

IoT for Food

Theme: Food Security

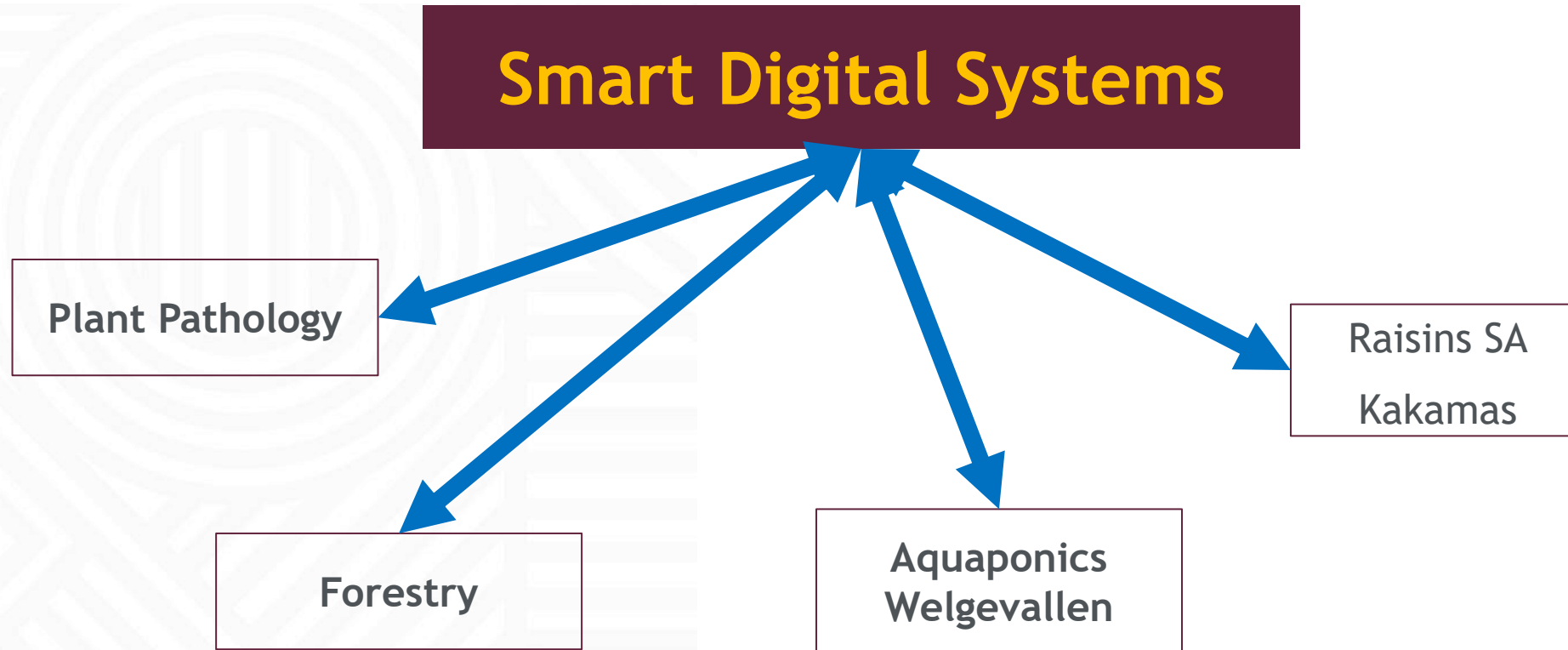
“om te meet is om te weet”
- to measure is to know)

Agriculture informatics

Smart Digital Systems

André van der Merwe
Diane Mostert

Smart Digital Systems - Agri collaboration



Dynamic Geographical Information Systems (DGIS)

CapeFarmMapper - agriculture regions



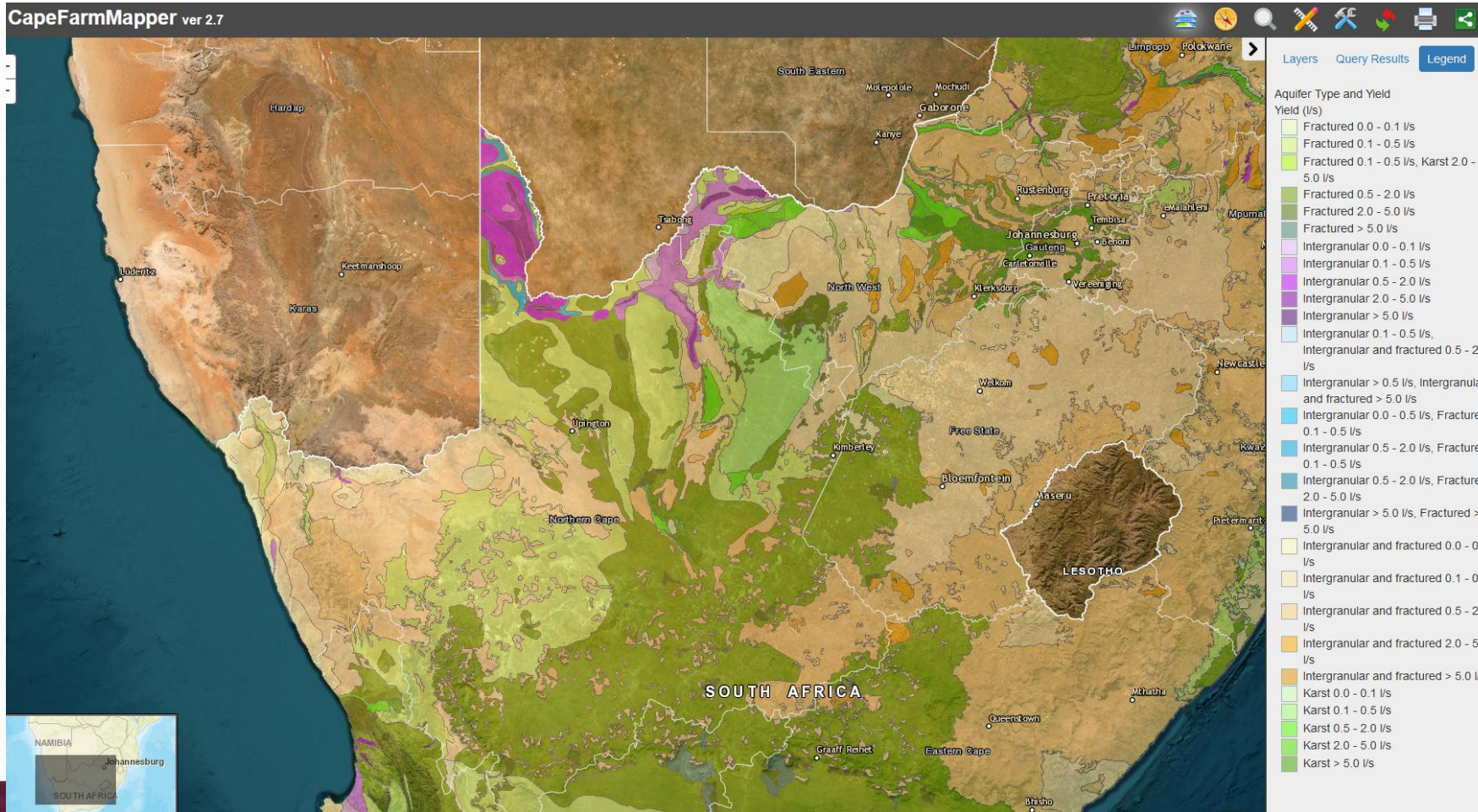
GIS static layers:

- Geological
 - Underlying rock types
 - Soil types
 - Contours
 - Rivers
- Regional (semi static)
 - Borders
 - Agricultural use
 - Irrigation schemes

GIS dynamic layers:

- Google Maps (static)
 - Traffic density (eg. of dynamic layer)
- Google Earth
- CapeFarmMapper
- ArcGis - esri South Africa - edu License
- agis.NDA.agric.za

CapeFarmMapper - aquifer type & yield (l/s)



GIS dynamic layers ?

- Rainfall (recent)
- Groundwater level
- Windspeed (current)
- Tunnel farming activity
- Aquaponics yield
- Tower farming yield
- Soil :
 - pH
 - N P K
 - EC
 - Temperature
 - Moisture
 - Moisture hold capacity

Data capture & analysis

Aim: monitor system data integrity



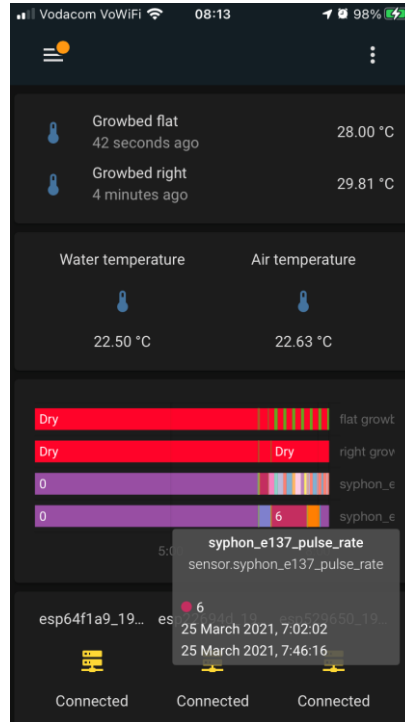
Telegram

NodeRed

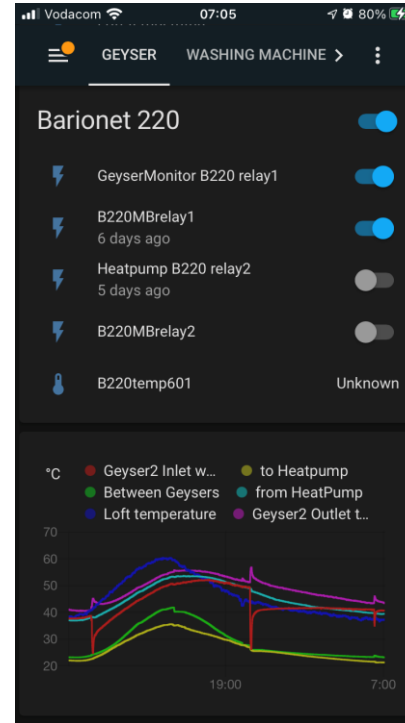
Python



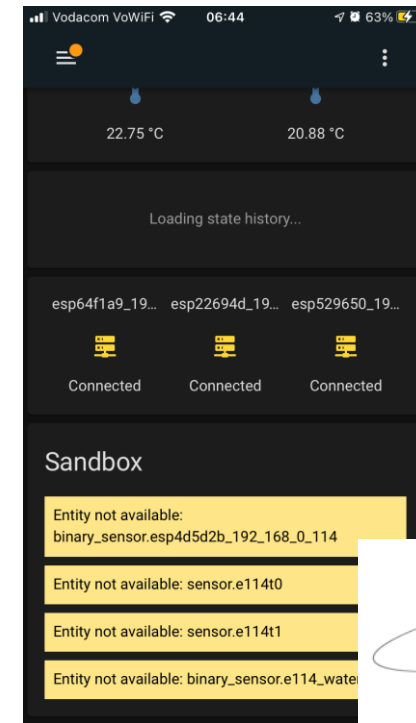
Level display



Event plot
Frequency alarm



Historic graphing



Device availability

GRAFANA

InfluxDB

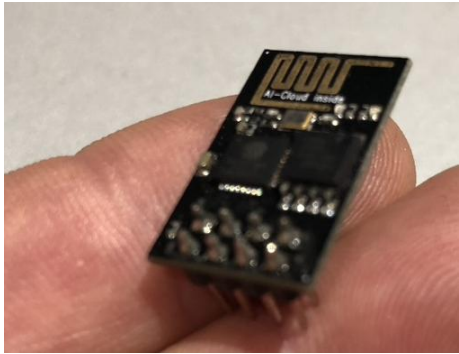
Stellenbosch
UNIVERSITY
IYUNIVESITHI
UNIVERSITEIT



Real BIG DATA - Prof Andries Engelbrecht

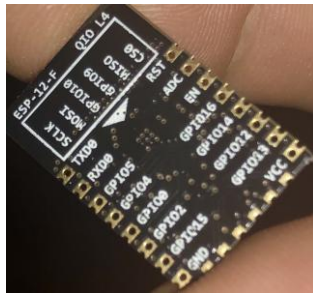
Devices

Aim: test robustness of system components to maintain service level



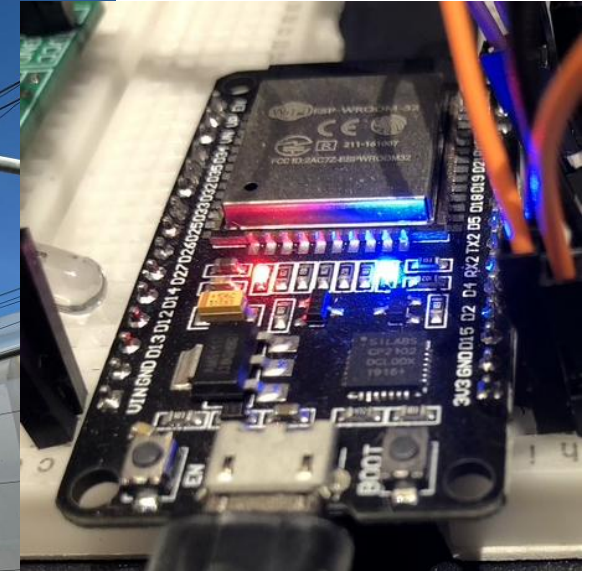
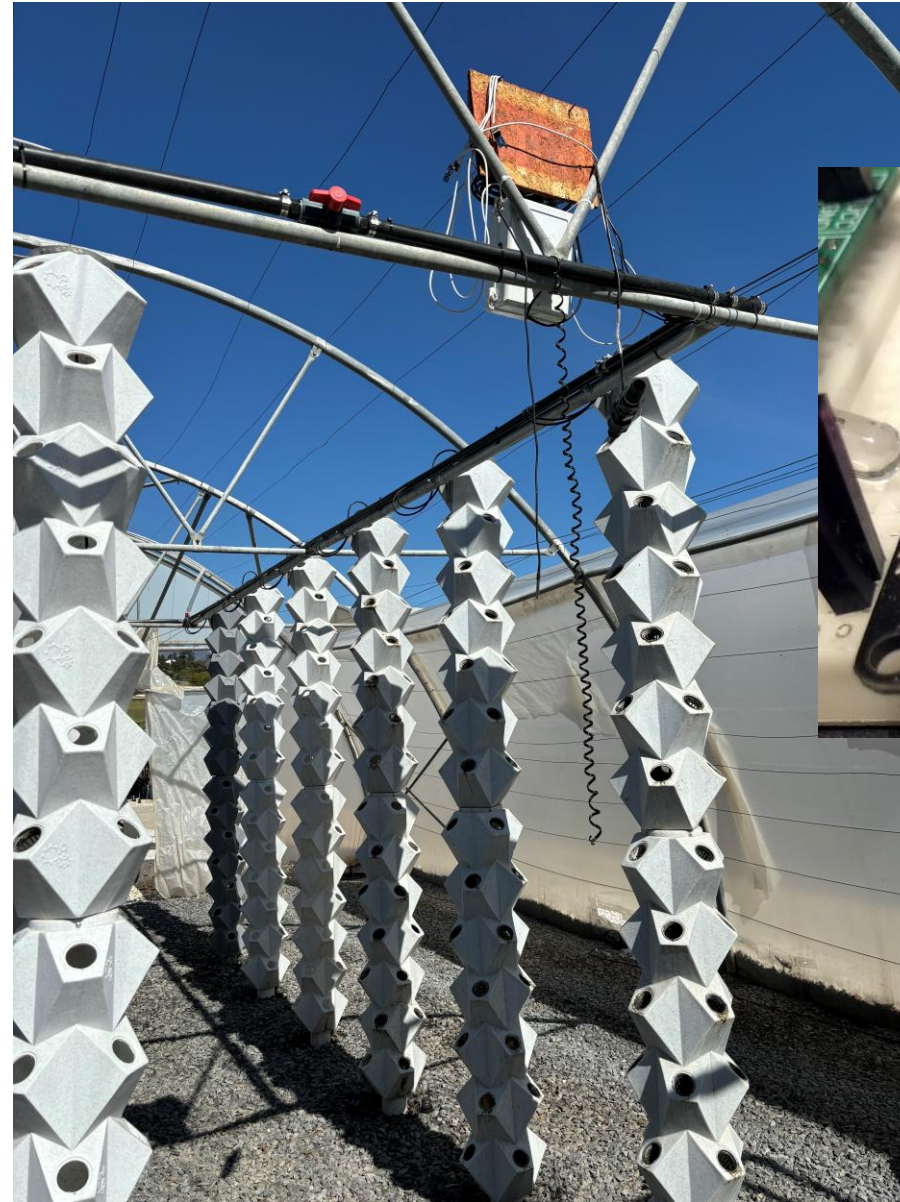
ESP 8266-01

- MQTT
- 4 x IO binary
- OneWire
- I2C
- R60,00



ESP 8266-12F

- MQTT
- 8 x IO binary
- Analog - voltage monitor
- OneWire
- I2C
- R50,00

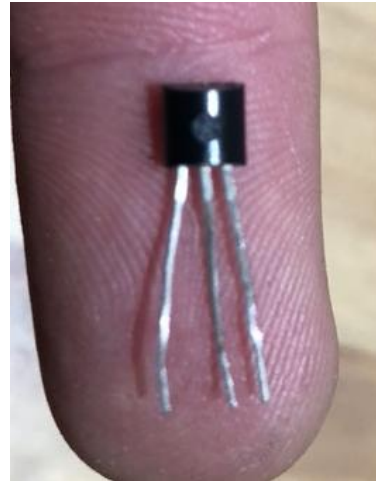


ESP 32

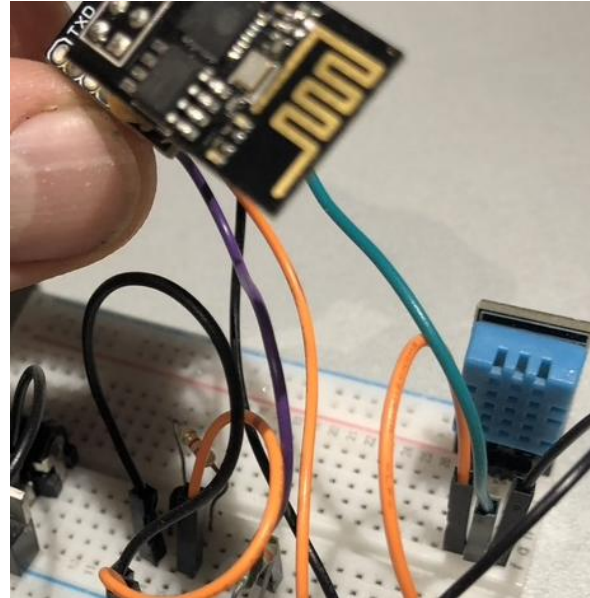
- MQTT
- 8 x IO binary
- Analog - voltage monitor
- OneWire
- I2C
- Camera add-on
- R120,00

Sensors

Aim: test robustness of system components to maintain service level



DS18B20 (digital)
- temperature
- OneWire
- R50,00



Humidity / Temperature (digital)
- I2C
- R120,00

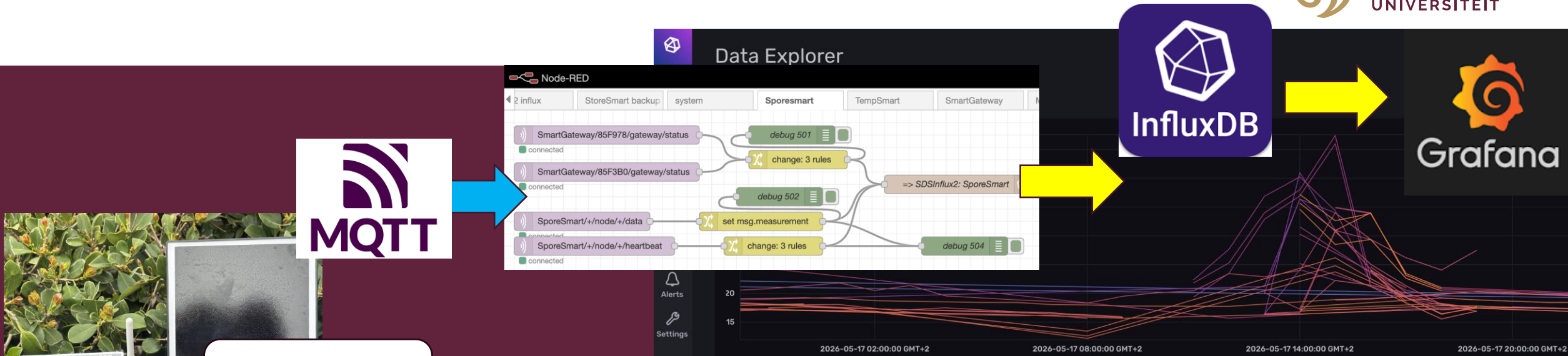
MPU6050 Accelerometer & Gyroscope

Features MPU6050

- MEMS 3-axis accelerometer and 3-axis gyroscope values combined
- Power Supply: 3-5V
- Communication : I2C protocol
- Built-in 16-bit ADC provides high accuracy
- Built-in DMP provides high computational power
- Configurable IIC Address




SMART DIGITAL SYSTEMS ARCHITECTURE




SmartGate 4Gateway

- Storage at each node and gateway level when upload not active. LittleFS
- Smart power management


SolarSmart
 node


DS18B20, INA226


SporeSmart
 node


BH1750, BME280, DS18B20, 7in1 NPK


SoilSmart
 node


BH1750, BME280, DS18B20, 7in1 NPK


TempSmart
 node

BH1750, BME280, DS18B20


MoveSmart
 node

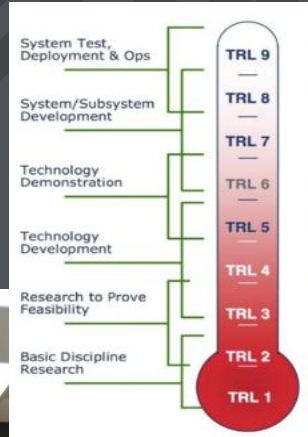
MPU6050


PedalSmart
 node

MPU6050



makerspace
 innovasieruimte • iqonga labayili



Norman Hebler

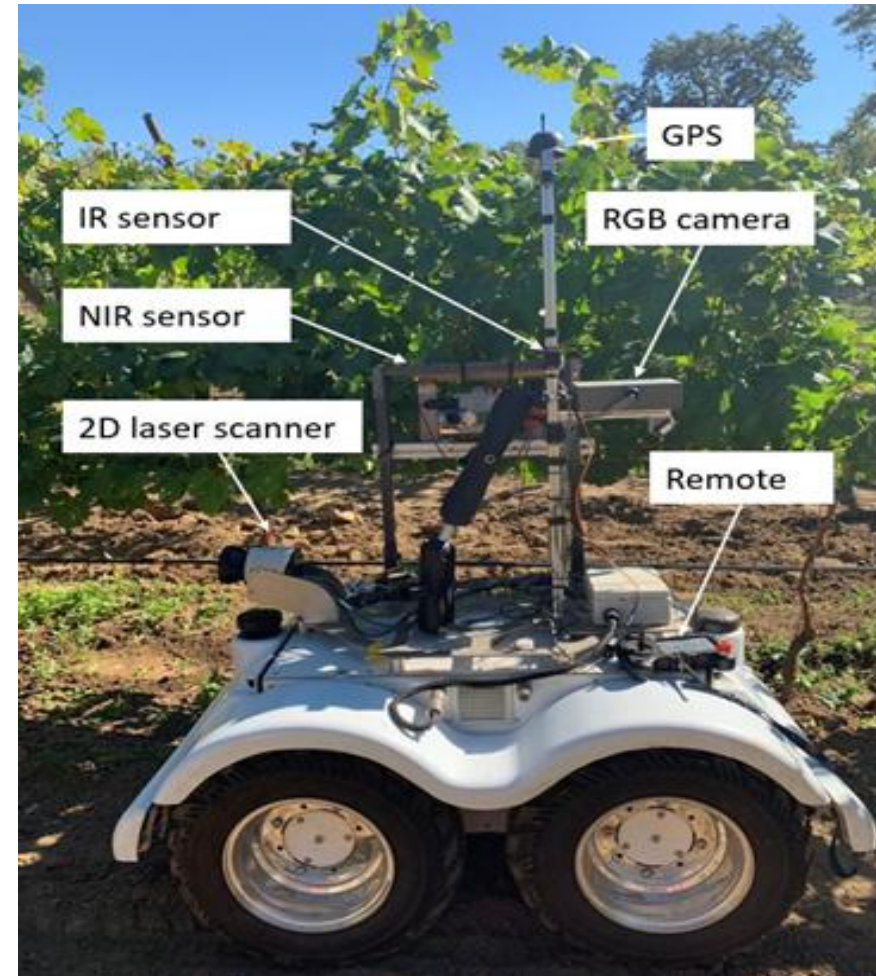


Case study : water stress in vineyards - robot

Study of the suitability of a Robotic platform to detect water stress in vineyards using proximal sensing technologies

The robotic platform contains a sensor suite that records various water stress indicators.

Conclusion: This pilot study showcases the potential for robotic platforms and infrared sensors to be used as a tool for mapping water stress.



Case study : Leaf roll recognition using AI

healthy



infected



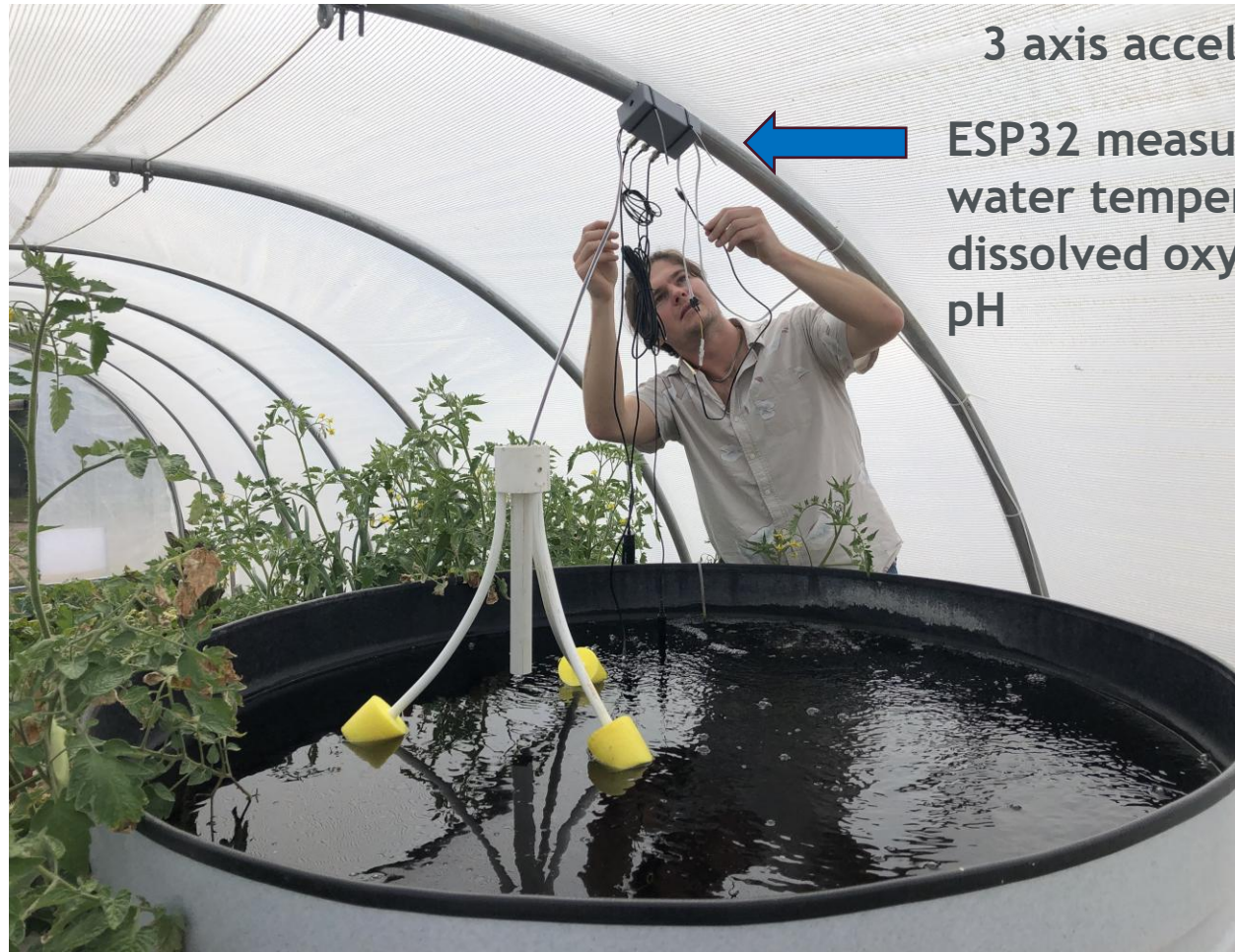
	Original	Augmented
train	256	385
validation	55	83
test	55	55

Number of images in original versus augmented subsets

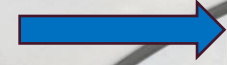
Evaluation Measure	Accuracy	Precision	Recall
Model 1	88.82%	86.84%	97.06%
Model 2	89.44%	86.96%	98.04%
Model 3	52.85%	75.08%	52.85%
Model 4	74.61%	79.19%	74.62%

Table 4.4: Accuracy, Precision, and Recall of three final models

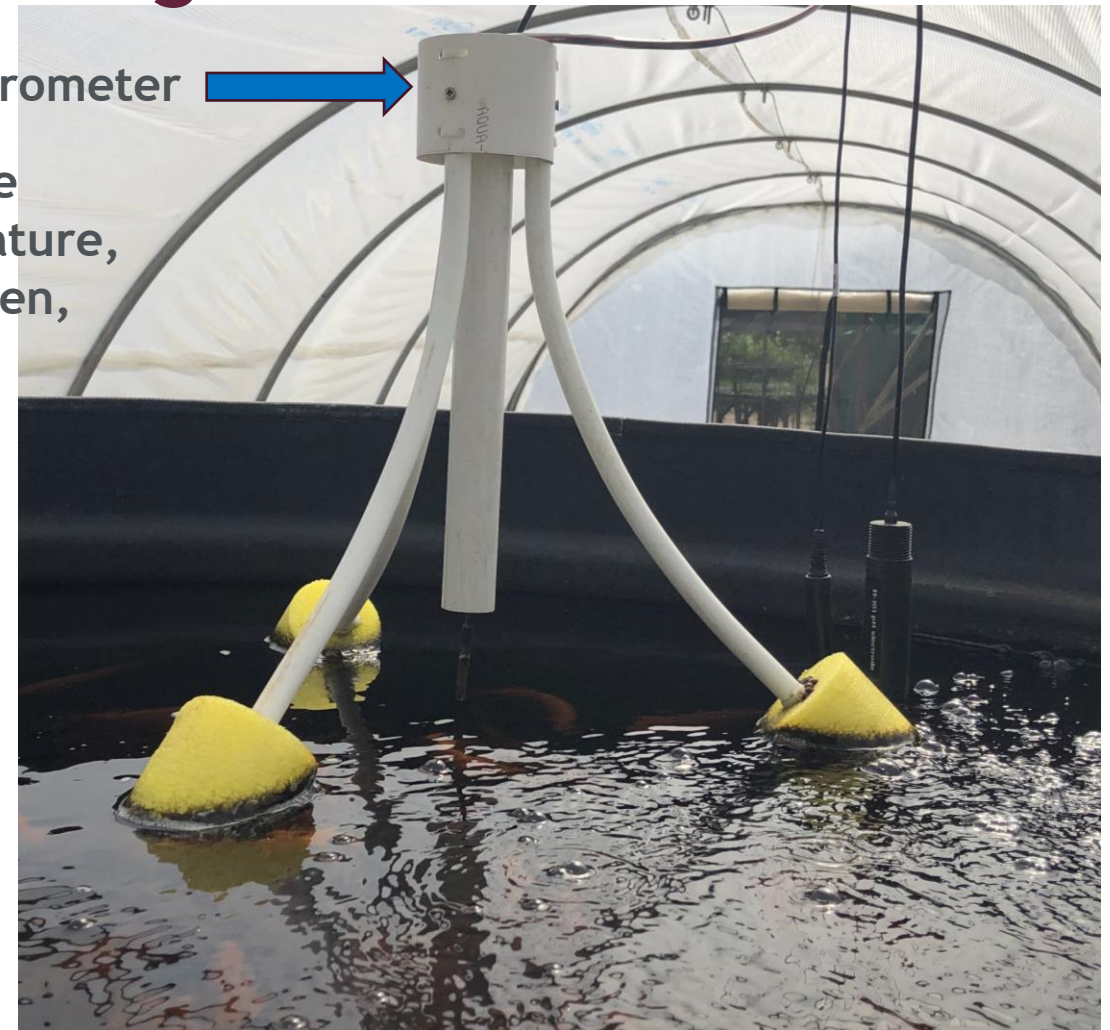
Case study : Fish feed demand using AI



3 axis accelerometer



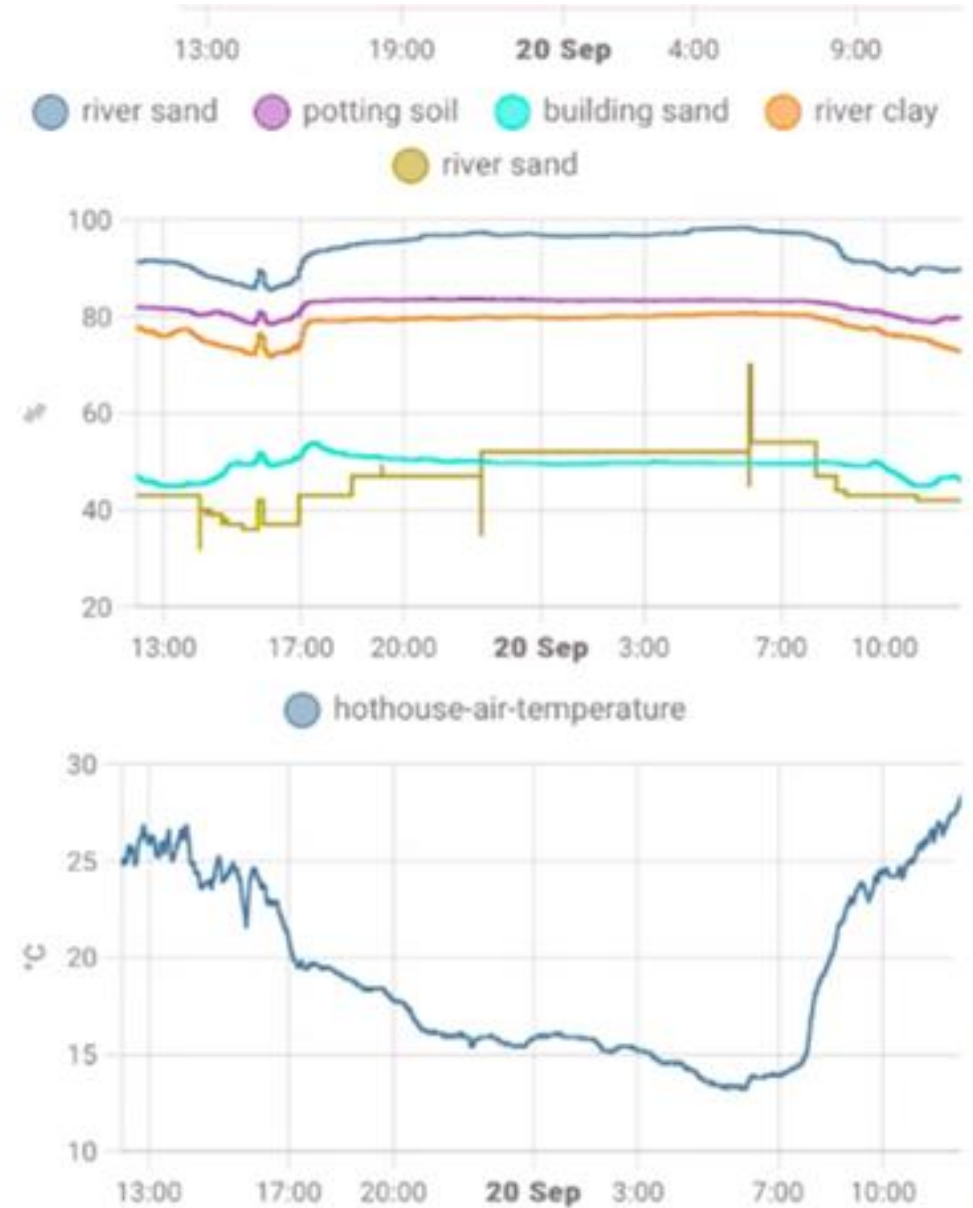
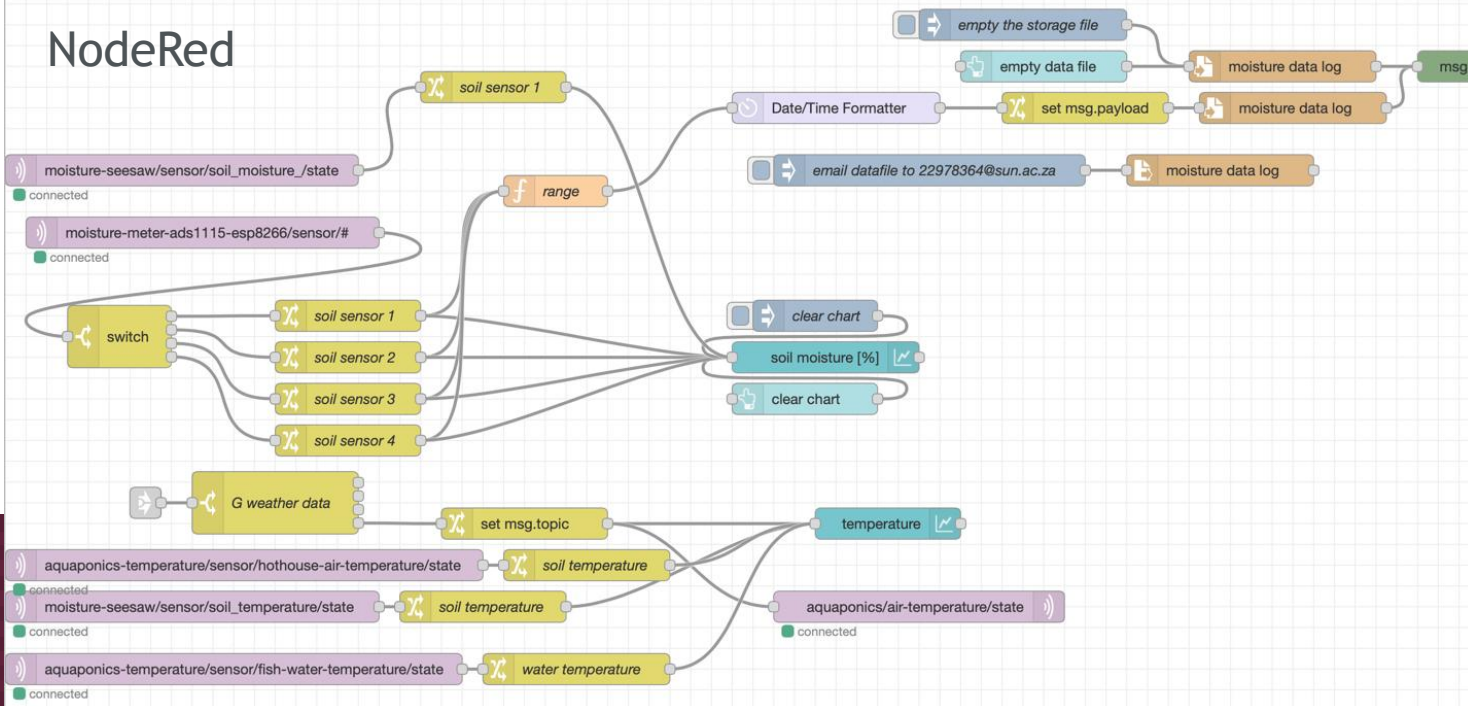
ESP32 measure
water temperature,
dissolved oxygen,
pH



Case study : Soil moisture sensor reliability



NodeRed



Case study : *Sclerotinia sclerotiorum* detection

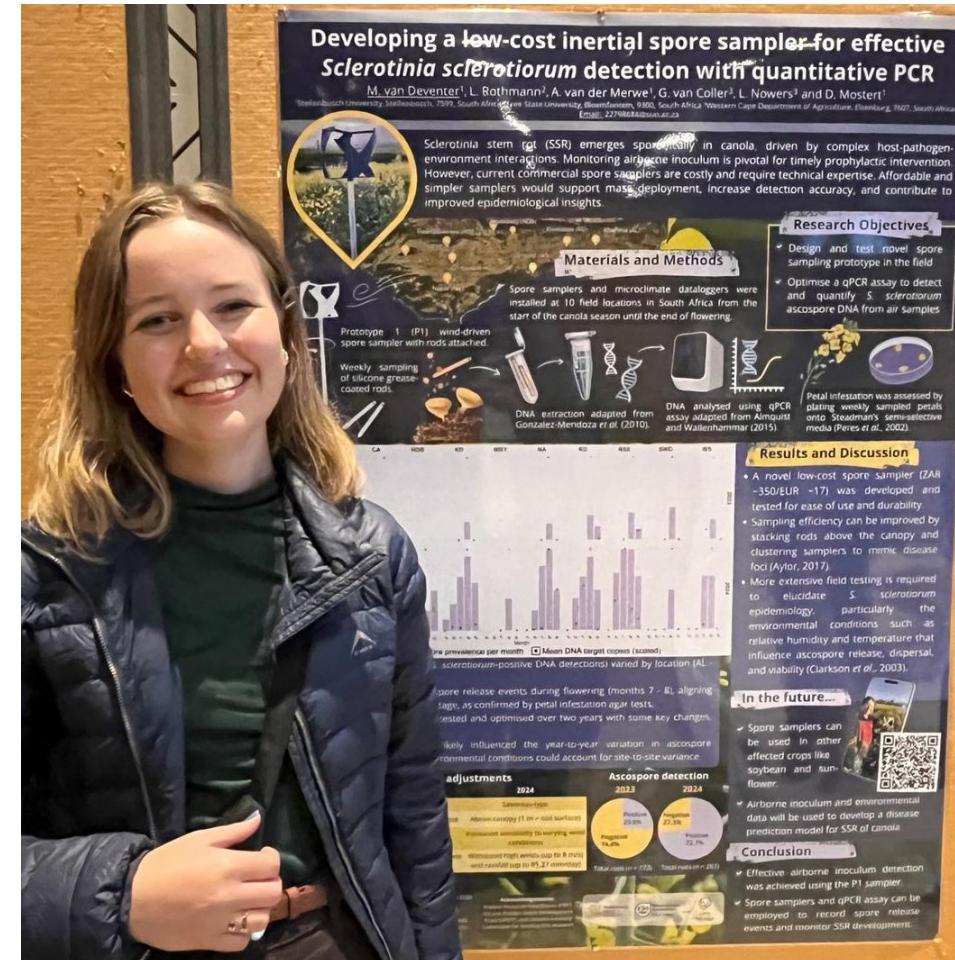
Study: In-field detection of microclimate conditions that are ideal for enhancing phytopathogen survival and growth.

The development of a SporeSmart system that measure microclimate parameters ideally suited to the occurrence of *Sclerotinia sclerotiorum*. AI modelling to predict risk of disease development based on infield parameters.

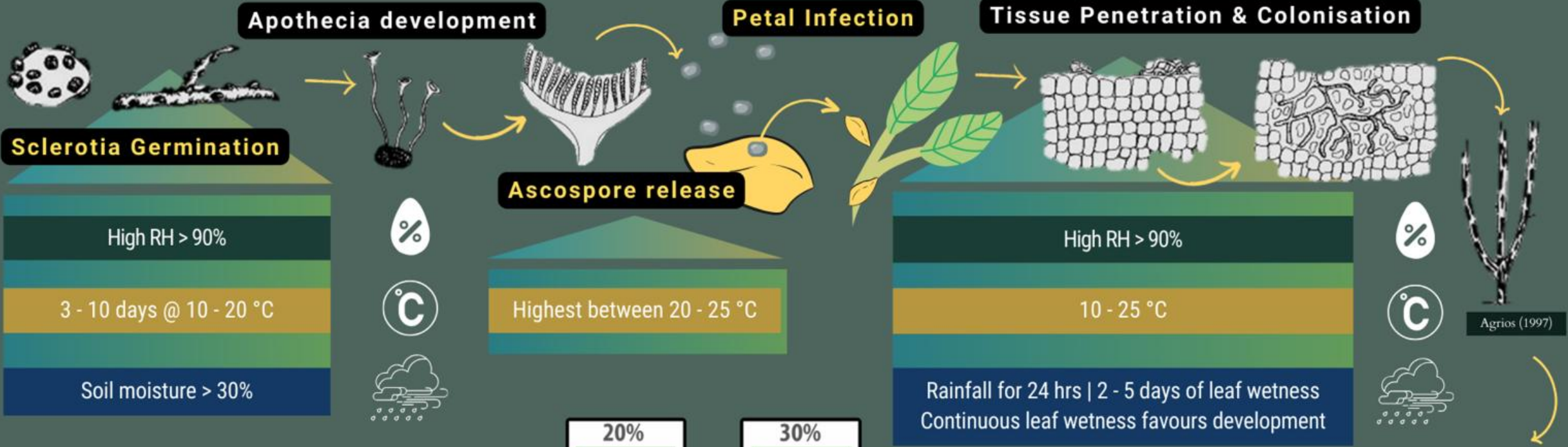
- Temperature air, soil,
- Humidity, Soil moisture,
- pH, EC,
- N P K,
- Solar DLI,
- air pressure.

Prototype 1, 2 tested. 3 currently in field

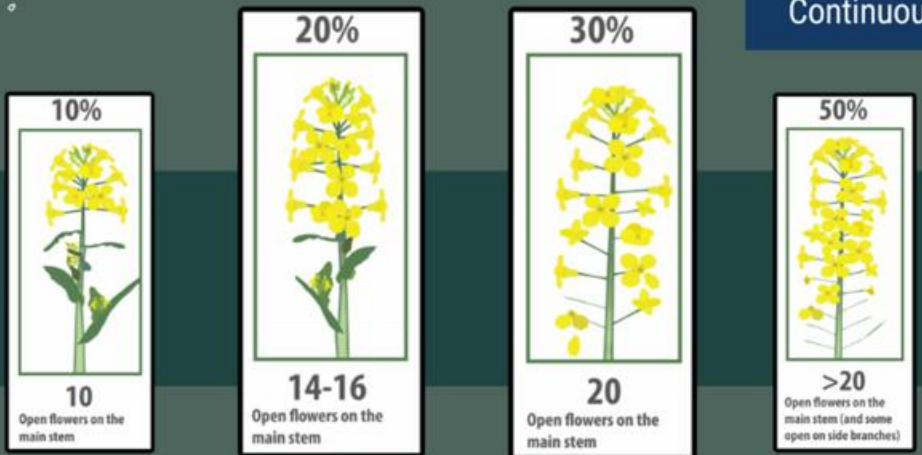
Conclusion: ongoing - progress report by Diane Mostert



CARPOGENIC GERMINATION



HOST PHENOLOGICAL STAGE





Disease Management Challenges:

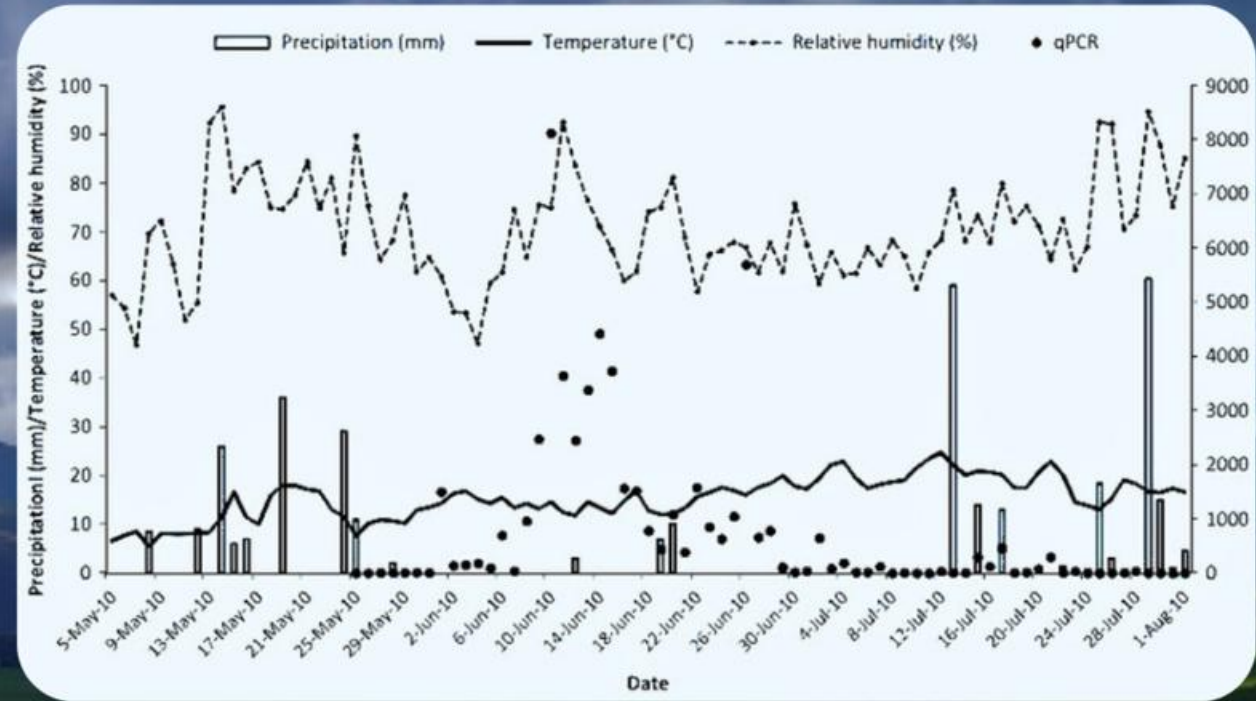
Chemical control



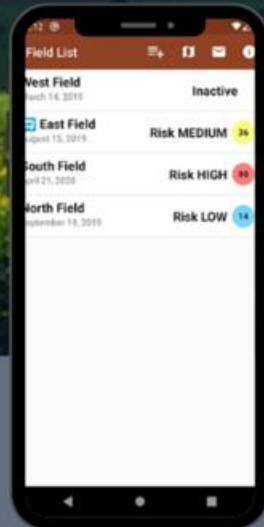
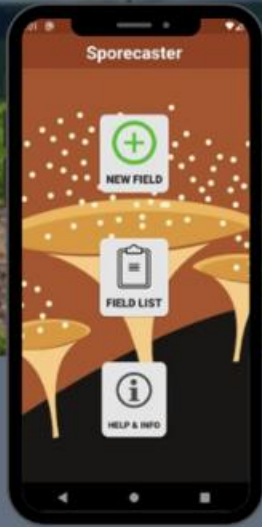
- Chemical control remains most effective for SSR management
- Fungicide application timing is **CRITICALLY** important
- Available chemistries are expensive and more than 1 application per season is often required
- Producers weigh risk of disease development against economic needs
- As a result, over- and under-application of fungicides with detrimental consequences

DISEASE RISK PREDICTION

- Disease risk prediction = better management decisions
- Prediction models are based on epidemiological factors
- Allow for more accurate and timely fungicide applications
- Models exist for several *Sclerotinia*-inferred diseases on economically important crops



Almqvist and Wallenhammar (2015)



Case study : *Sclerotinia sclerotiorum* detection P1



Case study 6: *Sclerotinia sclerotiorum* P2

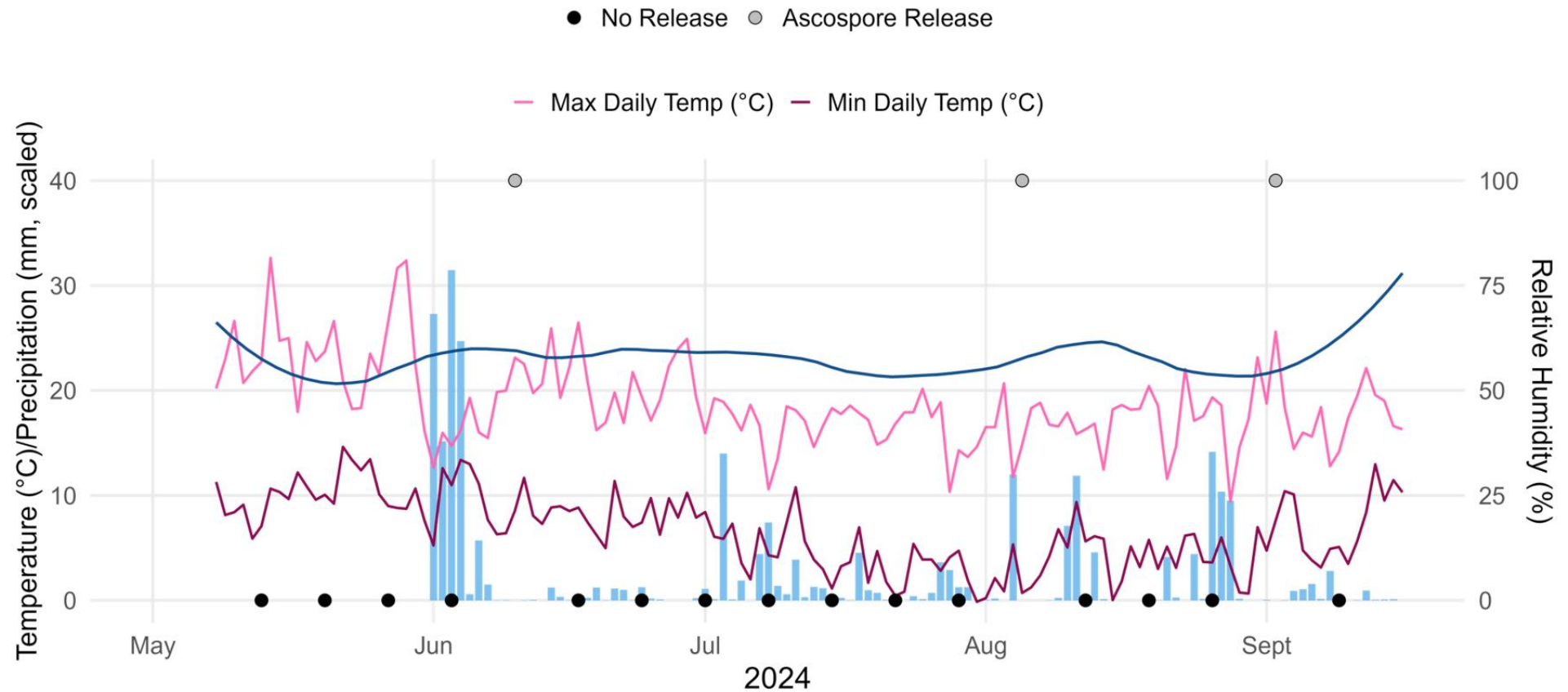


Results and Discussion

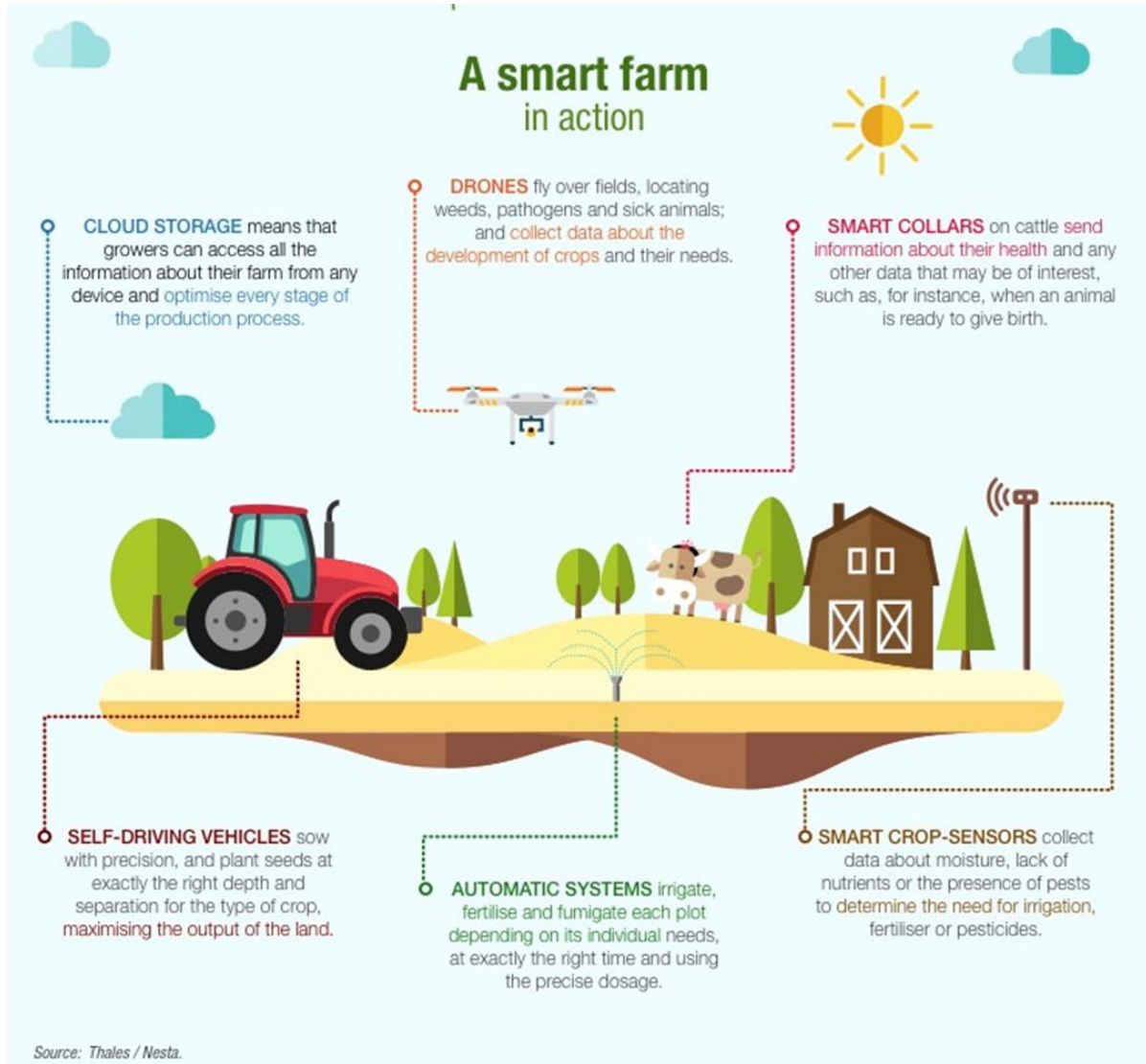
Effect of environmental parameters on ascospore release

Albertinia

2.67% SSR incidence



Benefits of the technologies



Beneficiaries:

- Governments
- Crop and livestock production and protections industries
- Research institutions