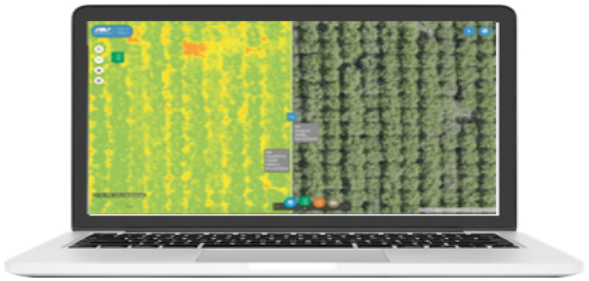
- Built-in dual 18MP cameras
- Simultaneously collects high-resolution RGB & Multispectral
- Incorporates a self-calibrating solar sensor

3 Operating Tablet & Quick-Look

- Fully automated control with single button launch command
- Quick-Look – Onboard processing delivers RGB and NDVI instantly on the operating tablet upon landing – no Internet required
- **NEW** In-flight status monitoring – flight direction, entry, exit and transition paths.

AV DSS™ SOFTWARE COMPONENTS

AeroVironment's cloud-based Decision Support System performs advanced image processing, analytics, comparative and historical reporting, providing actionable intelligence so you can make smarter, quicker decisions. AV DSS automatically aggregates all your data making it easy to use and understand to improve operational efficiencies and increase profitability.



1

AV DSS Portal - Review your aerial data using a full suite of easy toolsets and analytics.

- **New -** Quick Resolution upload option decreases upload and processing times by 50%
- **New -** Farm Management Software integration - Import Variable Rate Layer as a shapefile into a wide range of FMS
- **New -** Single click data transfer in to John Deere Operations Center Connected

2

Intuitive Dashboard with multiple reporting and publishing options

- Quantifiable Charts – automatic historical data comparison, alerts associated with each location
- **New -** Client management & publishing tools (Professional Package)
- **New –** Field Reports easily export with geo-location data and bucketized imagery data sets and statistics

3

Mobile Survey Tool - Upload, share and contribute data & images to AV DSS from any location.

- Used in the field
- All images uploaded to AV DSS with geo-locations
- **New -** Walk to pin feature - step-by-step directions to each survey location
- Available for iOS and Android™

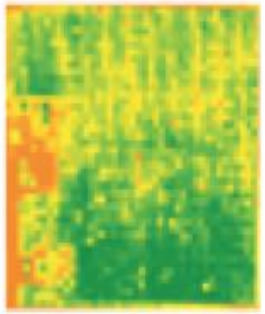
Data analytics

NDVI

Provides insight into plant health—where vegetation is thriving and where it is under stress

GNDVI

Indicates plant "greenness" or photosynthetic activity, shows water and nitrogen uptake



Canopy

For many crops, it is an important indicator of growth stage

Anomaly

Identifies areas in your field that differ from the norm, down to the plant level

Variable Rate

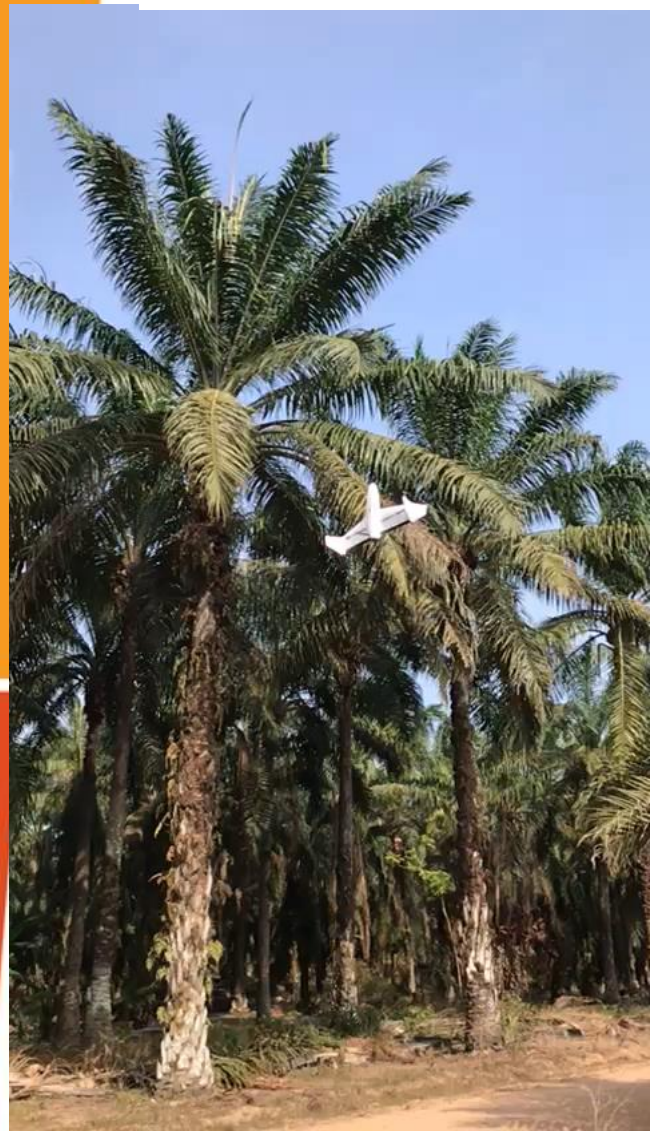
Create application maps by zone and generate prescriptions for FMS integration

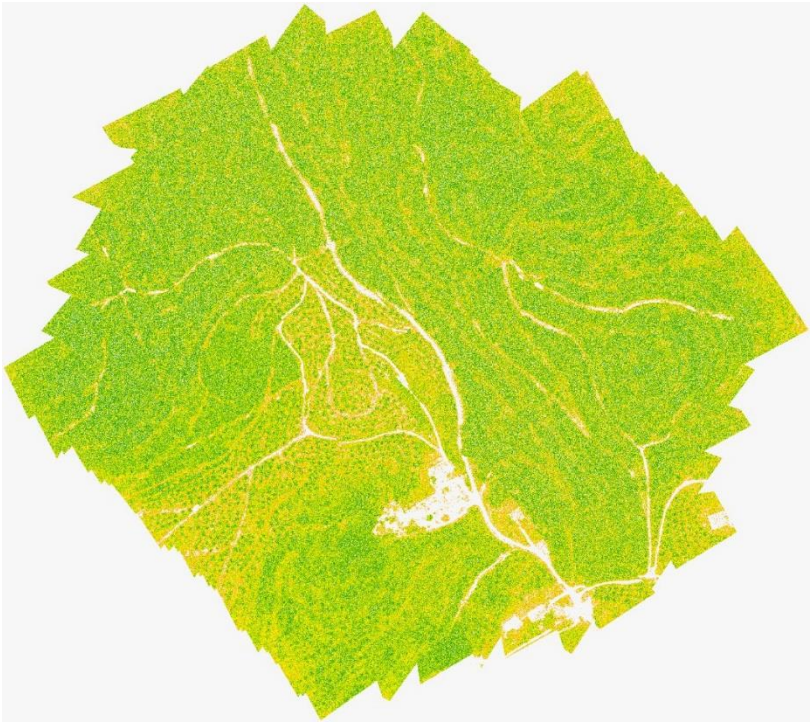
Plant Count

Automated plant counting - Call 888.372.2890 for more information

Vegetation index (NDVI, GNDVI) mapping

Study site: 300 ha

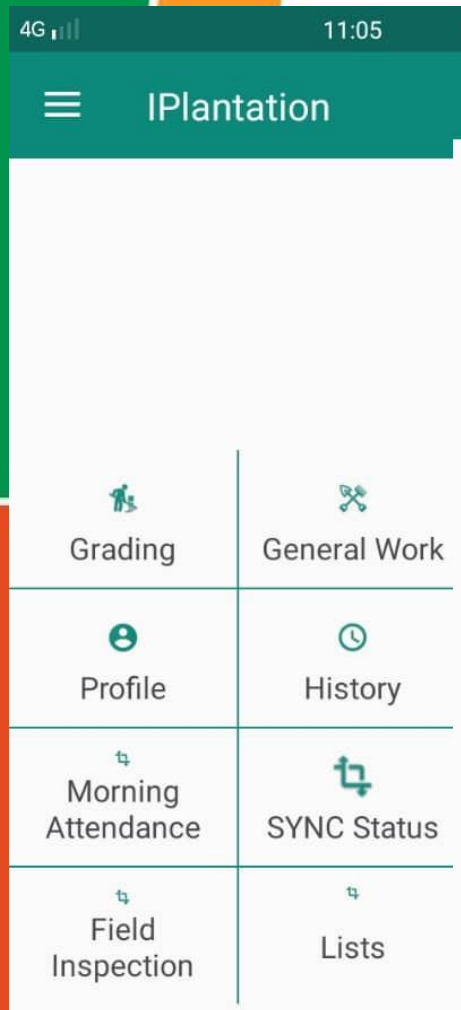


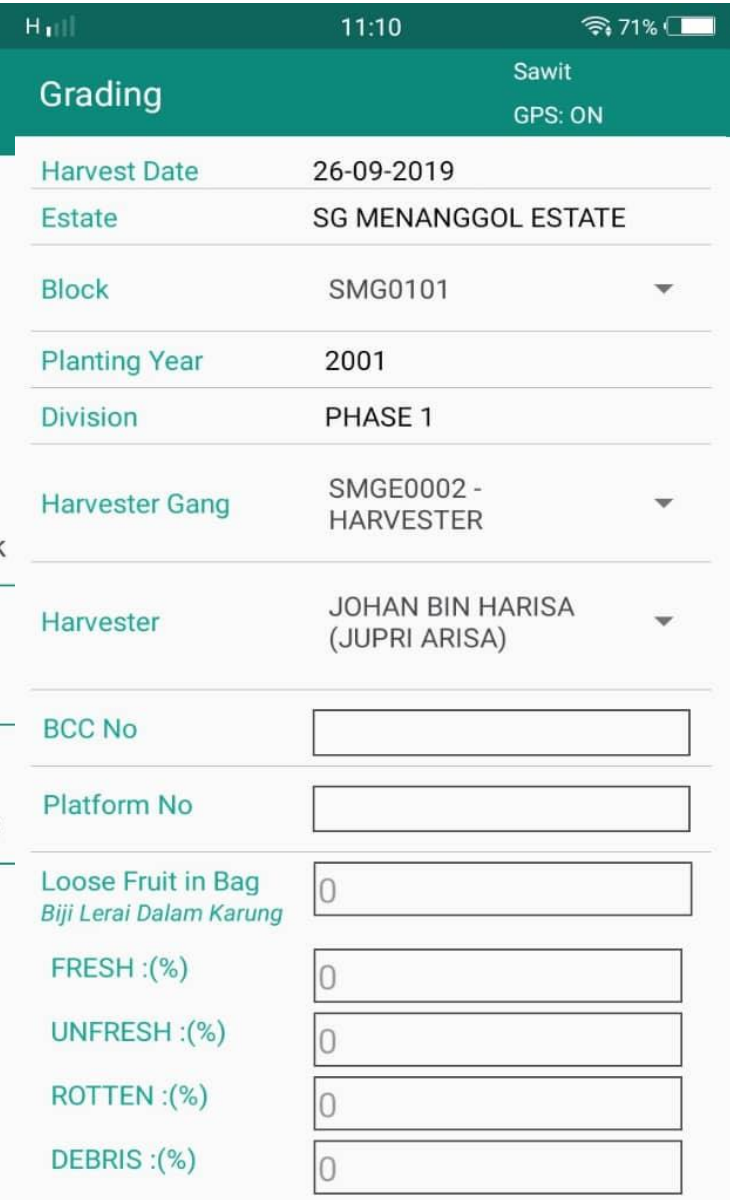


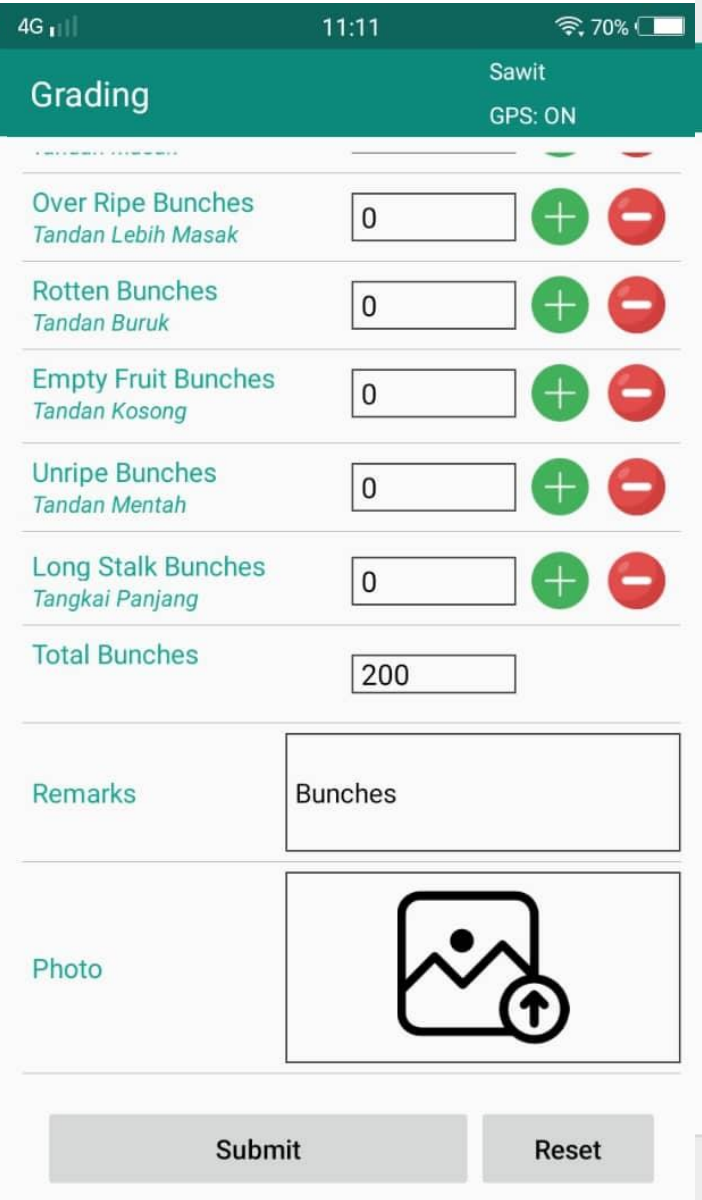
Recent test operation – flying below canopy

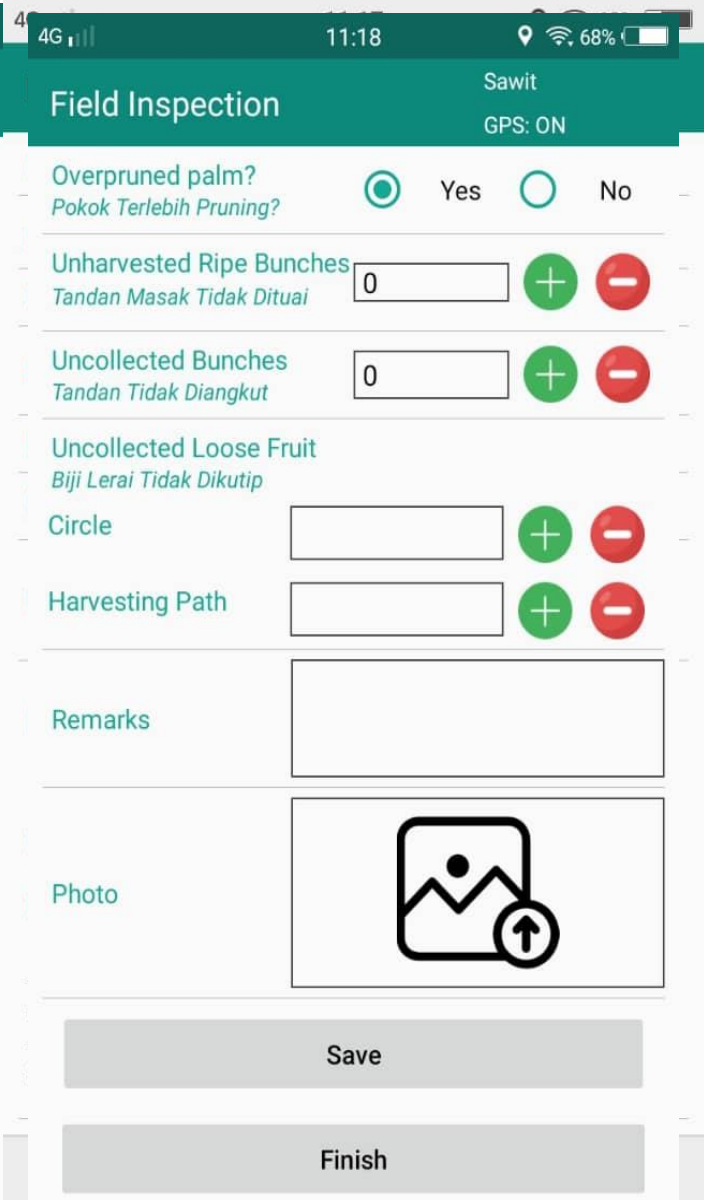
Mission: AutoHaFeWe (Parts 1 & 2)

Work in progress: i-Plantation mobile application









Thank you very much

Muchas gracias




ISPA International Society of Precision Agriculture

MPOCC MALAYSIAN PALM OIL CERTIFICATION COUNCIL

UPM UNIVERSITI PUTRA MALAYSIA BERILMU BERBAKTI

TAYLOR'S UNIVERSITY Wisdom • Integrity • Excellence

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