

MOISTURE

MODERATE

FarmBeats: Empowering Farmers with Affordable Digital Agriculture Solutions

Ranveer Chandra



The Agricultural Challenge



Global Access

1 in 9 people are undernourished (UN)

65% Reduce poverty for 65% of the world's poor who live in rural areas and work in farming

70% more food is needed by 2050



Sustainable Production

70% of global water resources are needed for Agriculture

24% of global greenhouse emission comes from Agriculture

251T liters of water to be saved in 2030 from implementing Smart Agriculture



Need for Economic Growth

30% of global workers are employed by Agriculture

10-30% Agriculture contributes 10% of global GDP and up to 30% in low income countries

\$4.8T Global Agriculture revenue

Data-driven agriculture

Precision agriculture has shown to:



Improves yield



Reduces cost



Ensures sustainability

NITROGEN
19ppm

Recommendation:
25ppm

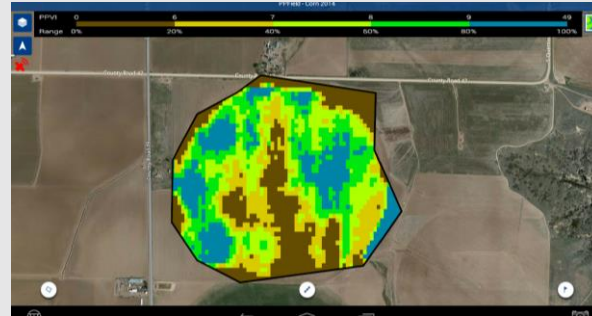


New Opportunities...



Connected Farms

Data collection with sensor deployments, drone flights, and farm equipment



AI-based Advisory

Real-time, actionable insights based on the ground conditions combined with remote sensing and weather patterns



Precision Farming

Irrigation, Fertilizing, Weeding and Spraying applications

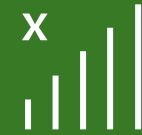


Traceability

Use of blockchain to track usage & compliance

According to USDA, high cost of manual data collection prevents farmers from using data-driven agriculture.

An end-to-end system that enables seamless data collection and insights for agriculture



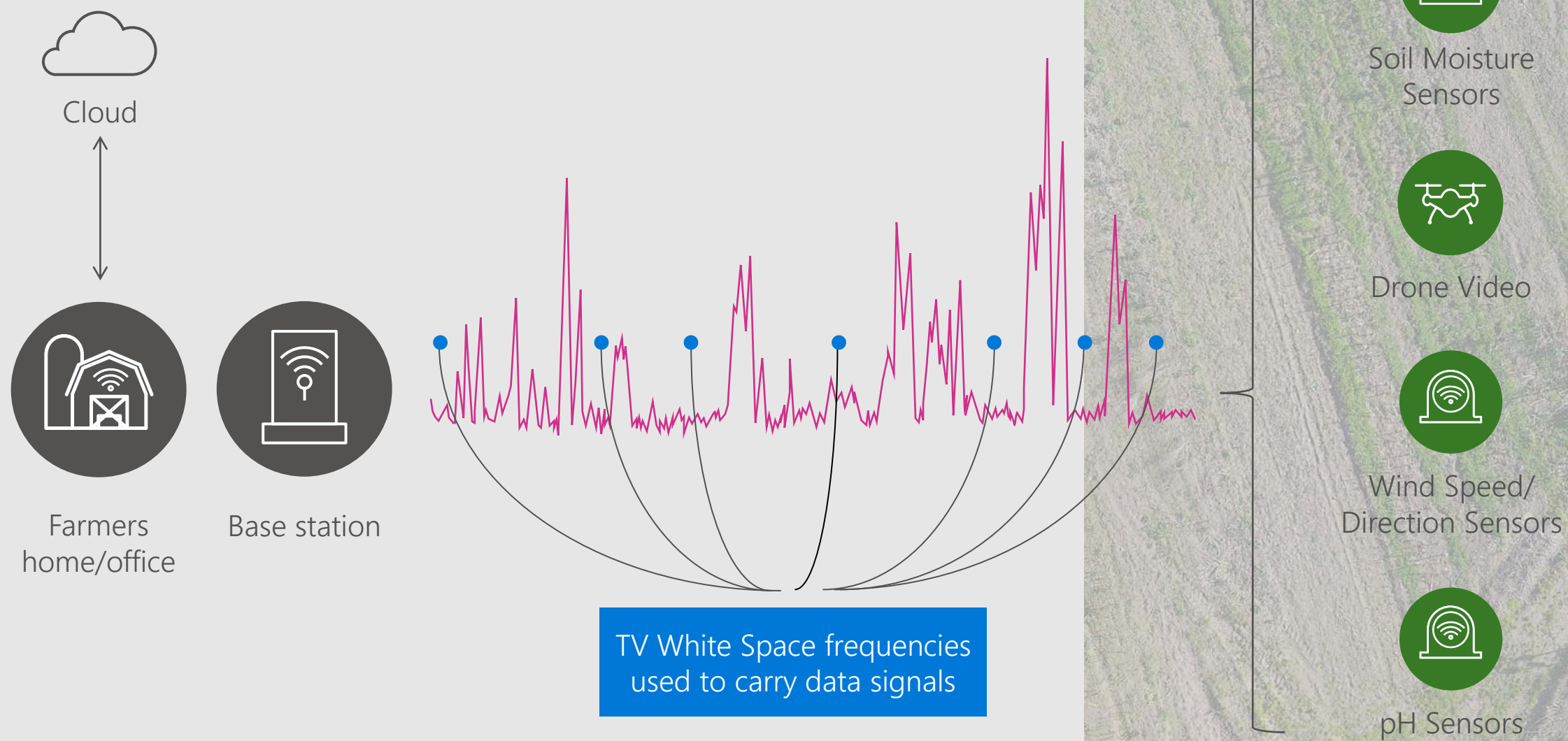
FarmBeats



Challenge: Farm connectivity

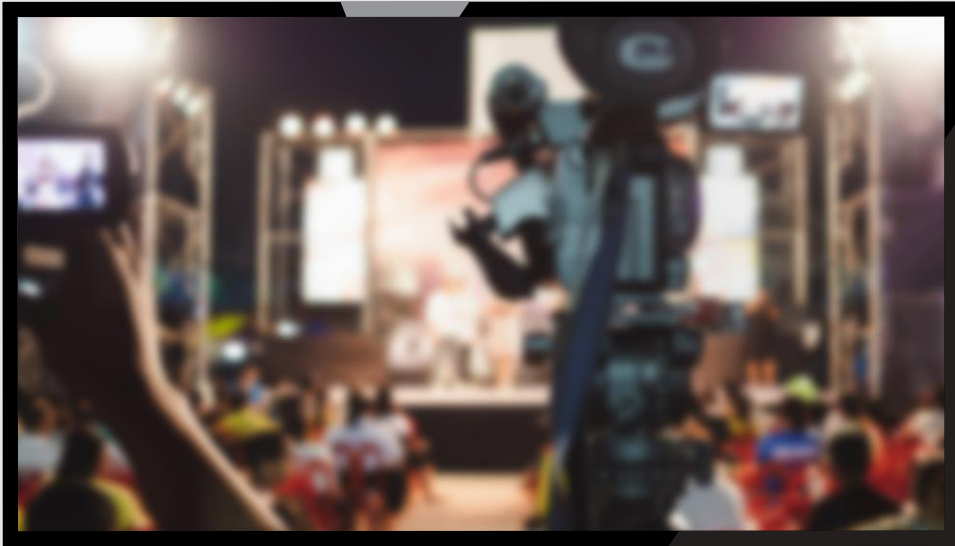


Challenge: Farm connectivity

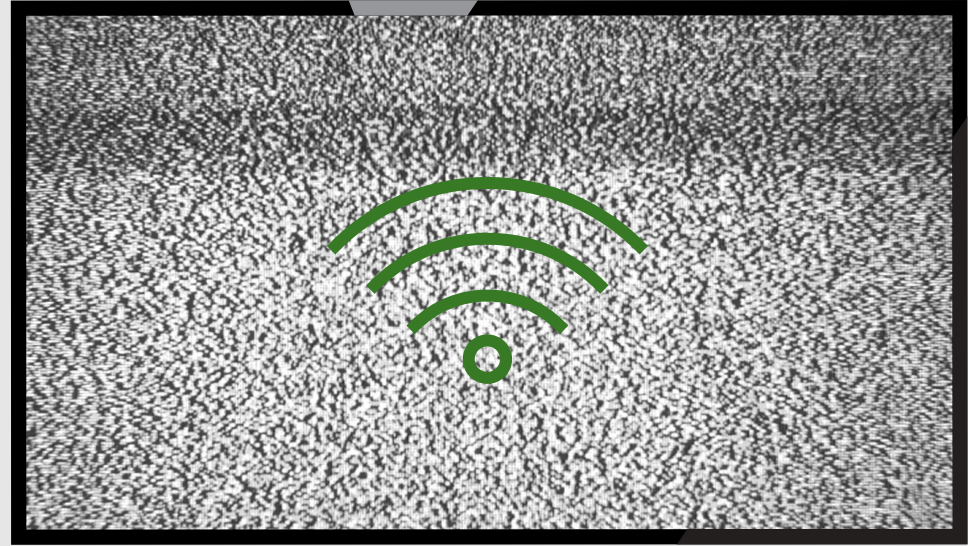


Microsoft Research has been studying this for over a decade...

Networking Over White Spaces (KNOWS)



TV channel on network



Unused TV channel

Airband

Internet Access

Active Projects

69

Population Covered

11,778,136

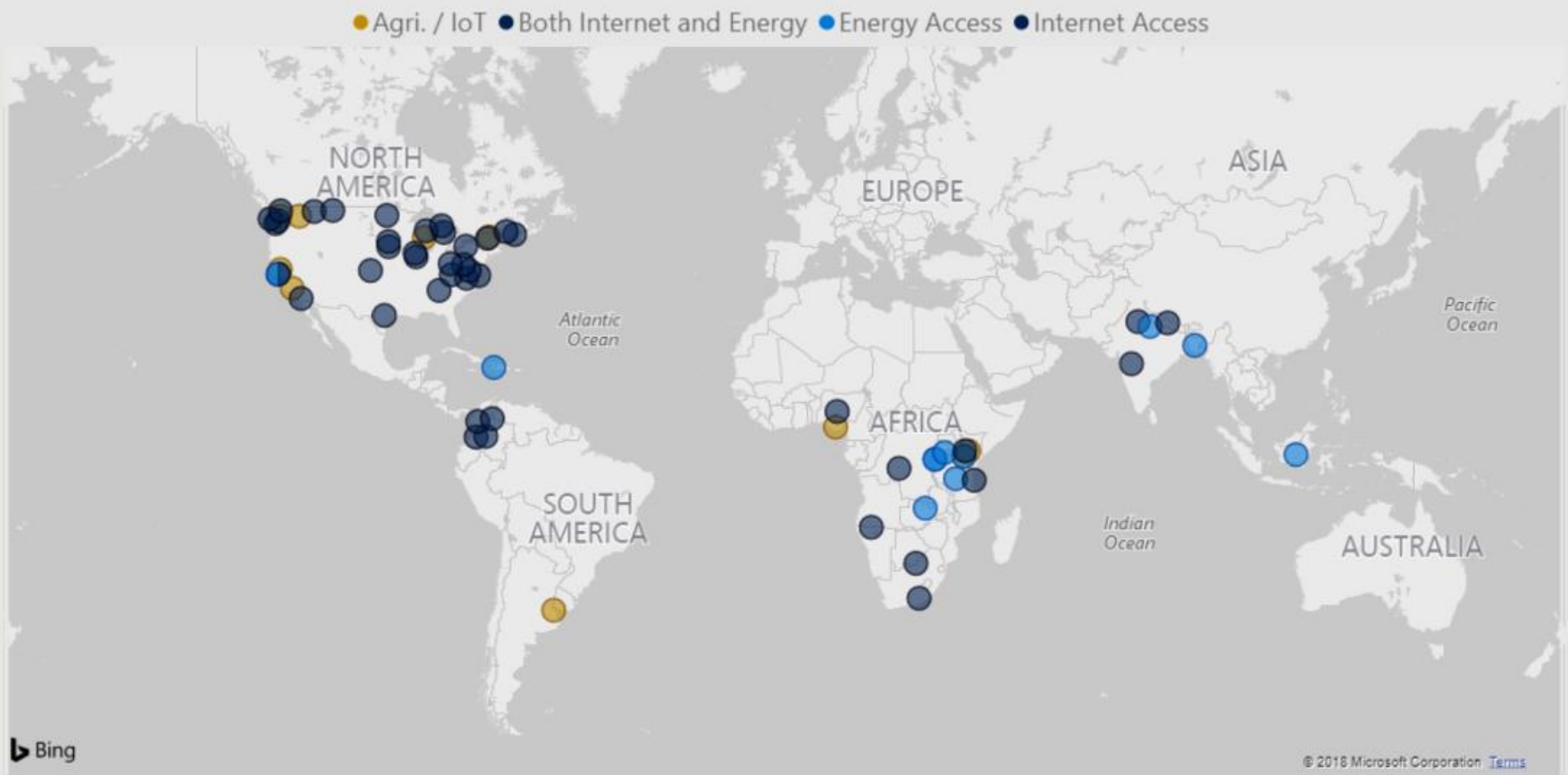
Population Connected

594,918

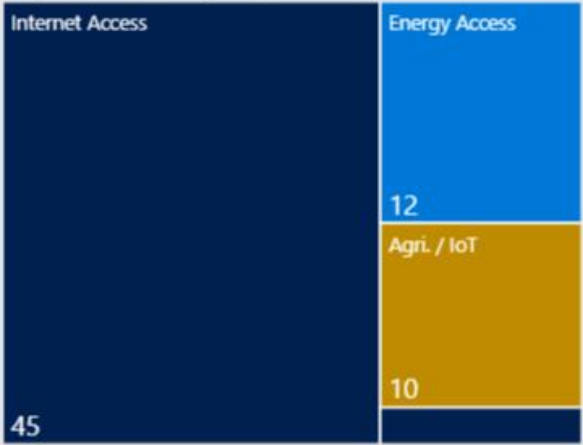
Energy Access

705,360

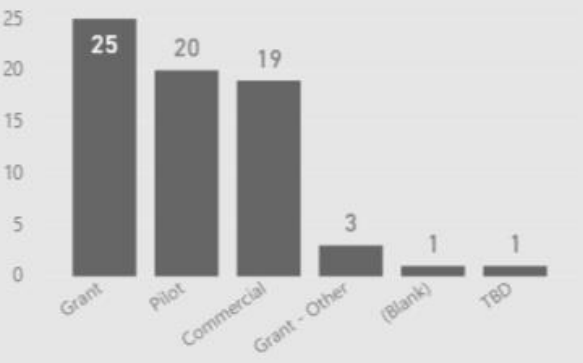
Project Locations



Project Count by Project Type



Project Count by Funding Type



TV White Spaces in the Farm

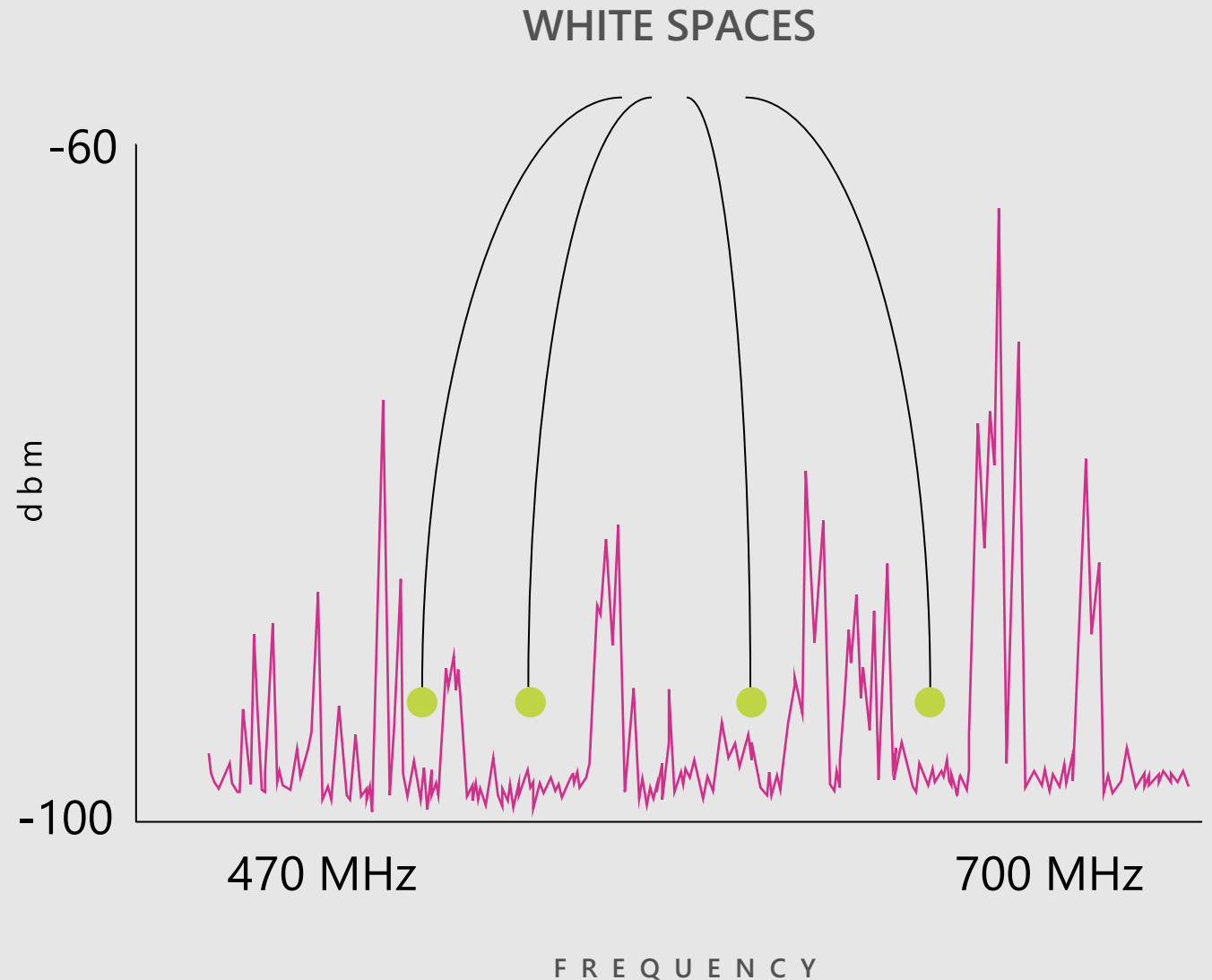
What are the TV White Spaces?

Unused TV channels

Key insight for farms:

“Lots” of TV spectrum is available,
more than 100 MHz

Just like Wi-Fi router covers the home,
TVWS base station can cover the farm

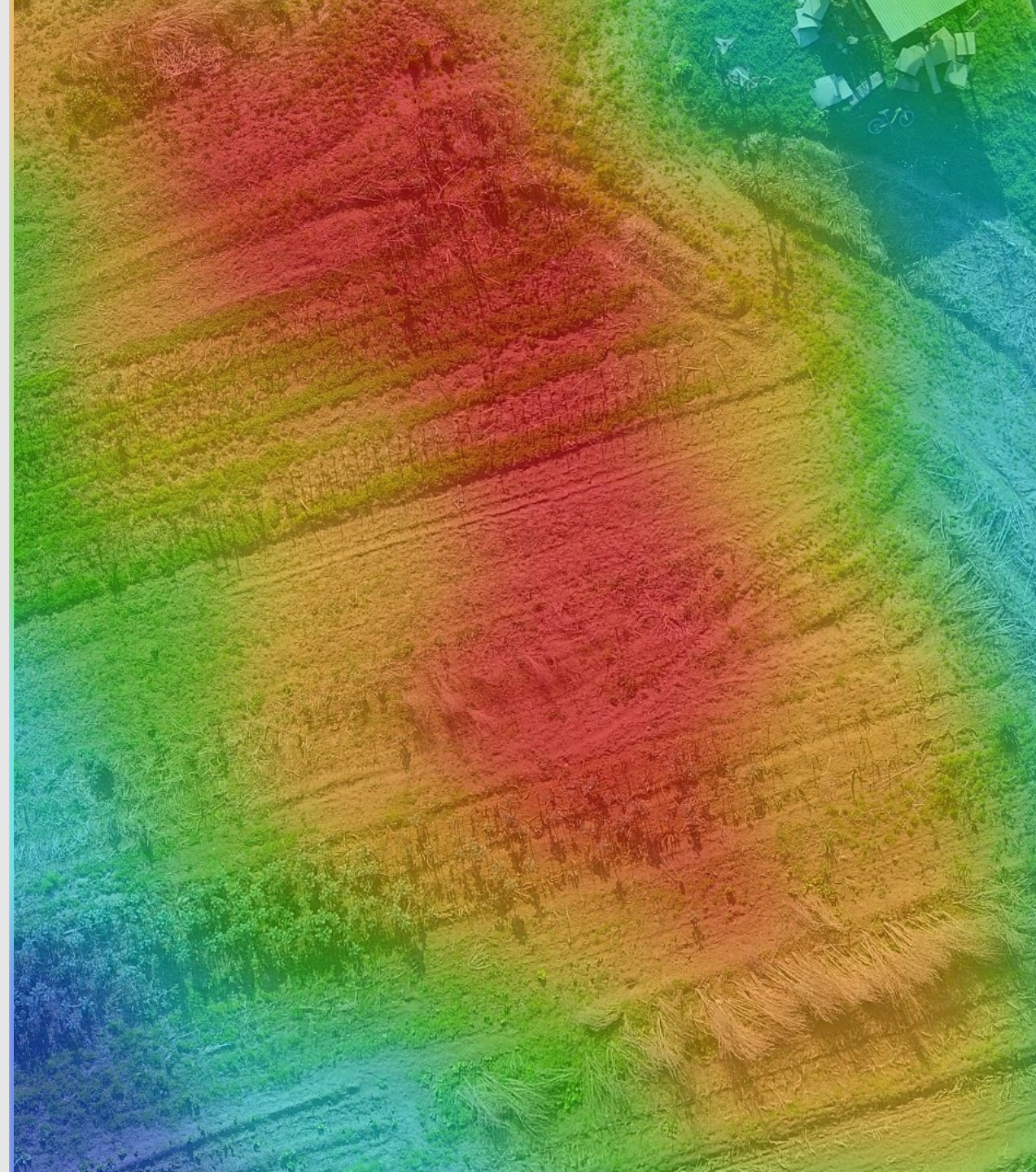


Challenge: Limited resources

Need to work with sparse
sensor deployments

- Physical constraints due to farming practices
- Too expensive to deploy and maintain

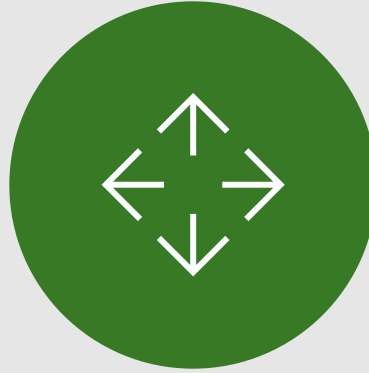
How do we get coverage with a sparse
sensor deployment?



Idea: Use UAVs to enhance spatial coverage



Drones are ~1000
dollars and automatic



Can cover large
areas quickly



Can collect
visual data

Combine visual data from the UAVs with the sensor data from the farm

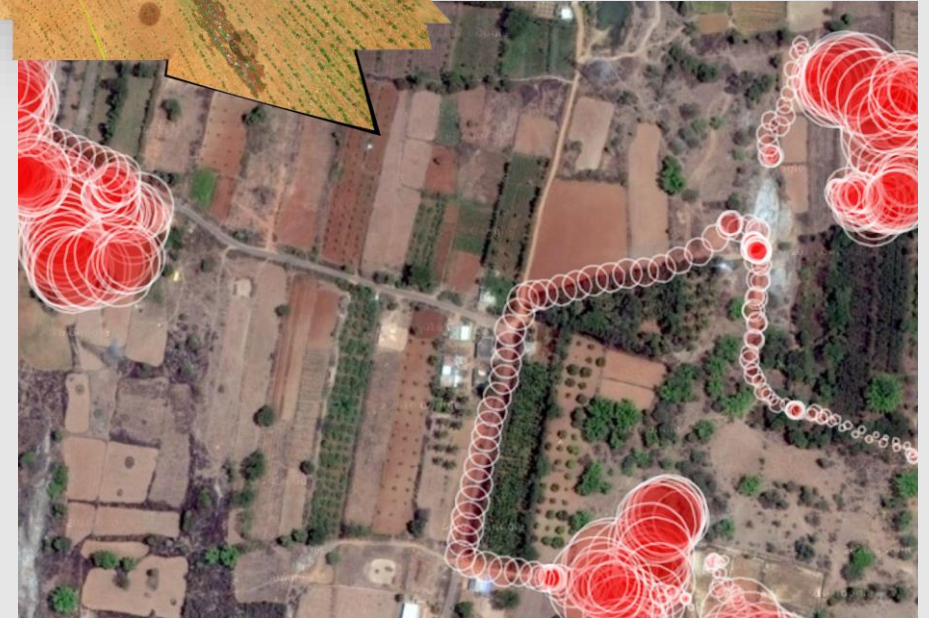
Low-cost aerial imagery: Tethered Eye (TYE)

UAVs have a few limitations:

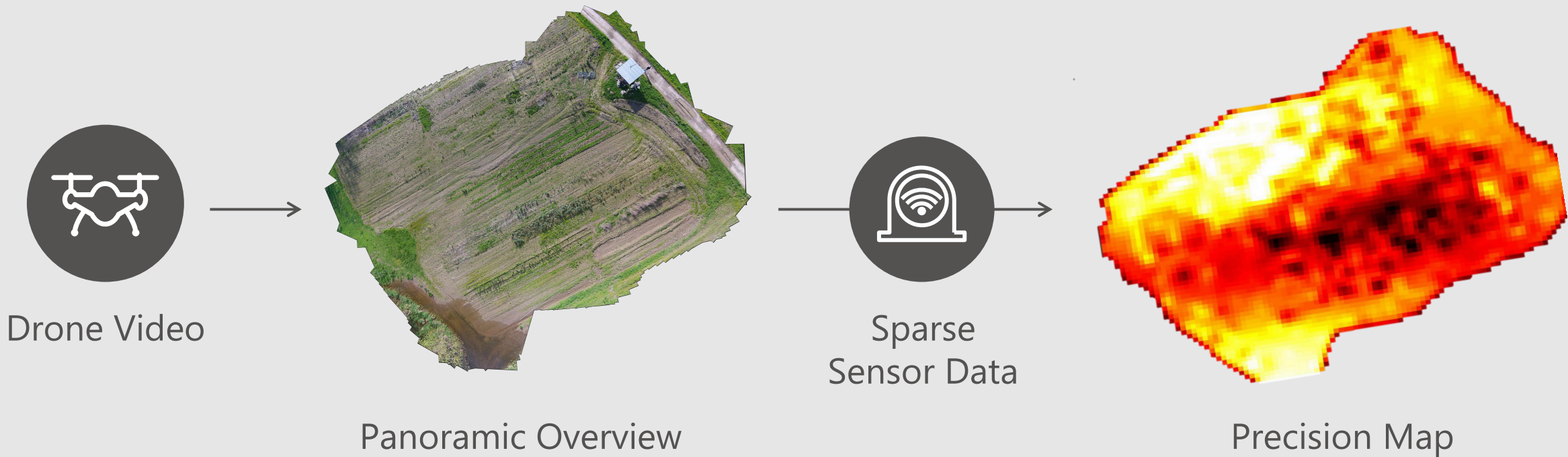
limited battery life

Regulatory concerns

Cost



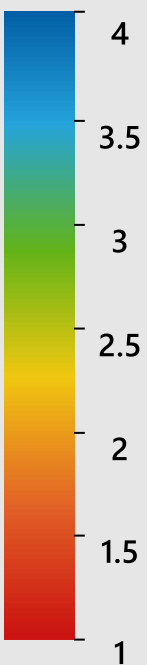
Idea: Use Drones to Enhance Spatial Coverage



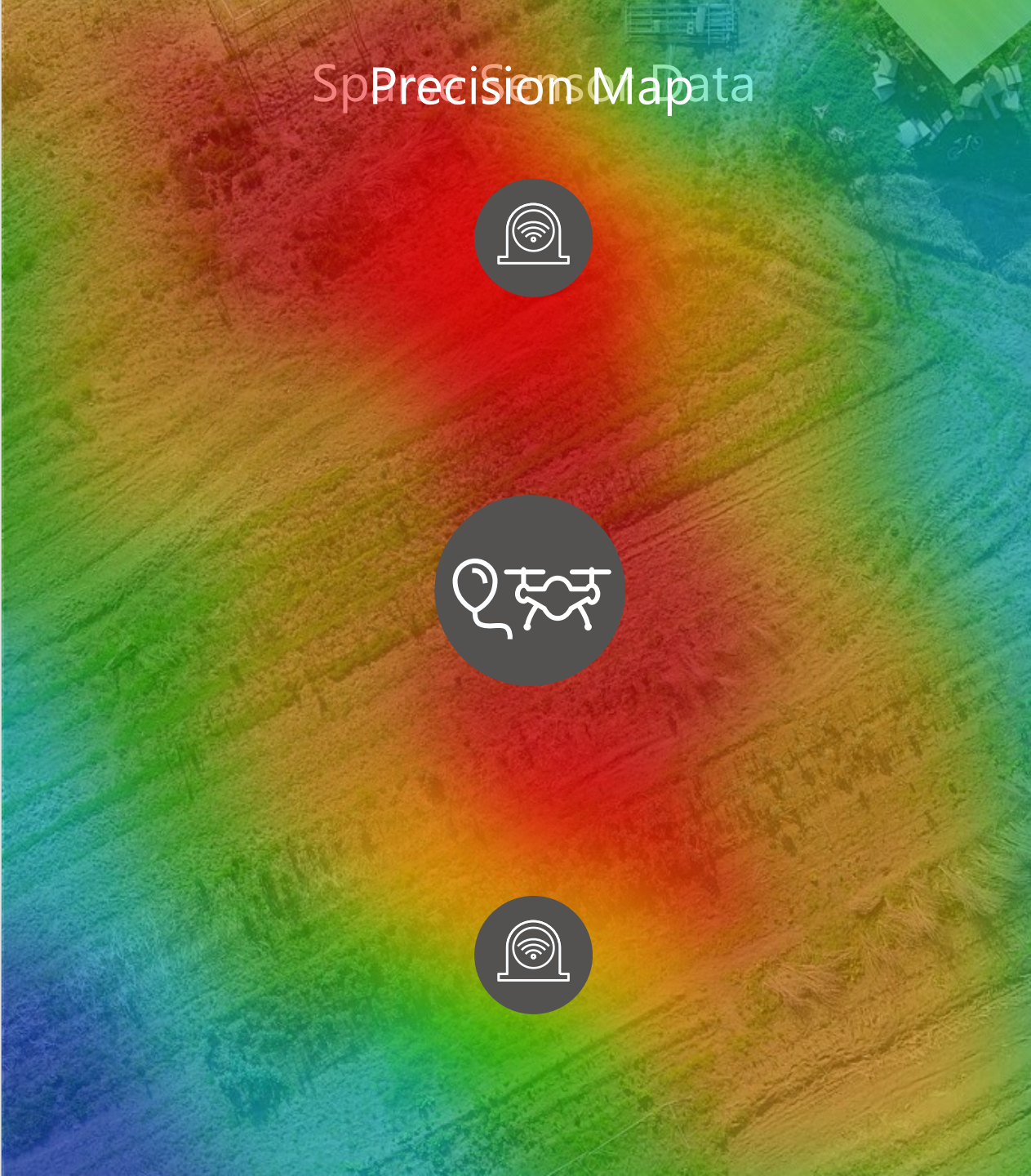
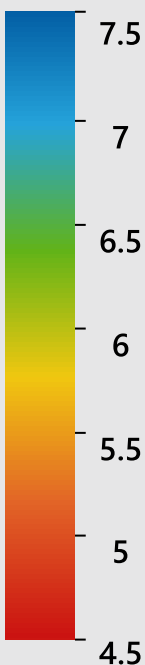
Idea: use drones/balloons to enhance spatial coverage

FarmBeats can use drones to expand the sparse sensor data and create summaries for the farm

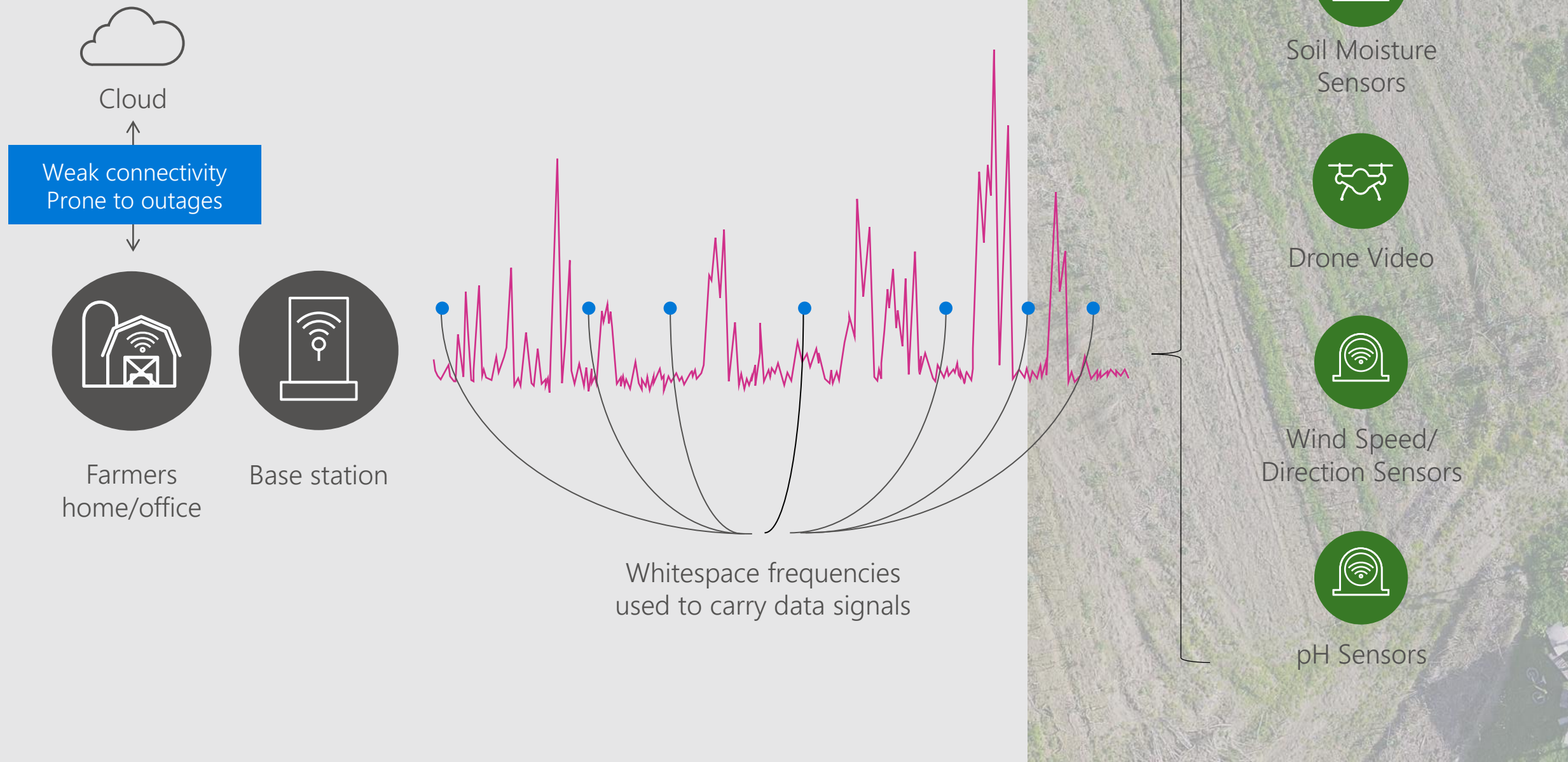
Precision Map:
Moisture



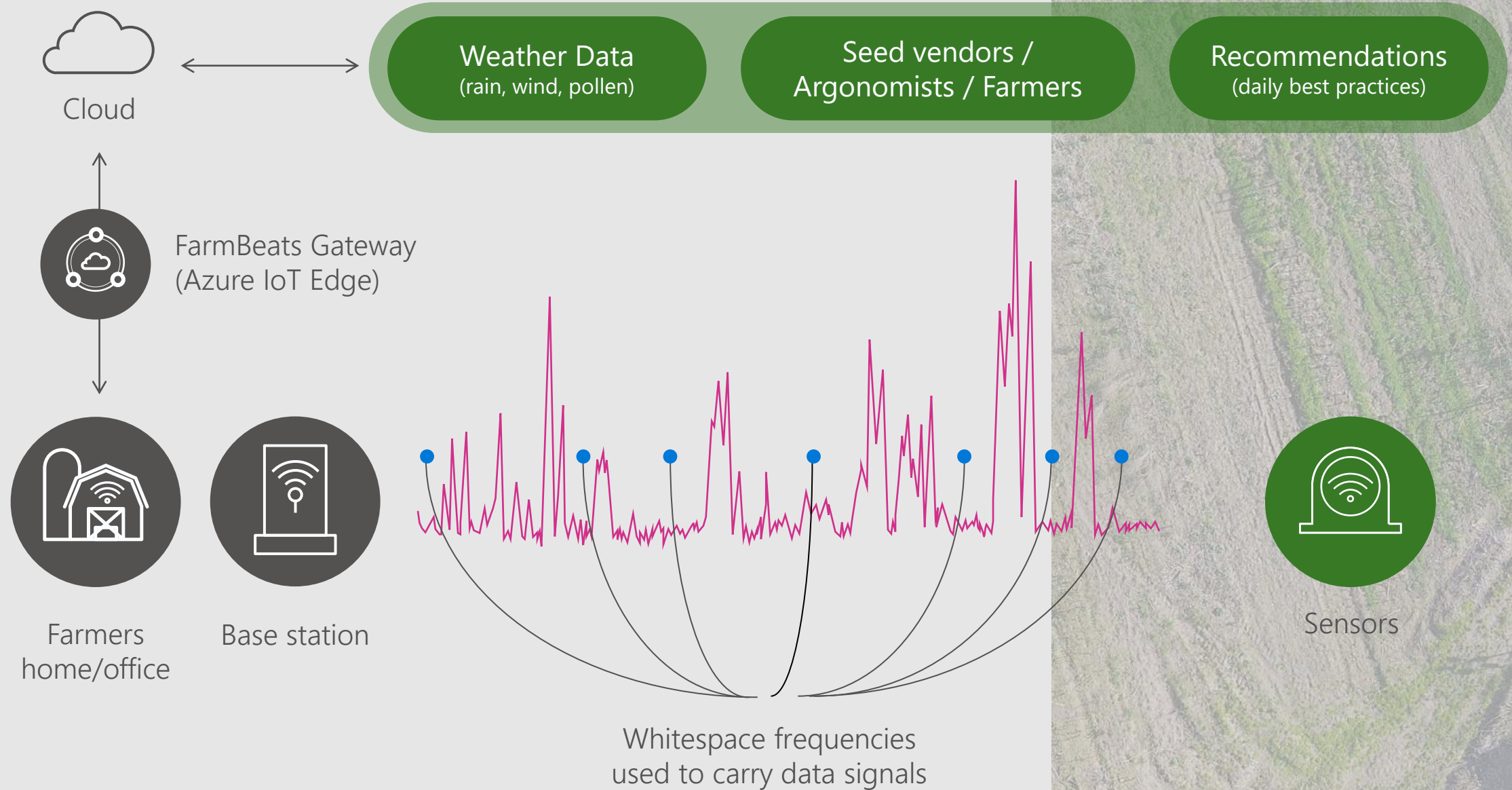
Precision Map:
pH



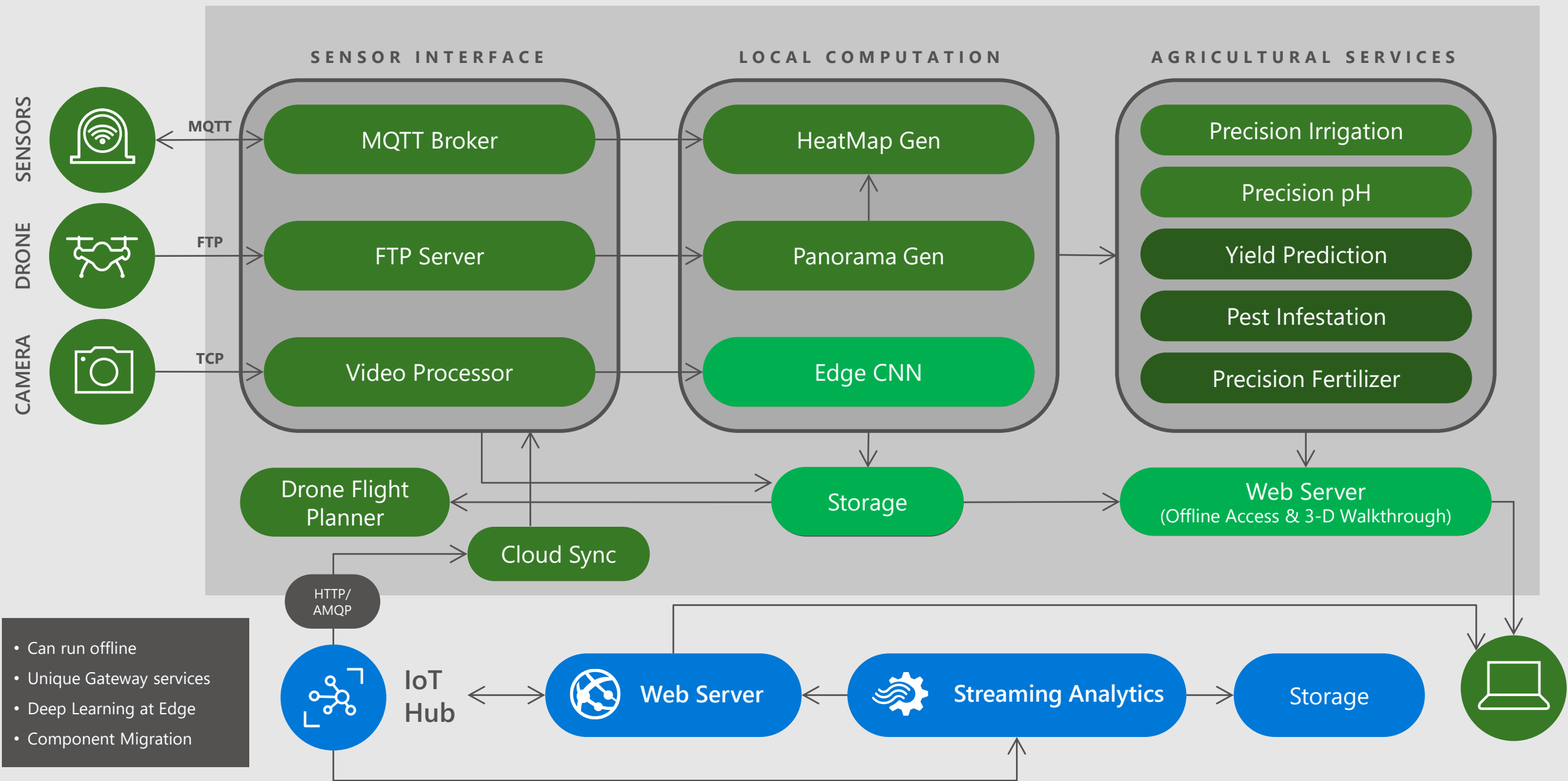
Challenge: Cloud Connectivity



The Real World



FarmBeats Gateway (Azure IoT Edge)



Deployment

Deployments in several locations including WA, CA, NY

Farm sizes range from 0.5 – 9000 acres

Sensors:

- DJI Drones
- FarmBeats sensor boxes with soil moisture, temperature, wind speed/direction sensors
- IP Cameras to capture IR imagery as well as monitoring

Cloud Components: Azure IoT Suite



Micro-Climate Forecasting

Goal:

Microclimate weather forecasting model based on FarmBeats sensors in the field.

Impact:

Knowing microclimate enables better modeling of plant diseases, application timing, and risk management.

Challenges:

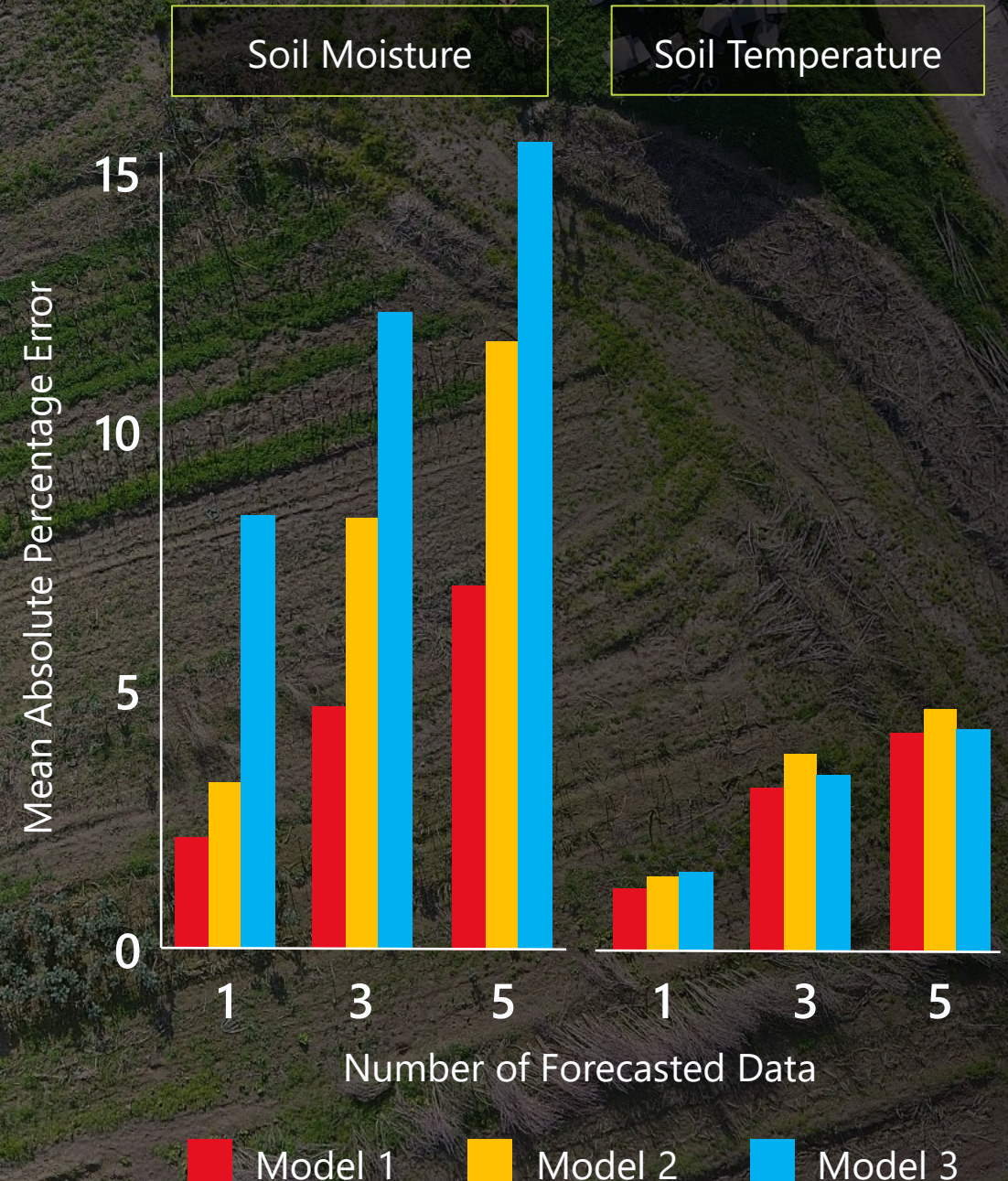
Forecast important variables for accurate plant disease prediction, not included in current weather forecasts (results shown).

Results:

Soil moisture & temperature forecasting error less than 10%.

Forecast for low temp was 42 degrees. Micro-Climate forecast was 31 degrees in lower areas of the field. Actual was 30 degrees. Instead of spraying grass herbicide, the farmer waited and avoided large crop damage in some of the most productive areas.

*The **lower the error**, the better the prediction.



Example: Panorama



Water puddle



Cow excreta



Cow herd

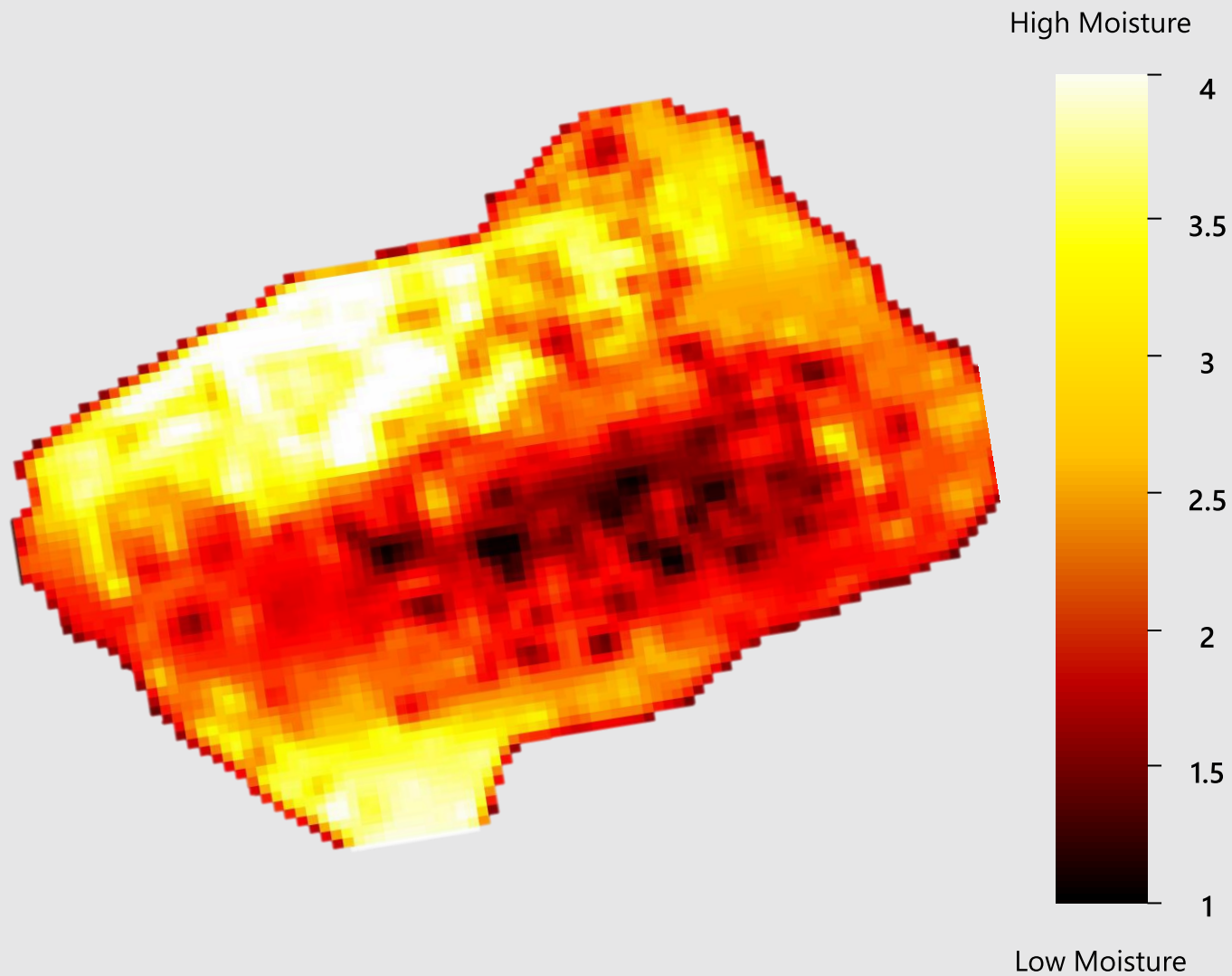
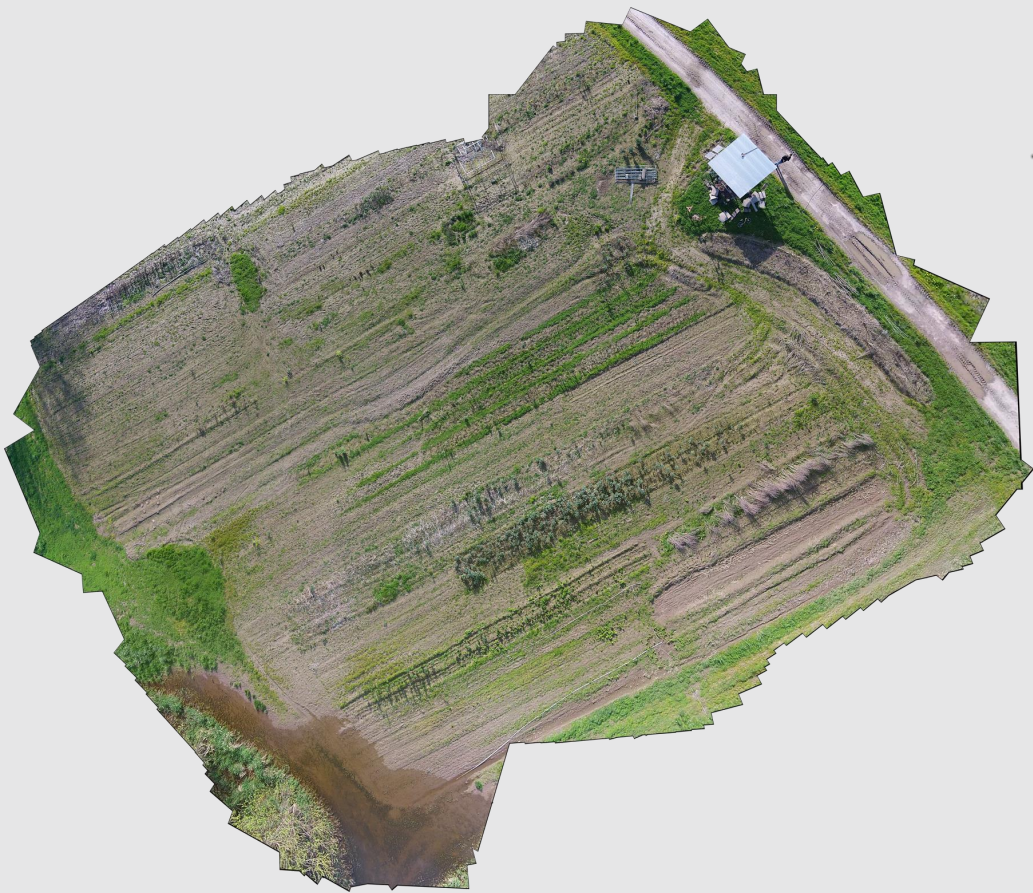


Stray cow

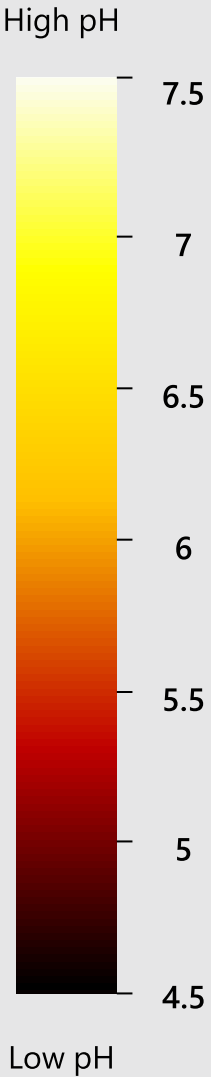
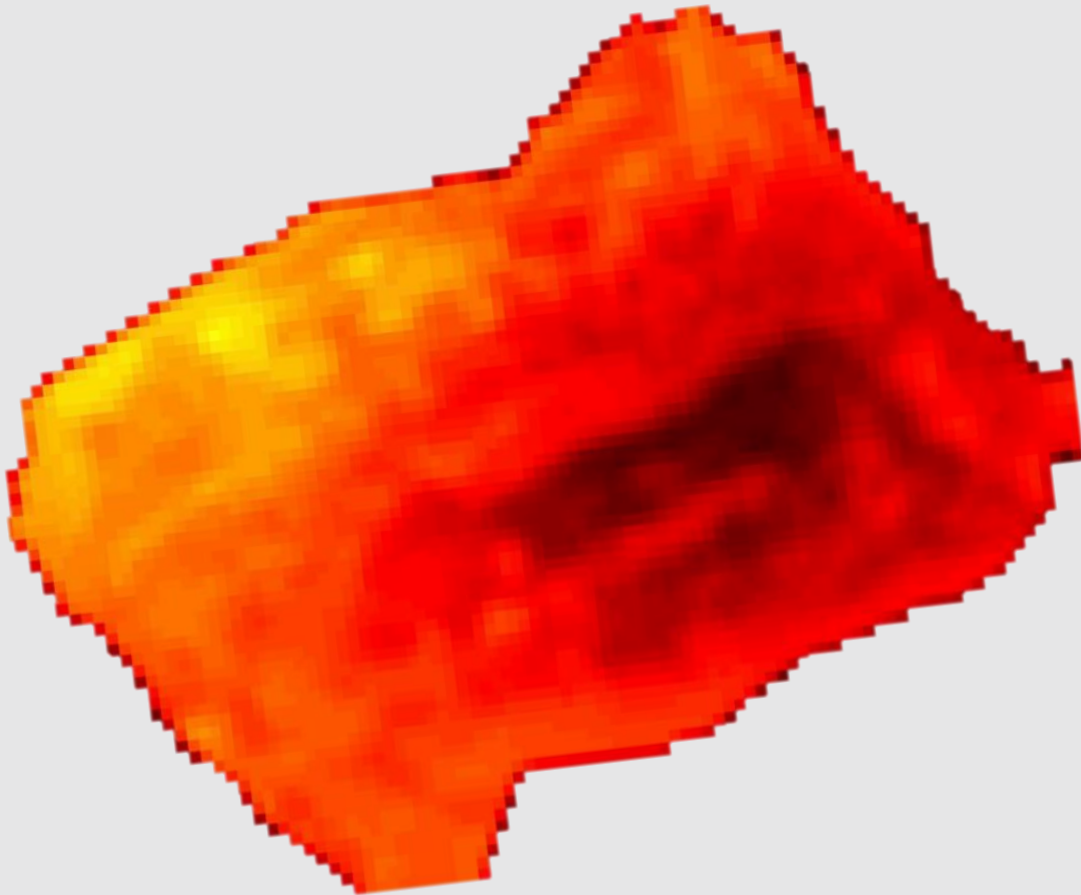
Precision Map: Panorama Generation



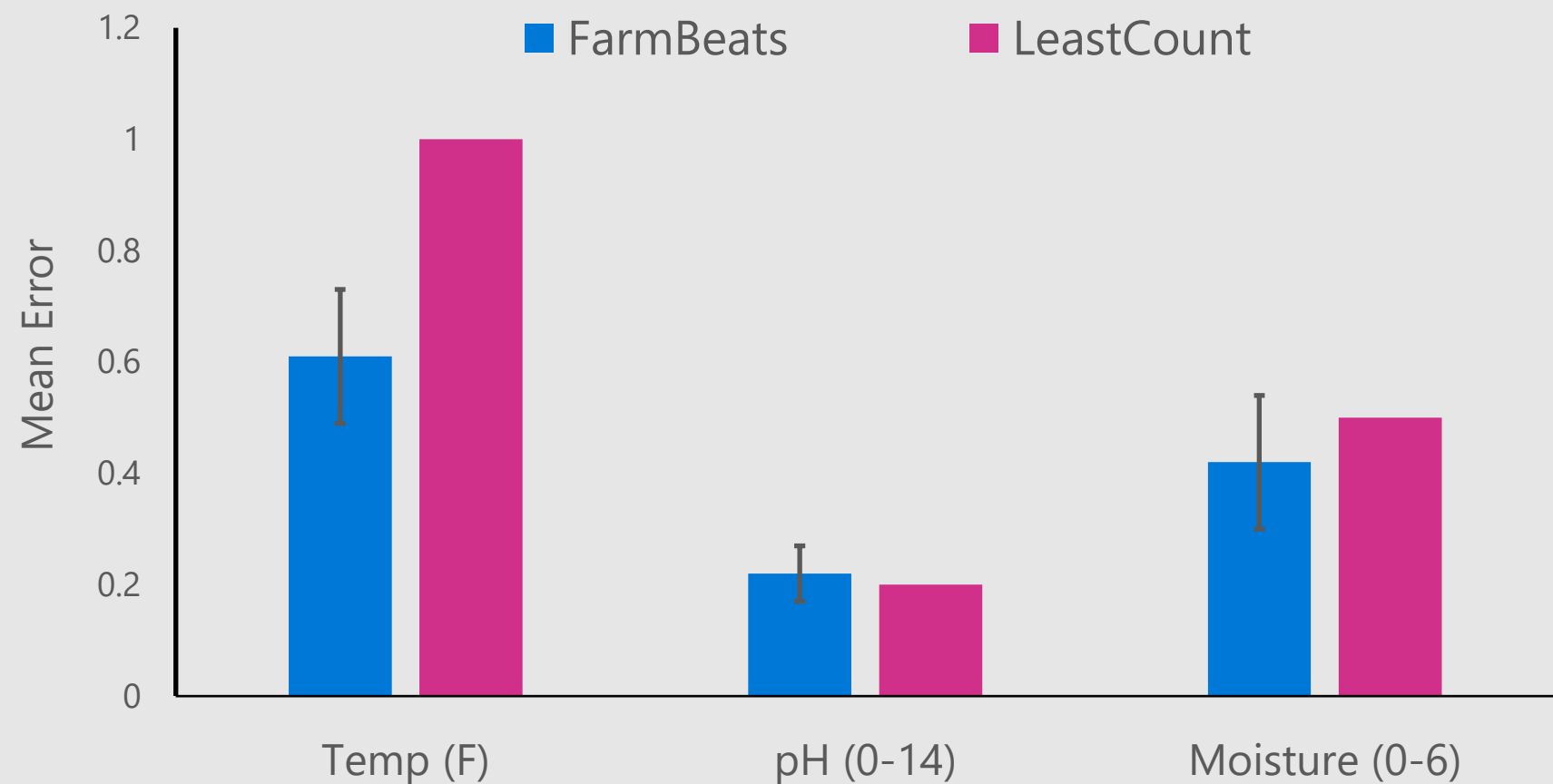
Precision Map : Moisture



Precision Map : pH



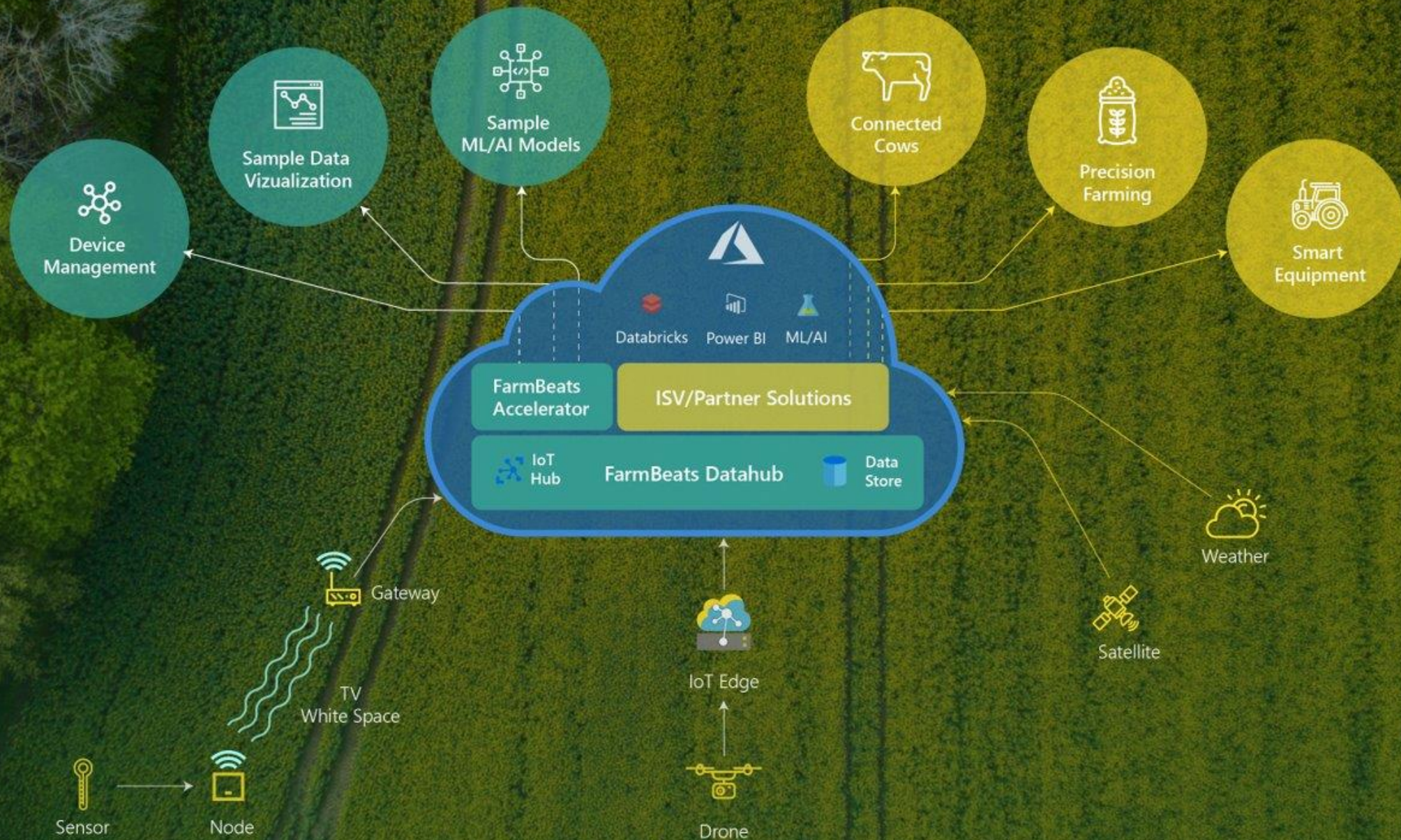
Precision Map: Accuracy



FarmBeats can accurately expand coverage by orders of magnitude using a sparse sensor deployment

Application: Cow-Shed Monitor





- ISV/Partner
- FarmBeats
- Azure

Strobe: low-cost soil moisture and EC sensing using Wi-Fi

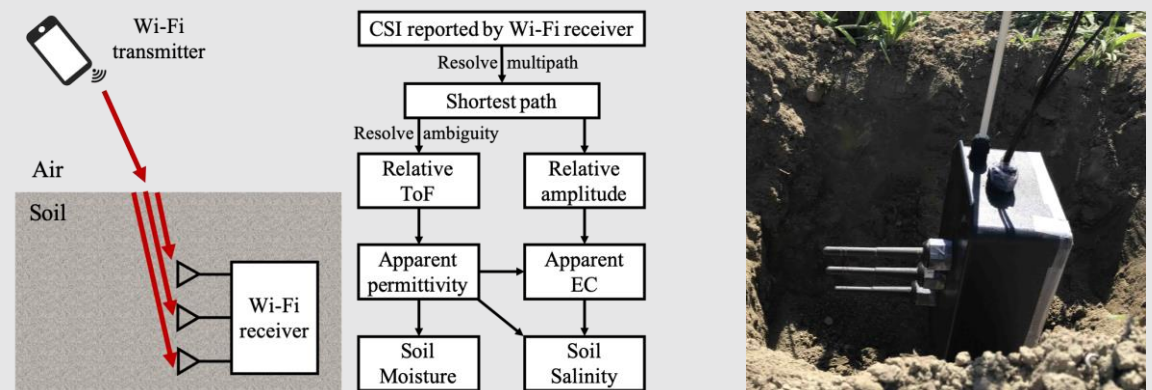
Motivation: existing sensors are expensive

- ~100s of dollars

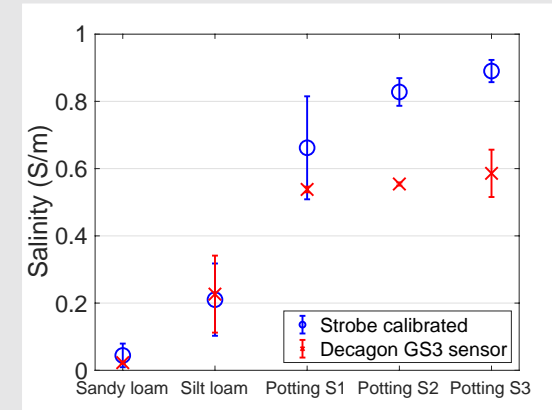
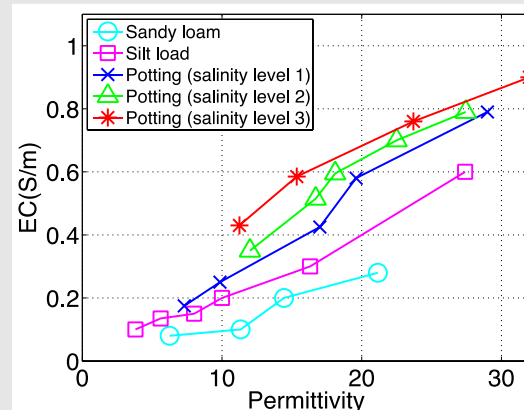
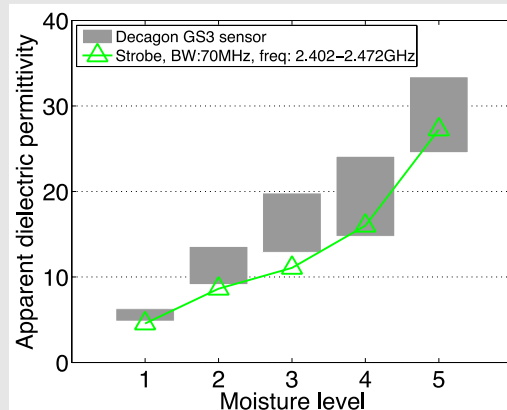


Strobe design: Wi-Fi cards with 2+ antennas

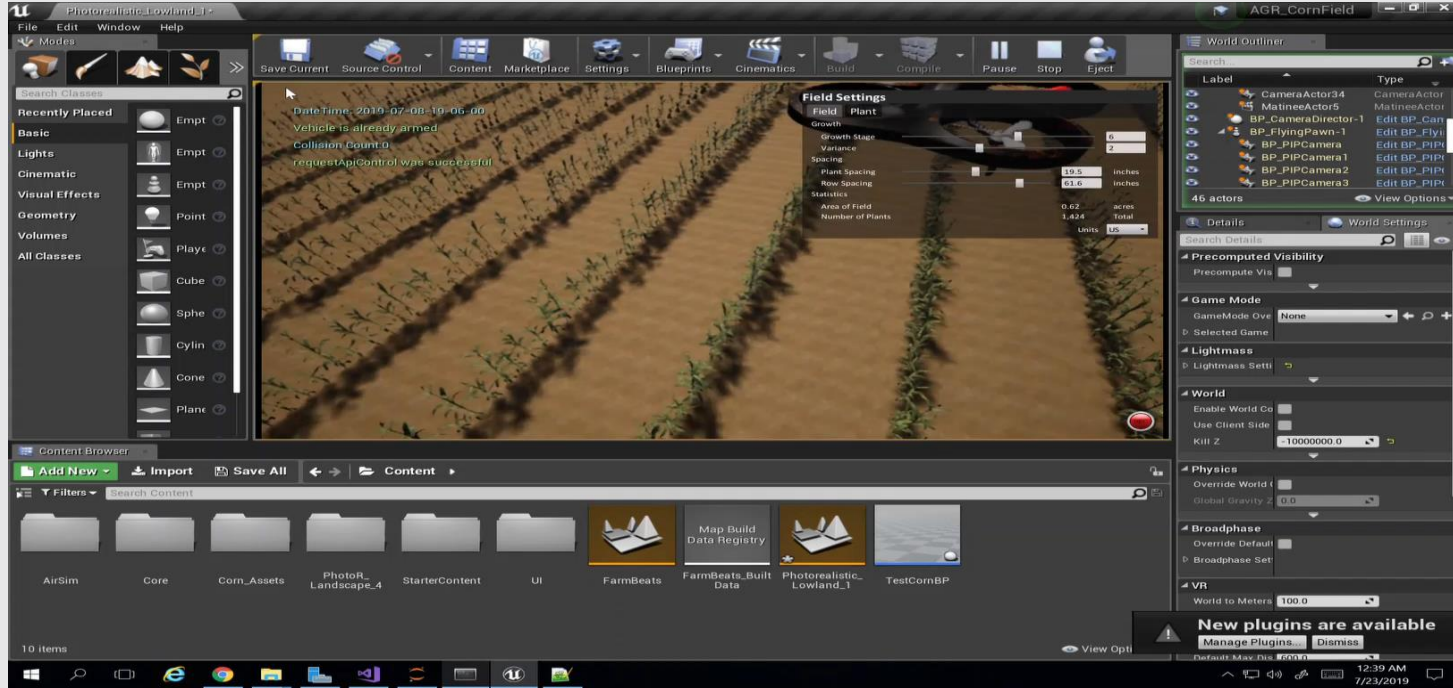
- Relative time-of-flight & amplitude



Results: Strobe can accurately detect moisture and EC change in soil



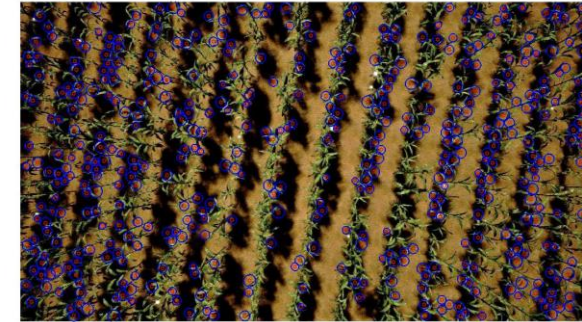
GAUDI – Multi modal simulations for driving farm intelligence



Validating ML models

- Different conditions
- Different Farms
- Different seasons ...

Example – crop counting



Current Model – 447 plants

Different farm & weather conditions



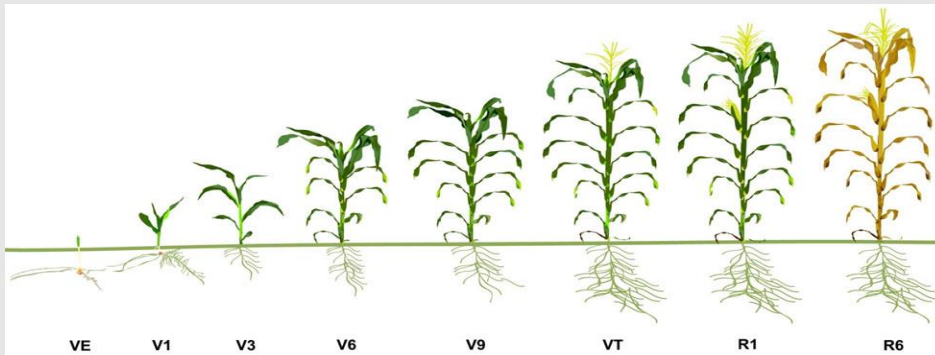
Same Model – 187 crops, the model misses a few plants!!

Parameter Tuning adapts model



Total crop count = 260
Model adaptation to increase accuracy!

Simulate farms with various conditions – different plant growth stages, field area, field abnormalities, species of plants, etc.



Different Corn growth stages

- Stage 0 – 0 inches
- Stage 1 (V1) – 13 inches
- Stage 2 (V2) – 18 inches
- Stage 3 (V3) – 30 inches
- Stage 4 (V4) – 42 inches
- Stage 5 (V7) – 67 inches
- Stage 6 (V9) – 91 inches
- Stage 7 (V12) – 105 inches
- Stage 8 (VT) – 113 inches
- Stage 9 (R2) – 117 inches
- Stage 10 (R6) – 115 inches

Microsoft's Approach to Agriculture



Research



Products



Societal Impact

FarmBeats IoT, Cloud, AI

Indoor Farming

Simulations

Azure IoT, IoT Edge

Azure Blockchain

Azure FarmBeats

AI for Earth



AirBand



TechSpark

Conclusion

FarmBeats: A system that enables seamless data collection and insights for agriculture

A tool to enhance farm and farmer productivity

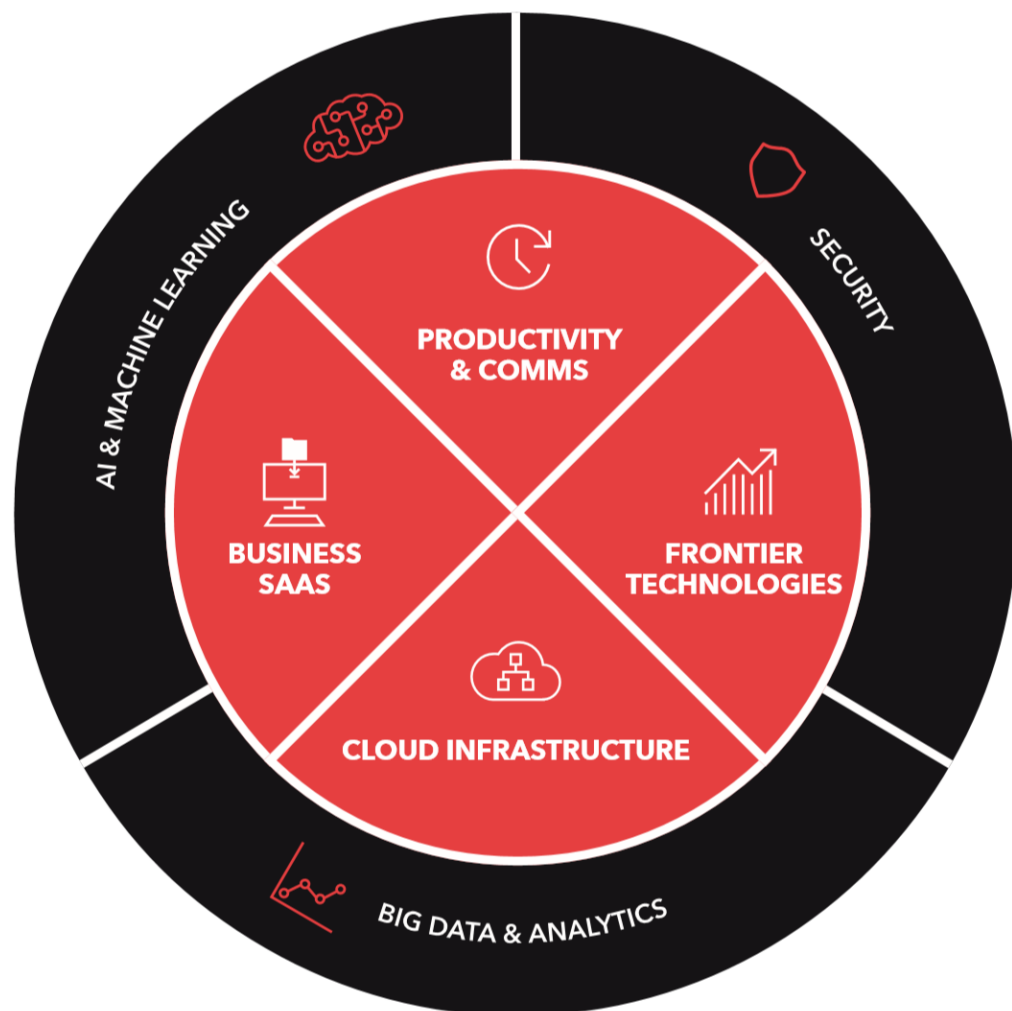
Microsoft's entire stack for Agriculture:

Data Capture (Azure IoT), providing Insights (Power BI), secure storage (Azure Data Lake), Traceability (BlockChain), AI & ML (Azure ML & Cognitive Services)



@ranveerchandra

Investment focus areas



Series A-C investments



Financially focused



Check size \$2M-\$10M



Board engagement



Enterprise only



Founder friendly

AGTECH LANDSCAPE 2019



IN-FIELD SENSORS & SYSTEMS

POST-HARVEST MONITORING & EFFICIENCY

Field Monitoring Sensors & Solutions



Soil Sensing / Analysis



Insect Sensing / Monitoring



Precision Applications



IoT Monitoring Platforms



Precision Irrigation



Water Monitoring



Labor Management



Crop / Farm Management Software



Digital Marketplaces



Automation / Robotics



Processing Technology



Post-Harvest Monitoring



Next Gen Logistics



Freshness Control



Cold Chain Monitoring



Food Recovery



Quality Mgmt / Compliance



ERP Specialty



ERP Commodity



Yield Forecasting



Supply Analytics



Crop Marketing / Trading Platforms



Finance & Insurance

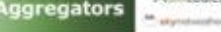


VALUE CHAIN ENABLERS

Blockchain



Data Aggregators



Food Safety Detection



Data Analytics (Platform)



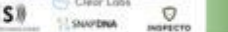
Food Safety Track & Trace



Imagery Analytics



Integrated Solutions (Platform)



Imagery Analytics



WWW.BETTERFOODVENTURES.COM

Seana Day
seana@betterfoodventures.com