CSIR Precision Agriculture Information System to support emerging farmers

2 November 2022, CSIR International Convention Centre

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science & innovation
Department:
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REPUBLIC OF SOUTH AFRICA

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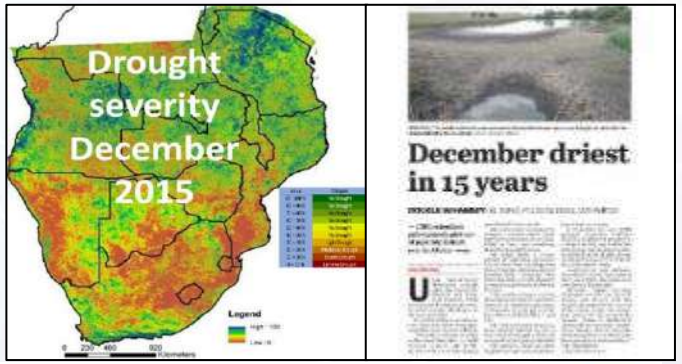
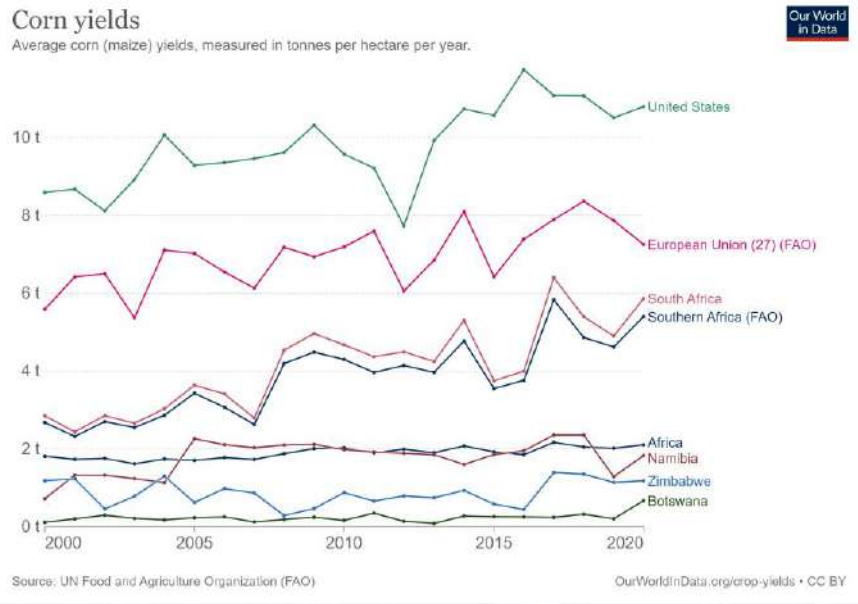
Agricultural Challenges in Africa

- Climate variability
- Low productivity
- Lack of finance
- Low tech environment
- Low involvement of youths
- Low levels of traceability
- Global supply chain volatility
- Big post harvest losses
- Market access
- Land tenure system clarity
- Pests and diseases
- Loss of biodiversity

"Droughts affect Africa more than any other continent, as 41% of the global droughts occur in the area."

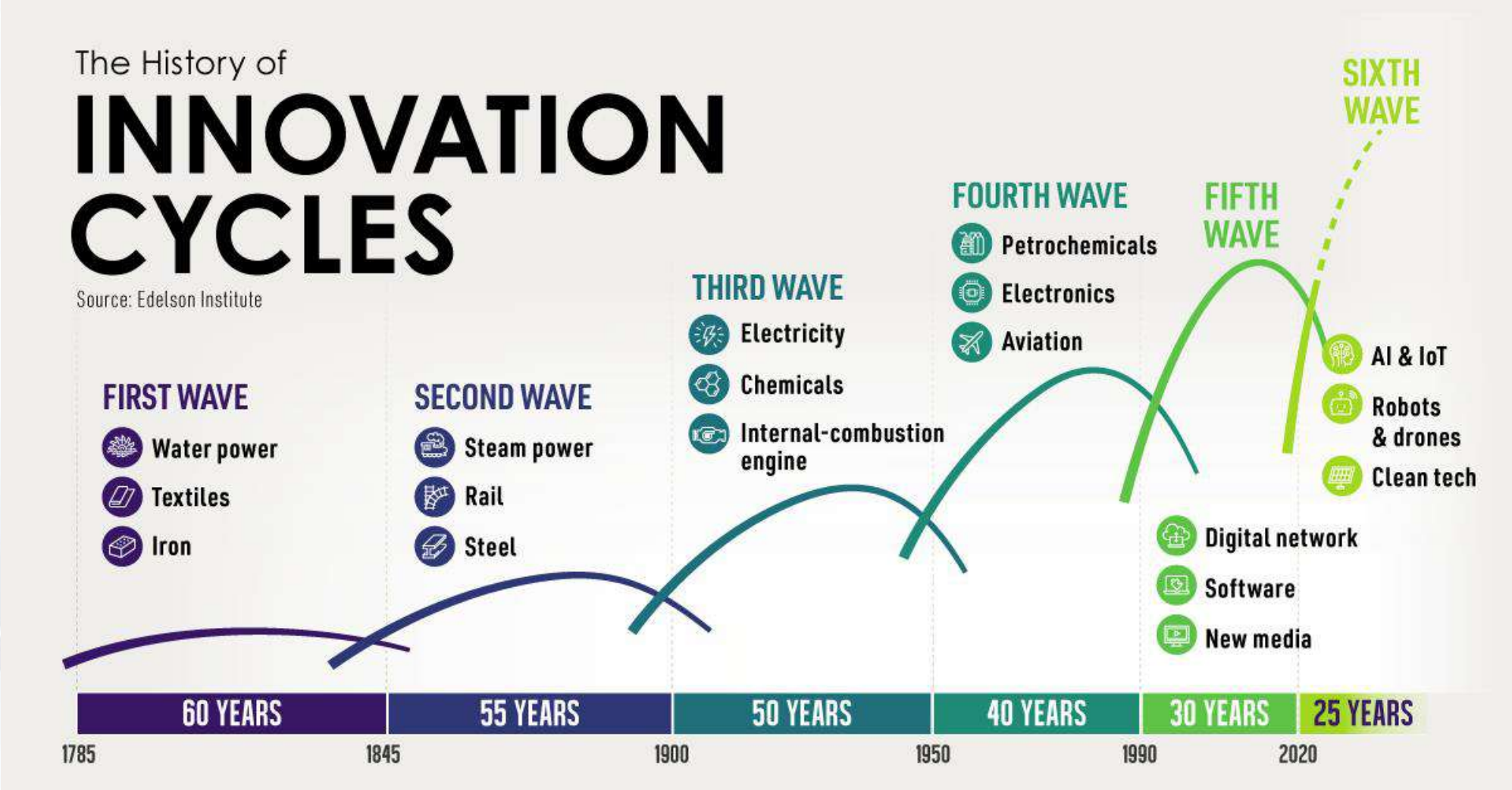
UNDRR, CRED. (2019). Human cost of disasters | UNDRR.





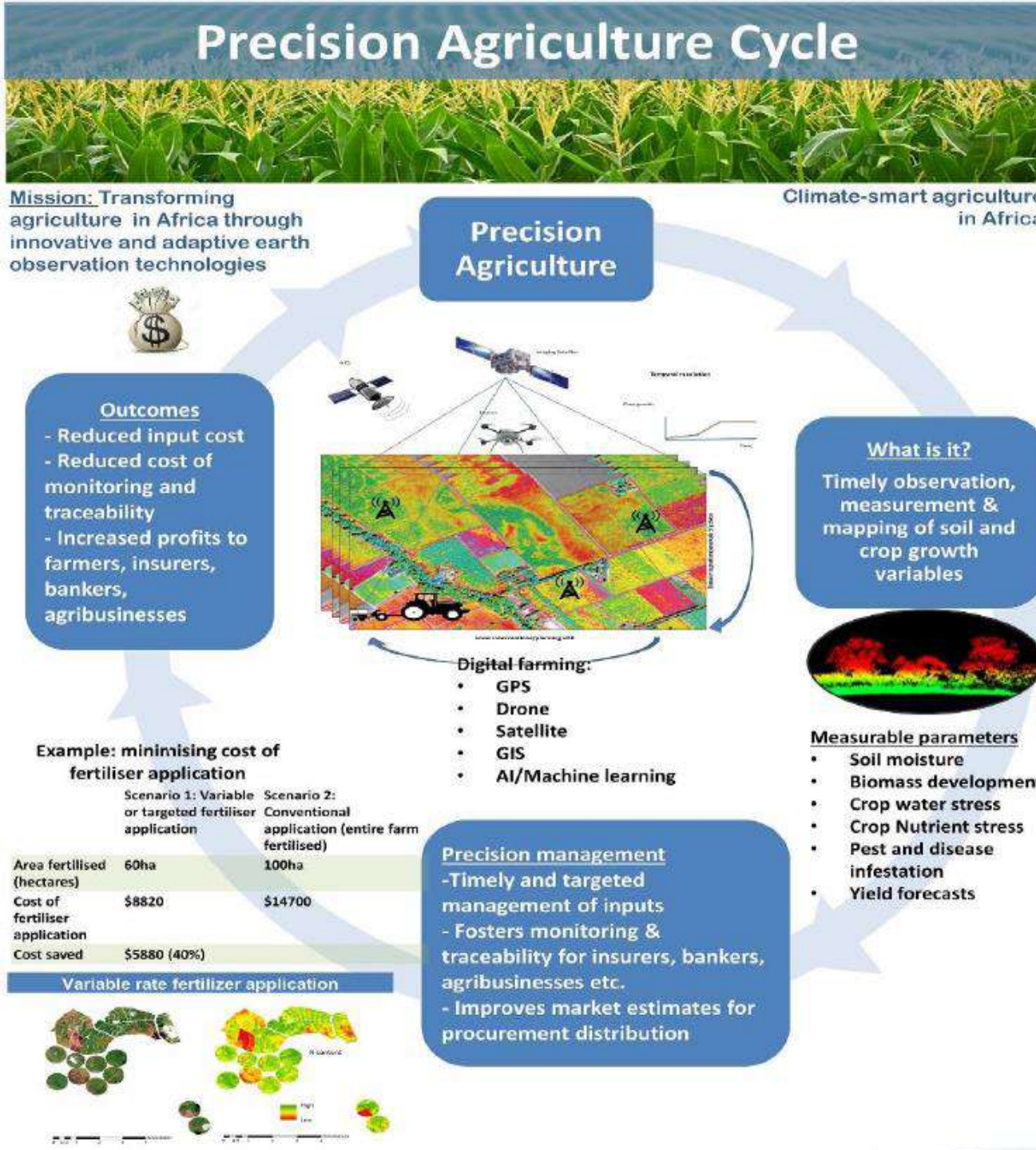
Addressing Challenges

- Sink, swim, or be left behind ?



Precision Agriculture / Smart Farming

- Need to do more with less.
- Observing, Measuring & Responding to within and between field variabilities in crop growth parameters.
- Minimise exposure to variable climate
- Sustainably optimise inputs, maximise outputs



Precision Agriculture / Smart Farming

- Beyond the individual farm:
  - Monitoring and evaluation would be key in order to efficiently manage parts of the agricultural sector.
  - Ensure funds are being used as intended.
  - Independent traceability, for funder and farmer.

agriculture, land reform & rural development
Department:
Agriculture, Land Reform and Rural Development
REPUBLIC OF SOUTH AFRICA

2030 NDP

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MEDIA STATEMENT
24 October 2022

MINISTER DIDIZA LAUNCHES A 3.2 BILLION BLENDED FINANCE SCHEME WITH LAND BANK TO ASSIST FARMERS

The Minister of Agriculture, Land Reform and Rural Development Ms Thoko Didiza, MP today launched a 3.2 billion Blended Finance Scheme with Land Bank to assist farmers. The programme will be implemented over a 10-year period with the department investing a minimum of R3, 2 billion over the period. The funding will be on a blended finance structure which is a combination of a loan and grant with the focus on commodities as per the Agriculture and Agro-processing Master Plan.

The department and Land Bank have each invested R325 million per annum which will effectively result in the creation of a R650 million fund a year and it will grow to R1.95 billion by end of Year 3.

Land Bank is a specialist agricultural Development Finance Institution (DFI) that is embarking on a revised strategy which is aimed at improving the effective balancing of financial sustainability and developmental outcomes in order to meaningfully contribute to the development and transformation of the agricultural sector in South Africa.

The bank achieved a clean audit outcome for Financial Year 2022 providing an indication of the bank's sound governance, management controls and processes to enable the successful implementation of the Blended Finance Scheme.

"Strategic partnerships like these are critical to ensure growth, food security, development of farmers and transformation of the agricultural sector, and contribute towards job creation," said Minister Didiza.

Drones / UAVs

Context:

- In the US:
  - sales of consumer drones to dealers > US$1.25 billion in 2020.
  - The US drone business was estimated at over US$13 billion,
  - > 208 000 remote pilot certificates
  - > 860 000 drones registered.
- The Chinese drone market valued at > US$3.4 billion in 2021.

- South Africa one of the first in the world to present fully fledged regulations
- 'To date, only well-capitalised and organized entrepreneurs have created businesses…In a country with 32% unemployment (46% youth unemployment)'
- South Africa: 83 operators, 1818 pilots

- Lost opportunity to develop new industries and create jobs (especially for the youth) ?
  - Innovation could force policy makers into change

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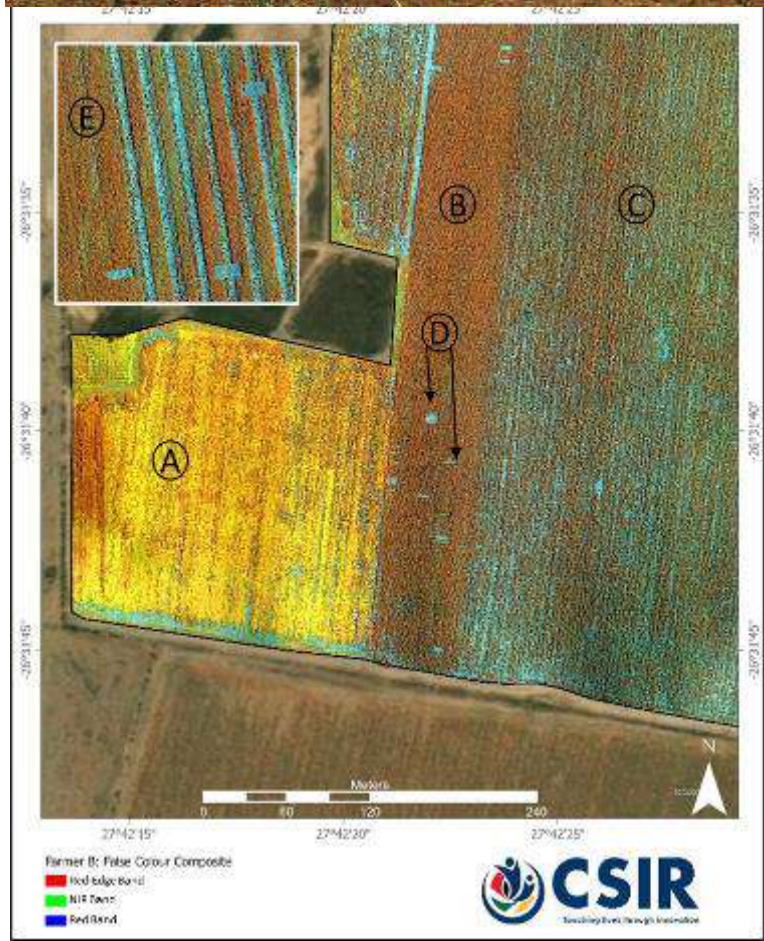
UAV Appeal

- Farmers appreciate detailed birds-eye views of their fields.
  - Repeated monitoring and evaluation of fields.
  - Operational flexibility (at high resolution)
  - Source of independent and verifiable information
  - Enabling farmers to monitor crop health, evaluate soil quality, plan sowing and follow-up regimes.
  - Farmers that can consistently conduct these field surveys can map out their fields (in 2D and 3D) and make decisions that optimise both resource and land utilization.

- <u>However</u>, the cost and complexities associated with drone data processing and analysis are still high.
  - Low adoption rates (esp. small and emerging class)
  - Cost limitation (Drone + sensors + software + processing & analysis)

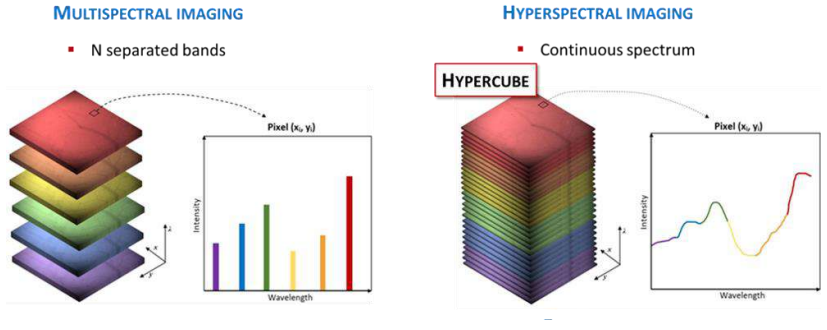


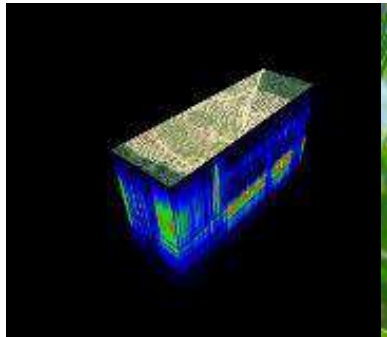
UAV Capabilities & Opportunities

- CSIR's hyperspectral-LiDAR UAV capability will provide highly precise (2D & 3D) aerial information, which may be 'invisible' to the majority of (multispectral) sensors on the market.
  - This allows for detection of subtle changes in plant condition before it is visible to the naked eye or other sensors.

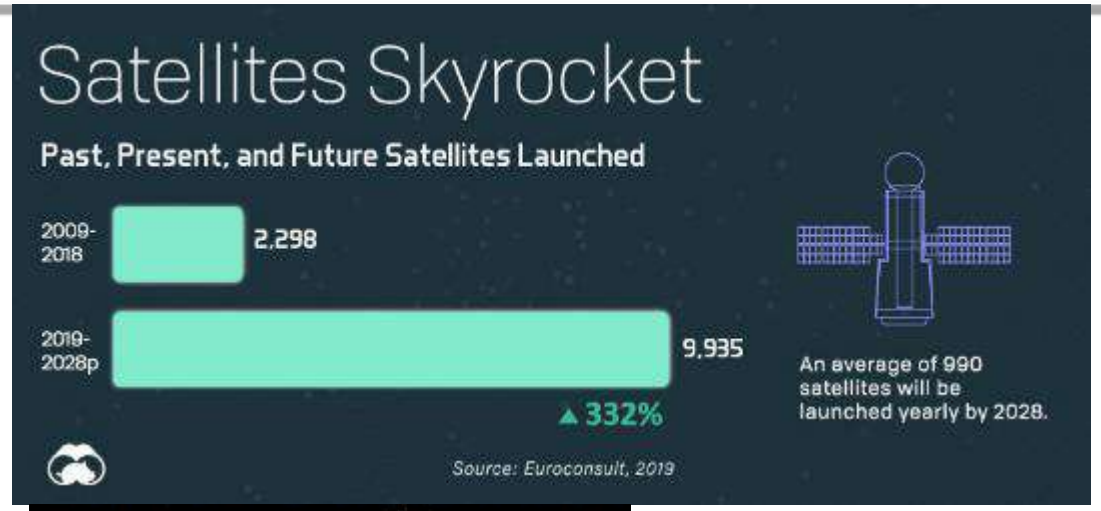
- Ability to detect, study, and recommend specific solutions to domain challenges
  - E.g.: Assist in detecting a specific plant disease using the hyperspectral-LiDAR drone, then develop more operationally scalable solutions for detecting this disease using more cost-effective sensors and/or methods.
  - Could be applicable to a variety of sectors, e.g. Agriculture, Mining, Biodiversity.

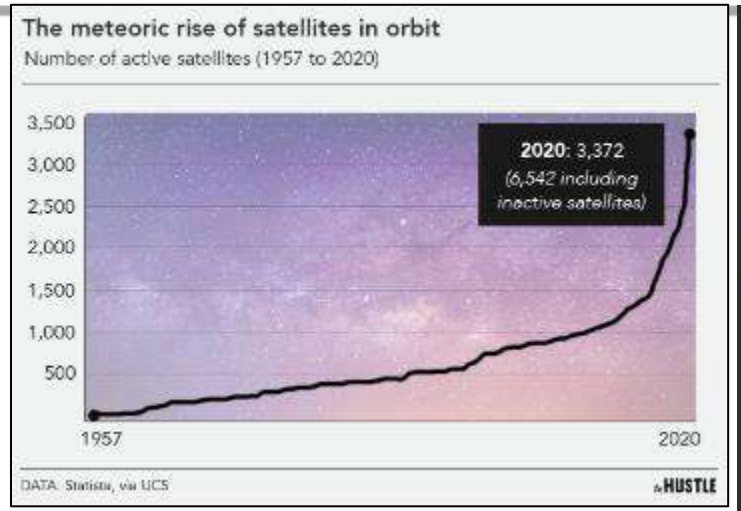
- *Fit-for-purpose* drone solutions, that may include processing routines, science-backed algorithms and analysis wrapped into software and/or hardware outputs.

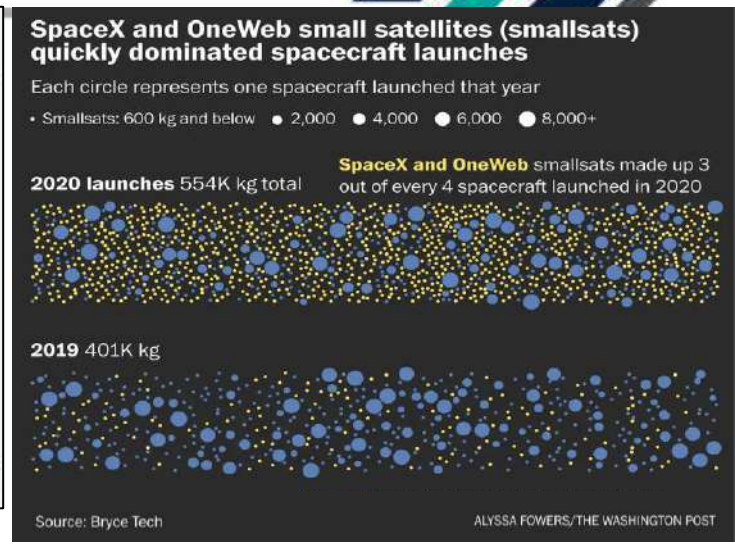




Beyond the horizon…







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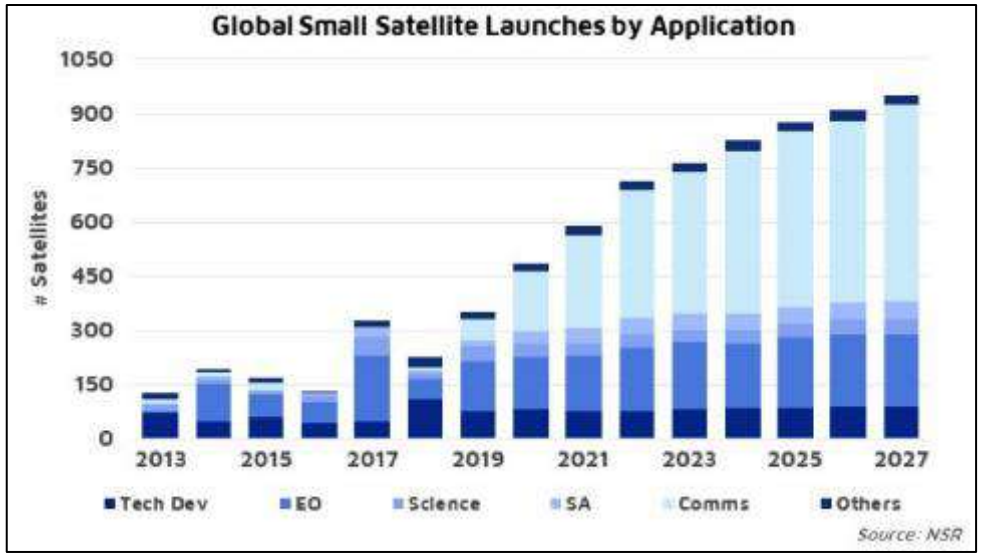
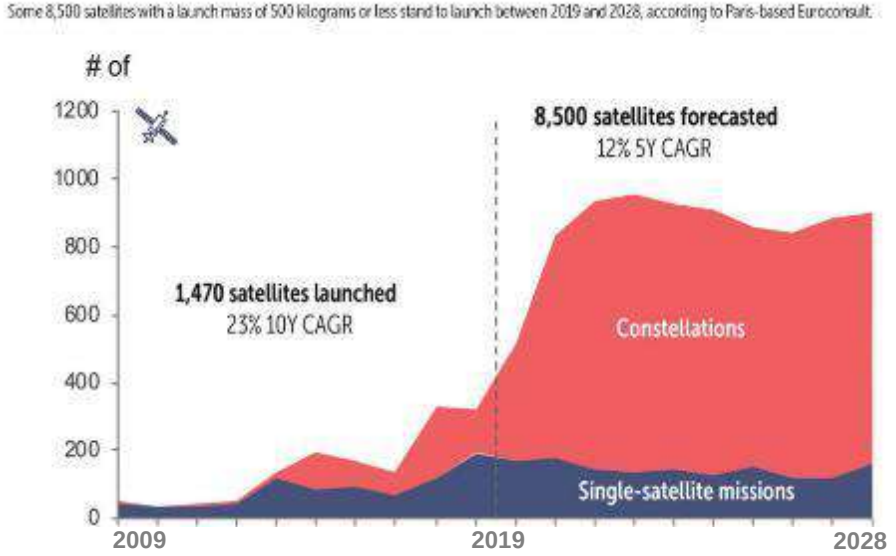
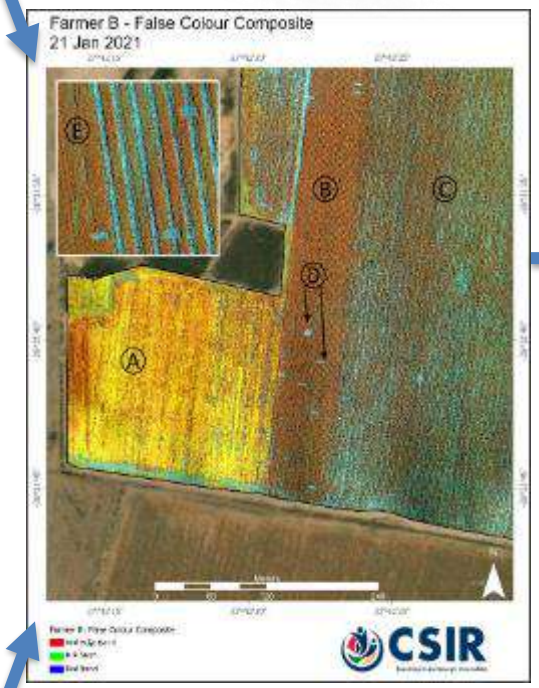


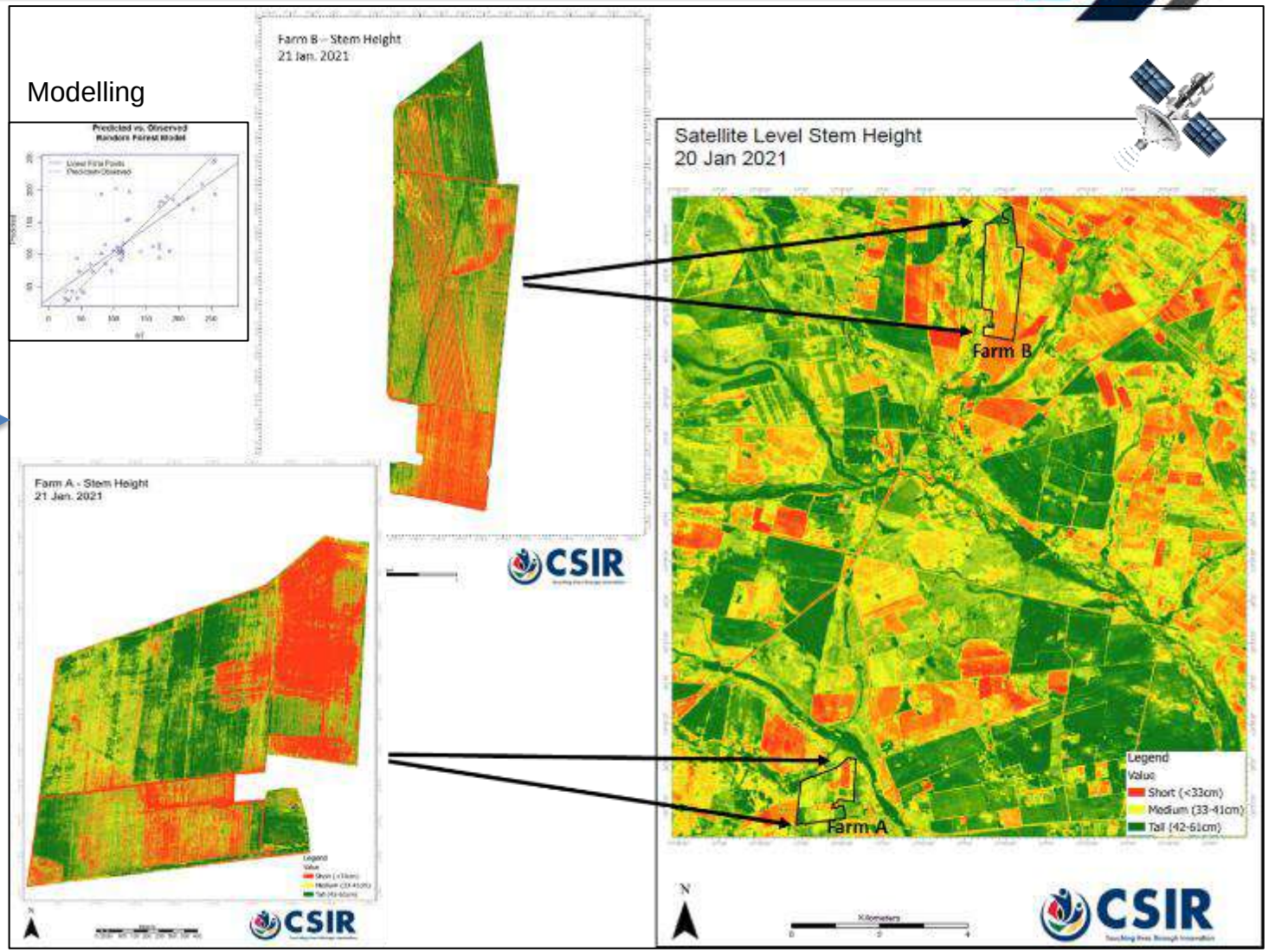


UAV to Satellites

- Opportunities for extrapolation/scaling up



Modelling

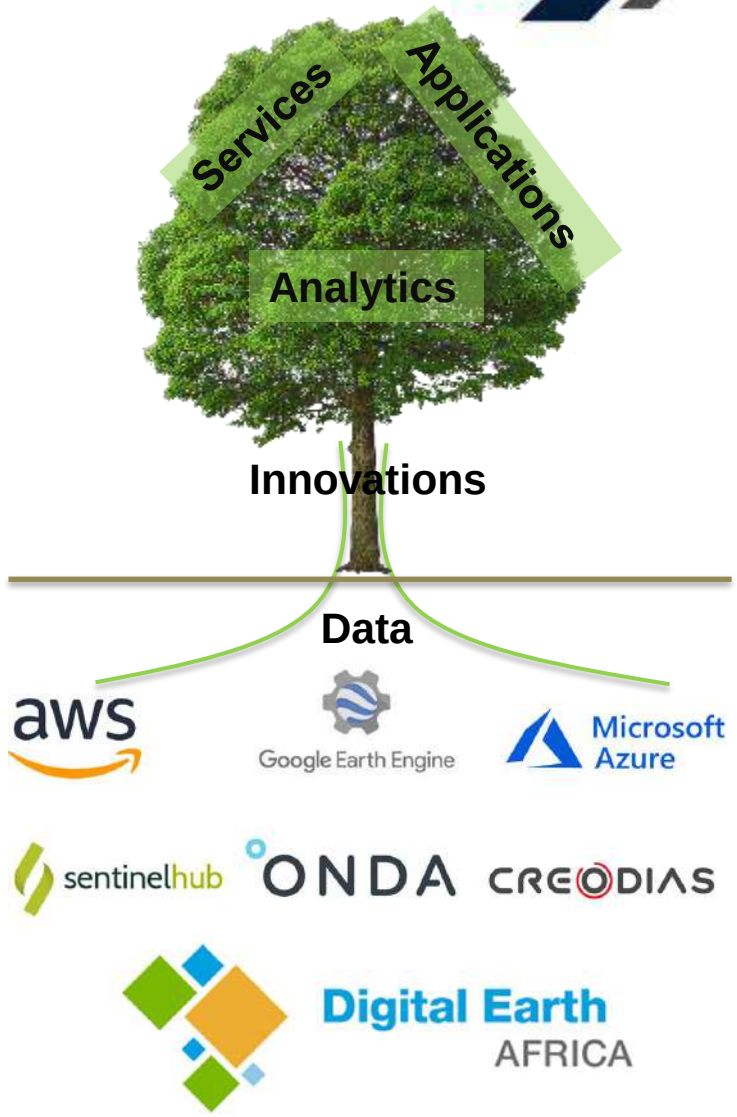


Cloud hosted satellite data

- Petabytes of satellite imagery hosted
  - Analysis Ready Data (i.e. minimal pre-processing)
- All available through a web-browser and few lines of code
  - No expensive/specialized software
  - Reduced learning curve
  - Gov't specialists, Private Sector, Scientists, Individuals

- Great potential for innovation across several applications

- "Data is increasingly becoming the new soil from which businesses and economies can grow. Information accessibility and visualization are critical to unleashing the full potential of statistics … to bring tangible benefits to Africa." (*Broader Perspectives on Digital Earth Africa Report)*



Precision agriculture information system

Goal: To support industries along the agricultural value chain with actionable farm-level data or intelligence to enable precision agriculture and cost-effective business decisions at all levels of the value chain

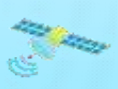
Data

In Situ

- Farmer provides info on:
  - Field boundaries
  - Planted crop type
  - Planting dates / growth stage
  - Irrigation vs rain-fed
  - Pests & date

Sensors

- Sensors collected data:
  - Drones
  - Satellites
  - Hand-held spectrometers
  - Soil moisture



Climate

- Weather information*

Analysis and decision support

- Satellite Image processing:
- Weekly images
- Pre-processed imagery
- Crop specific modelling
- Different levels of product
  - Level-1
    - Biomass development
  - Level-2 to 3 image products
    - Crop Condition
    - Soil Condition
  - Level-4 products
    - Treatment maps

- Cloud Computing Environments
  - Big data analysis
  - AI & machine learning
  - Database management
  - Actionable intelligence:
    - Image Products
    - Statistical Reports
    - Recommendations

Farmer

Two-way communication between farmers and system for continuous learning

PAIS

Farm advisory services

Financial sustainability

- Based on up-to-date and independent farm level data, the **farmer** has confidence to approach and negotiate the best prices possible from:
- Farming Co-operatives (Grain SA, Seed Co, AFGRI etc)
- Financiers (Government, Banks, Insurance)

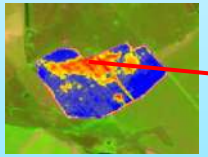
- Based on up-to-date and independent farm level data, **financial service providers** can:
- Set and adjust pricing strategies to attract more customers.
- Monitor claims and reduce losses
- Build confidence portfolios on their lending customers, and potentially expand their client base

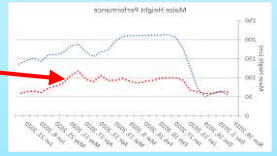
Application and precision management

- Facilitate interactions with agri-service providers
  - Seed
  - Herbicide
  - Pesticide
  - Machinery

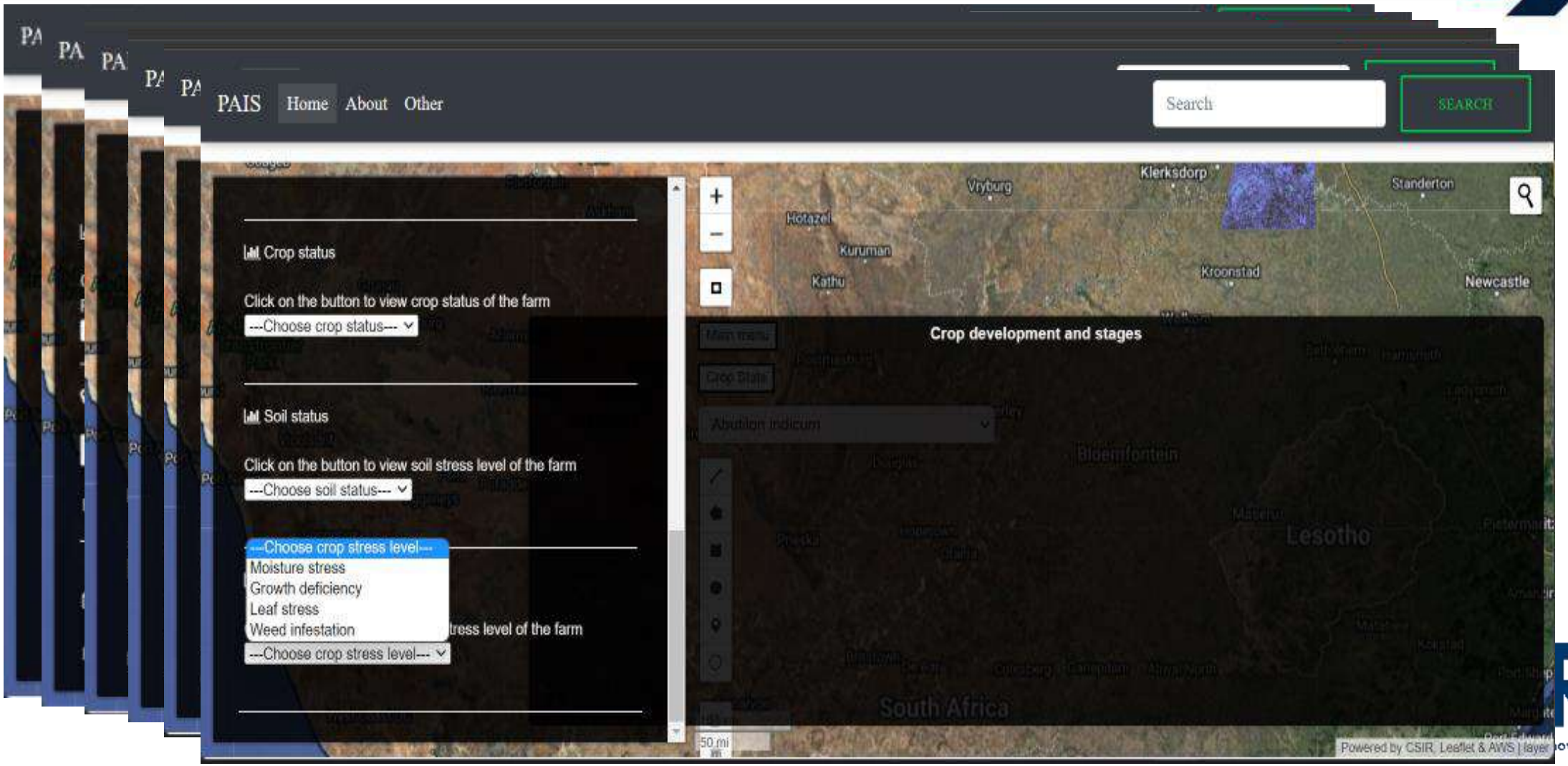
- Aggregated statistics regarding regional farmer needs could be retrieved for efficient service providers provisioning and distribution.

- Actionable technologies* and/or farmer interventions:
  - Variable rate seeding
  - Variable rate fertilization
  - Variable rate herbicides





Precision Agriculture Information System



Precision Agriculture Information System

- Different levels of information

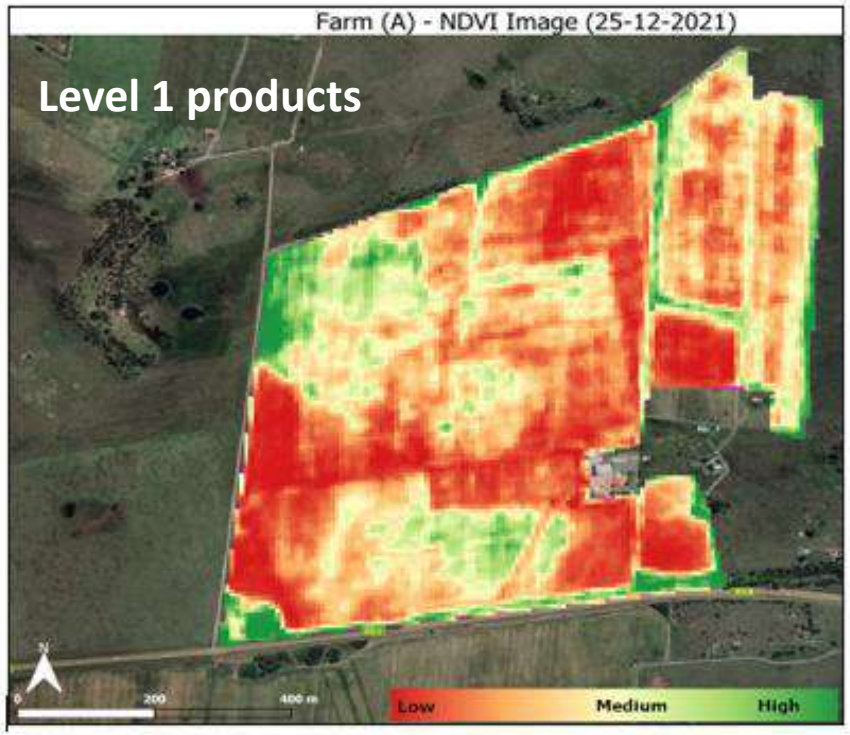


Fig.5. Level 1 product showing the NDVI index, which is a common proxy for crop biomass development. A very wet beginning to the growing season may have prevented proper vehicle access to fields, which may explain high variability and uneven crop growth in this Dec 2021 image.

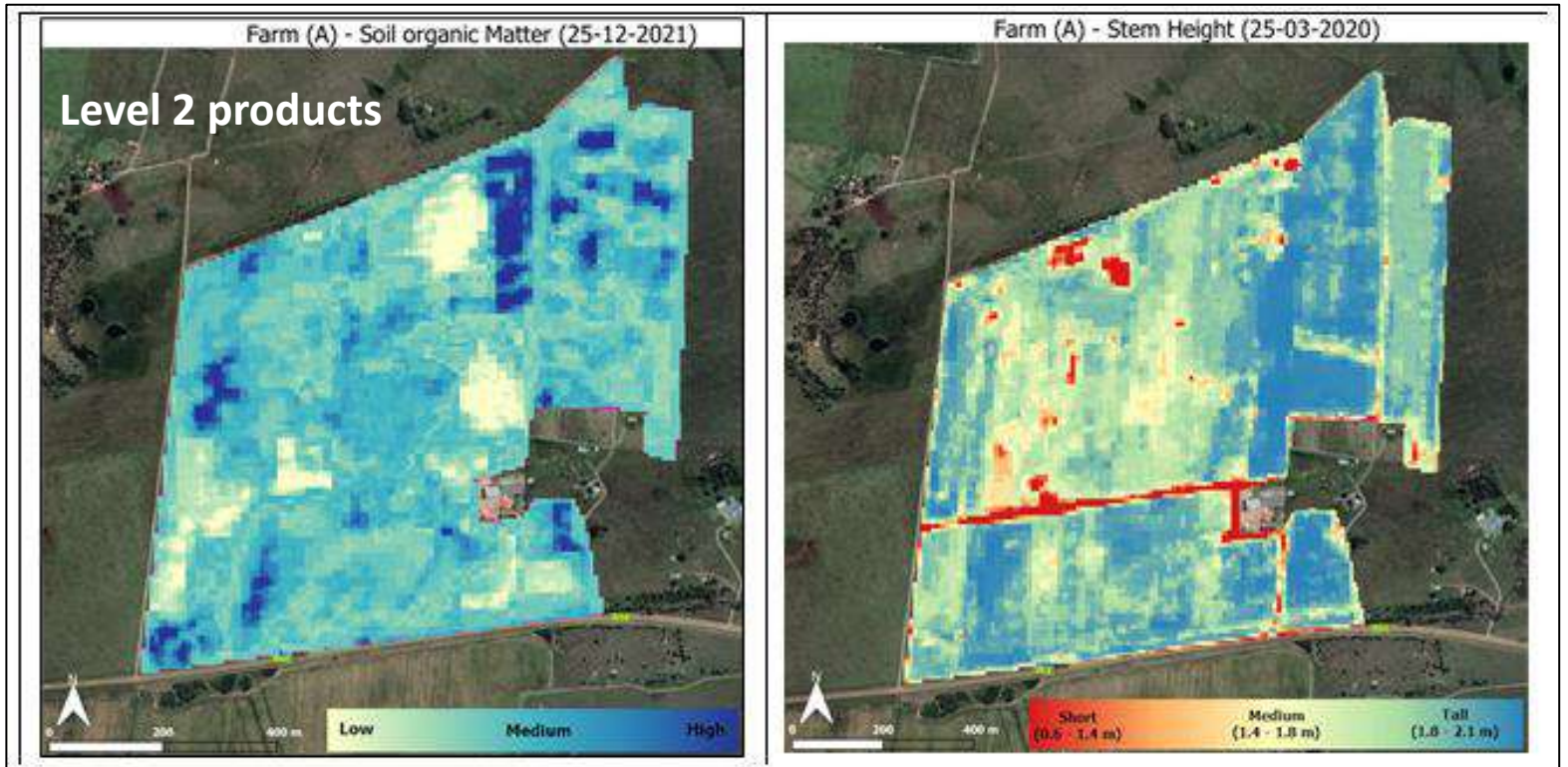
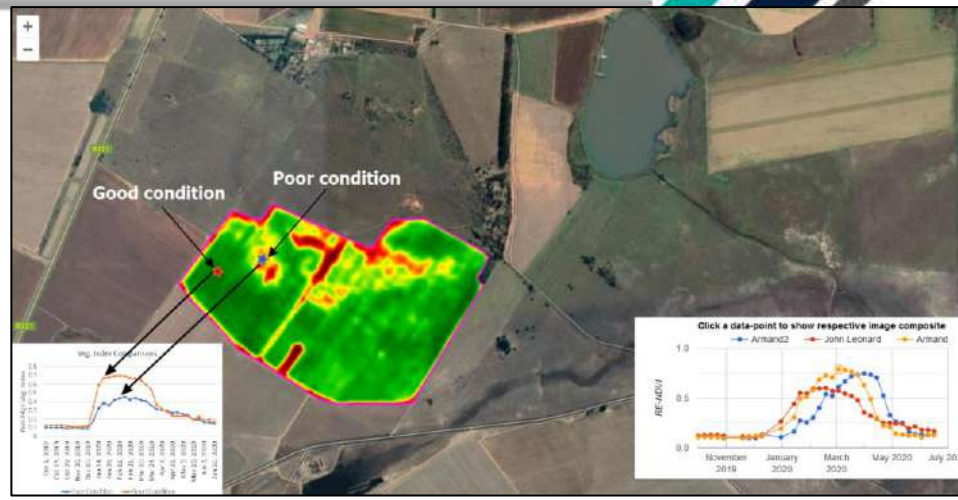
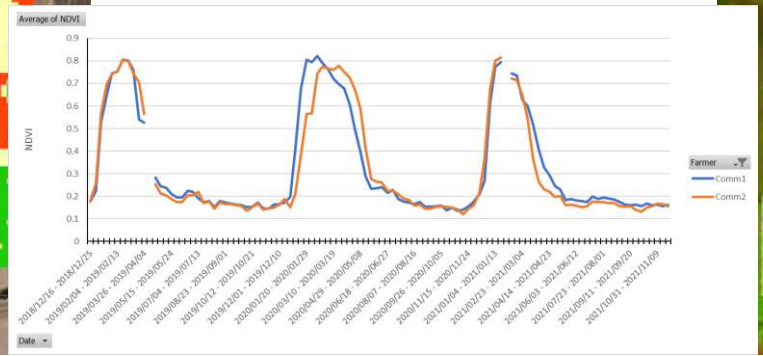


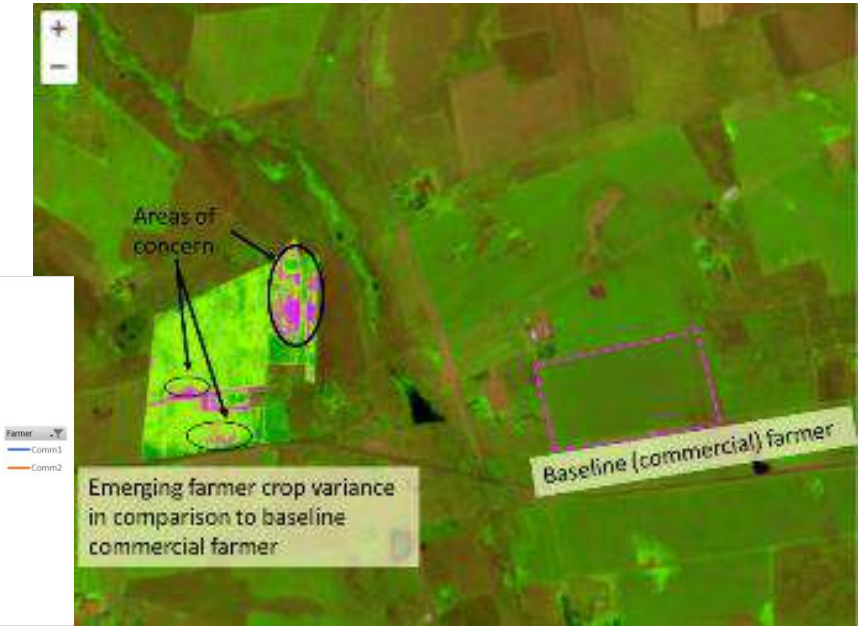
Fig.6. Example of Level 2 products showing random forest predicted i) soil organic matter (left), and ii) maize stem height towards the end of last season's growing season (right)

Precision Agriculture Information System

- Level 3 products
  - Statistical anomalies







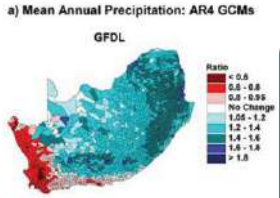
Collaborations

- FarmSol Holdings
  - Incubator of emerging farmers
  - Access to farmers for field data collection and data interpretation

- Department of Agriculture, land reform & rural development.
  - Free State
  - North West,
  - Limpopo

- Offer training and support to new farmers
  - MOU in progress

Digital transformation of the Agri sector at the CSIR

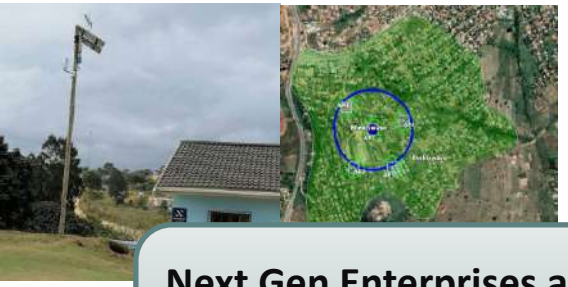


Smart Places:
- Climate modelling
- Yield forecasting

Indigenous Knowledge systems:
- Sustainably marry tech with indigenous knowledge

Robotics and Future Production:
- Drone hardware and software
- Sensor networks

Dassie1 (photo supplied by CSIR)



Precision Agriculture Group:
- Remote sensing
- Drones
- Data analytics
- Field data collection

Photonics Prototyping:
- Sensor development

Next Gen Enterprises and Institutions:
- Rural internet via TV white spaces

Enterprise Creation and Business Development:
- Business development and commercialisation

EDT4IR

Artificial Intelligence & Augmented Reality

Internet of Things

Distributed Ledger Technologies

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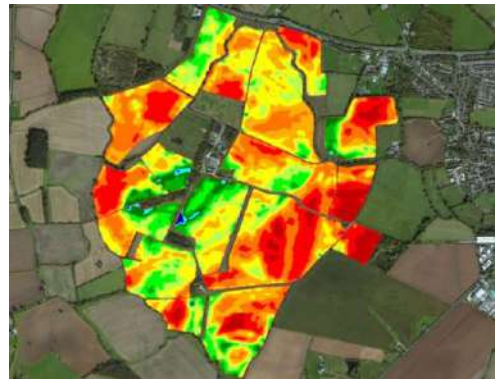
Conclusions

- Looking to support farmers and industries along the agricultural value chain
  - Improve yields and profits
  - Enable climate adaptation
  - Build ecosystems of innovation (through remote sensing)
- Capacitate (emerging) farmers and young people
  - Training and building of scarce skill sets
- Facilitate job creation
  - Digitization of extension services
- Improve food security




THANK YOU