

Status of ICTs in sustainable food security in Africa

The Agbiz Grain Perspective

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Outline

Introducing Agbiz Grain

The Wireless Farmer

Land

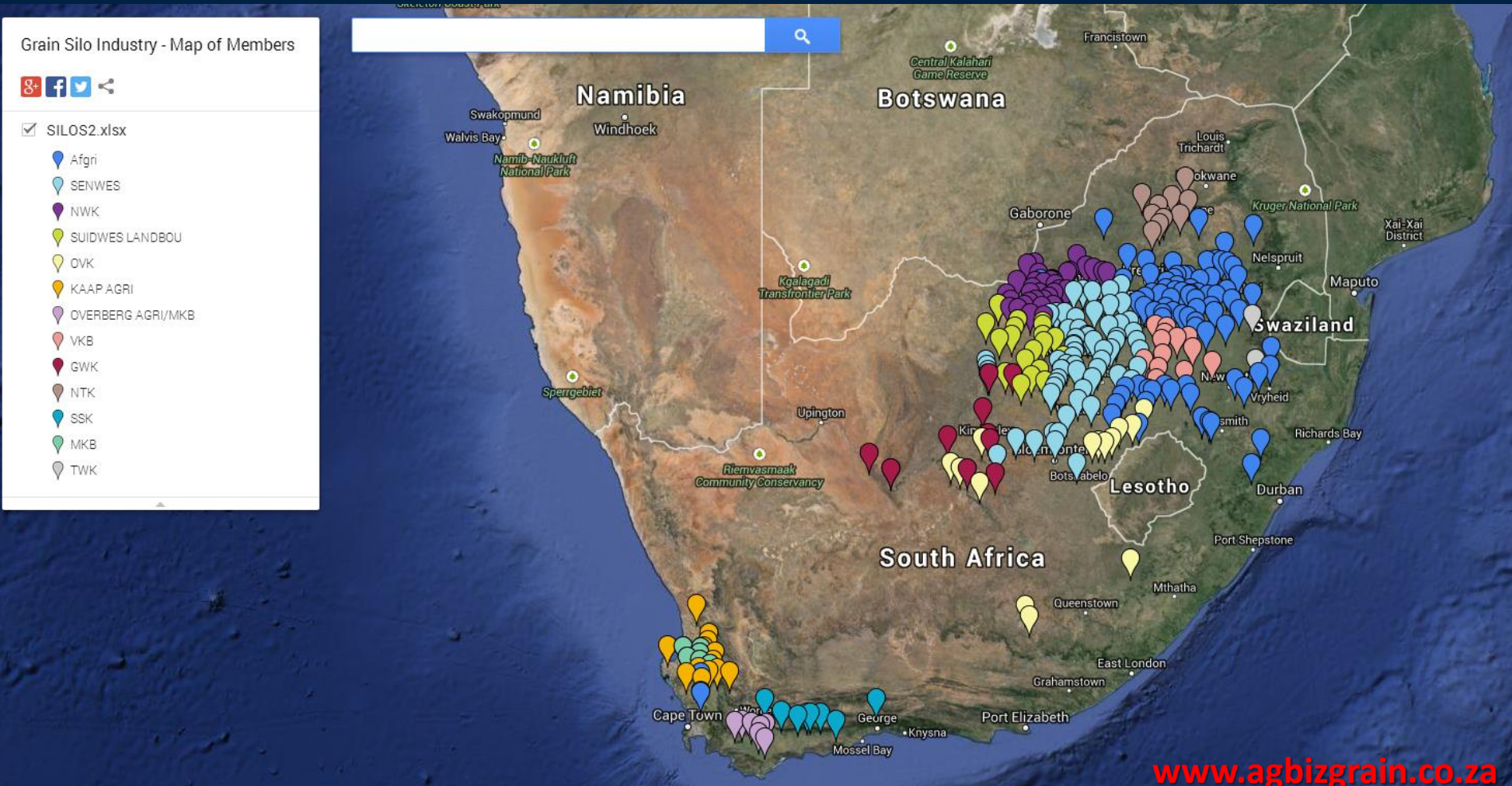
Weather

Crop



Introducing Agbiz Grain






- Silo distribution.
- Total silo capacity 15 million tons.
- 12 Members operating 243 grain silos.
- Handle white maize, yellow maize, sunflower, soya beans, sorghum, wheat, barley, oats and canola.



The Wireless Farmer

- **Crop Planner** – Project management for a crop, including costings and yields
- **Task Manager** – Create and delegate tasks to different operators
- **Planting Record** – Information about the Harvest
- **Spraying Record** – When, water volumes, which equipment, wind direction, temperature
- **Fertiliser Record** – Track when, when and how much fertilizer must be used
- **Harvest Schedule** – Review when harvest will be ready within withholding day period
- **Harvest Forecast** – Reports on when harvest will be ready
- **Purchase order** – Raise purchase orders which can be approved by the supervisors
- **Recommendations** – Make recommendation for dealing with defects and disease
- **Crop Monitor** – Track different actions & issues occurring within a crop
- **Stock Transfer** – Transferring product from one chemical shed to the next
- **Soil Treatment** – Managing and assessing parts of soil within a crop in the ground
- **Irrigation** – Tracking levels and usage of water on the crops at certain times of the year
- **Trading** – Electronic certificates and warehouse receipts
- **Stock exchange** – Grain Futures and Options are Derivatives Contracts

Remote Sensing Platforms

		SATELLITE	Days
		Delivery time: Typical resolution:	Weeks 50 cm/pixel
		MANNED AIRCRAFT	
		Delivery time: Typical resolution:	Weeks to months 10-30 cm/pixel
		MINI-UAV	Immediate
		Delivery time: Typical resolution:	Immediate 1.5-15 cm/pixel
		TERRESTRIAL MEANS	
		Delivery time:	Depending on qualified worker availability



Professional / Commercial
DJI Spreading Wings S1000 sensefly eBee
<10K Units
≥\$3,000
Large payload, extended range and flight time, advanced sensors

GEOGLAM

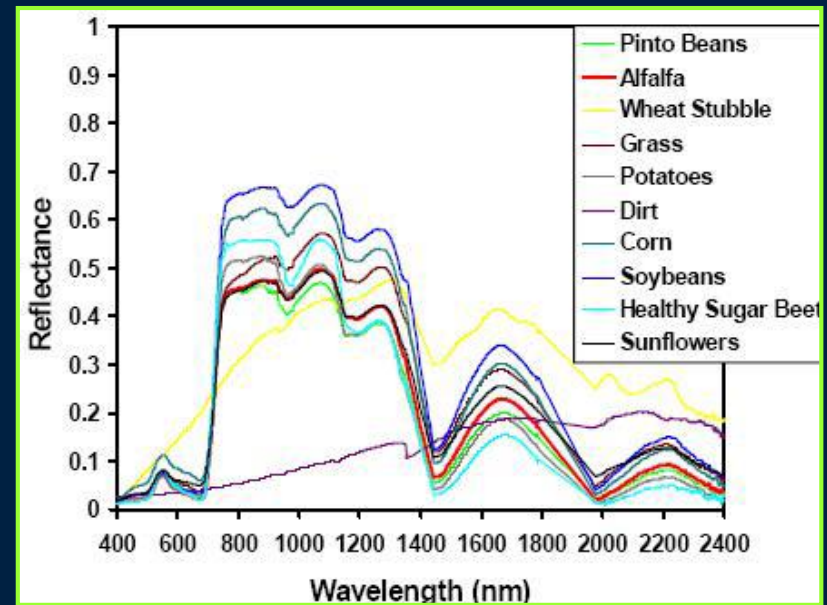
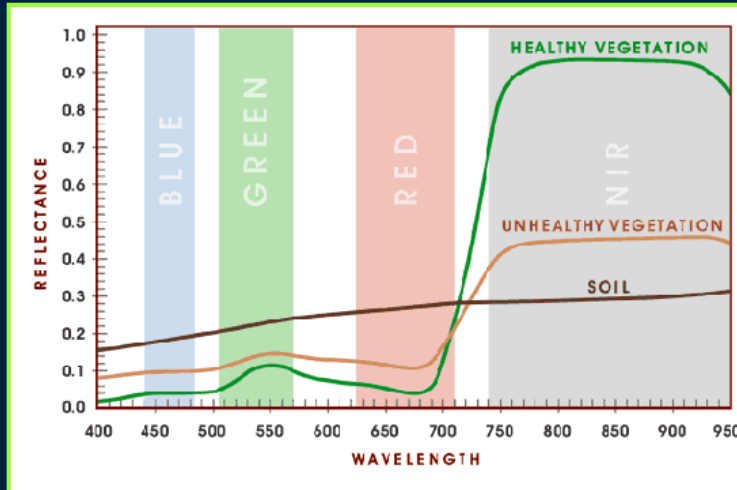
(Group on Earth Observations-Global Agricultural Marketing)



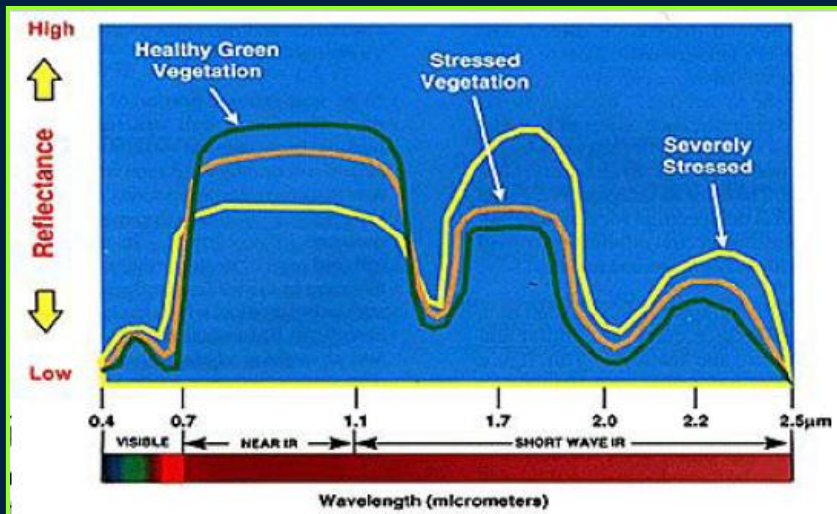
Voluntary partnership: governments including 102 nations, European Commission, and 103 participating organisations. Envisions coordinated, comprehensive and sustained Earth observations and information.

Introducing EO

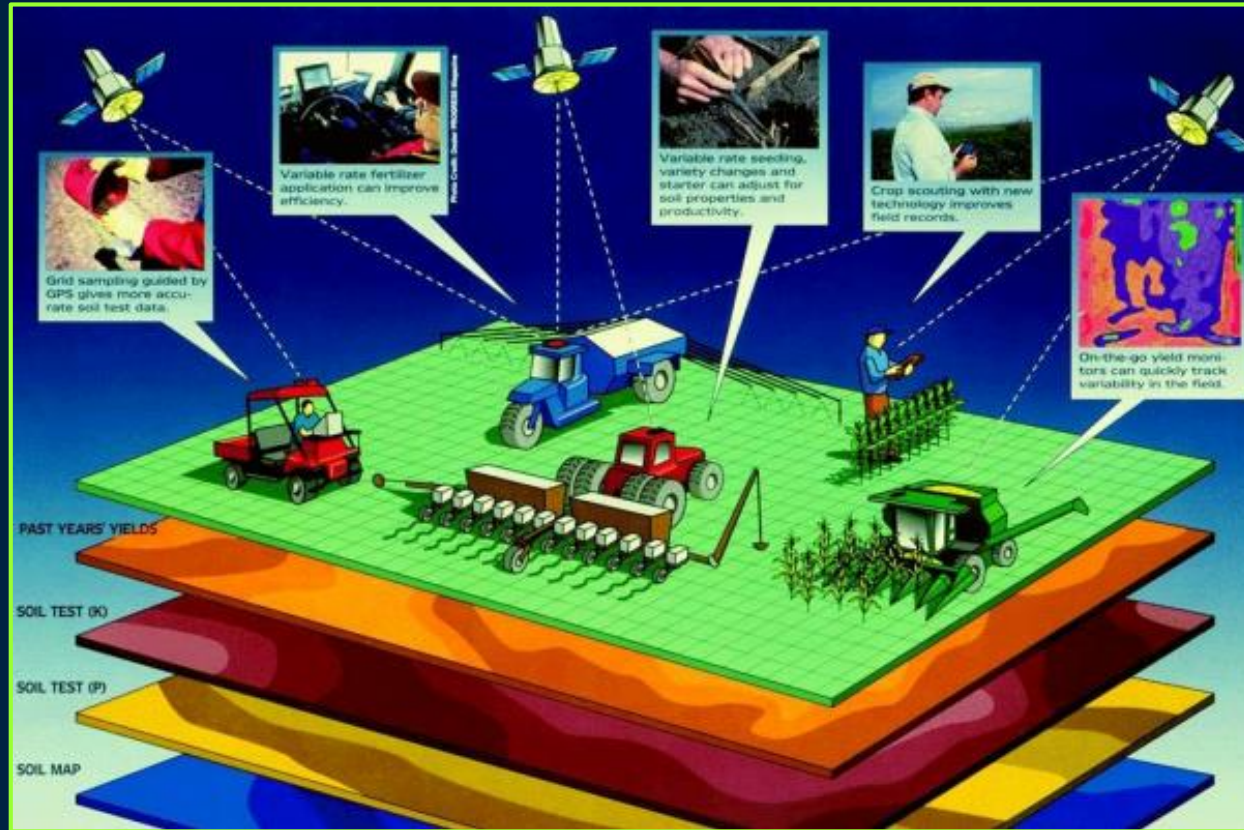
Need for better agricultural monitoring capabilities → EO (Earth Observation)
The Ultimate Goal: Integrated Sensing Systems in Agriculture



Crop Reflectance



Layers of information



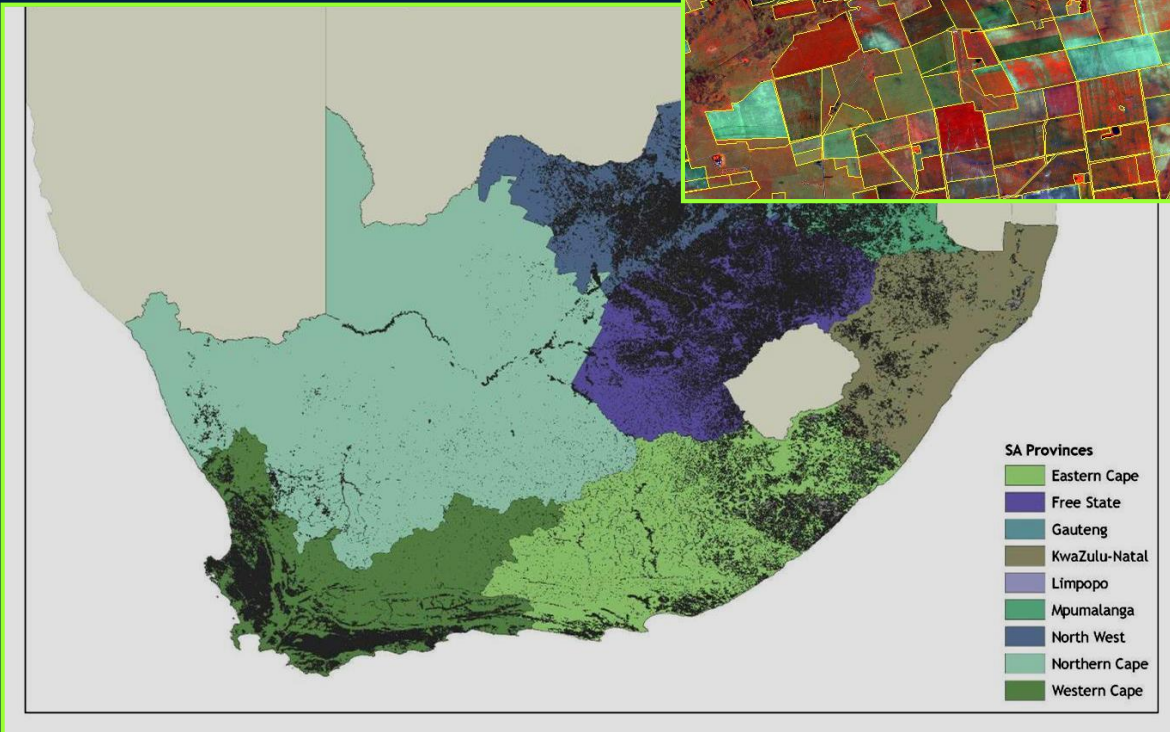
Precision agriculture



Land coverage

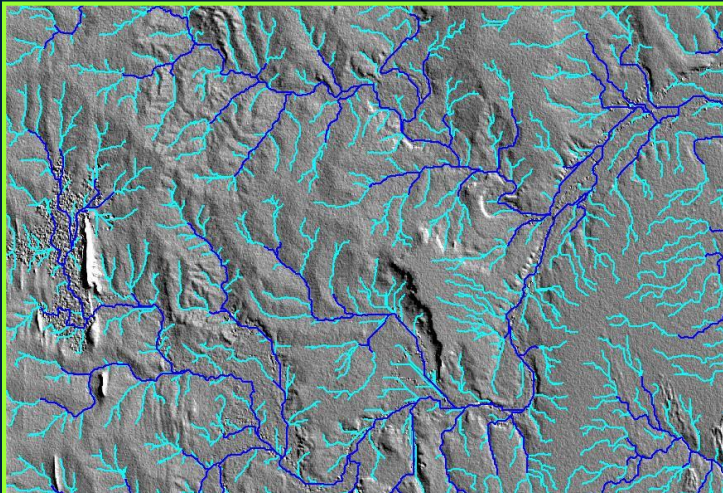
Digitised Field Crop
Boundaries

SA coverage: 14 million ha
10% of SA

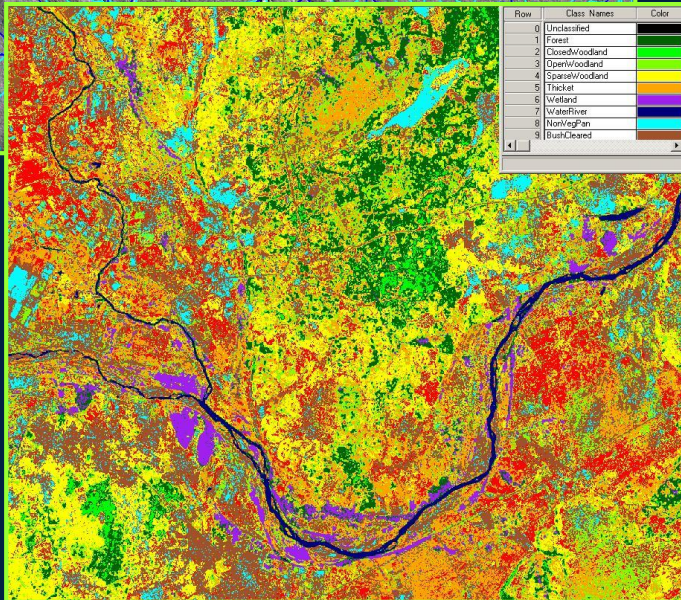
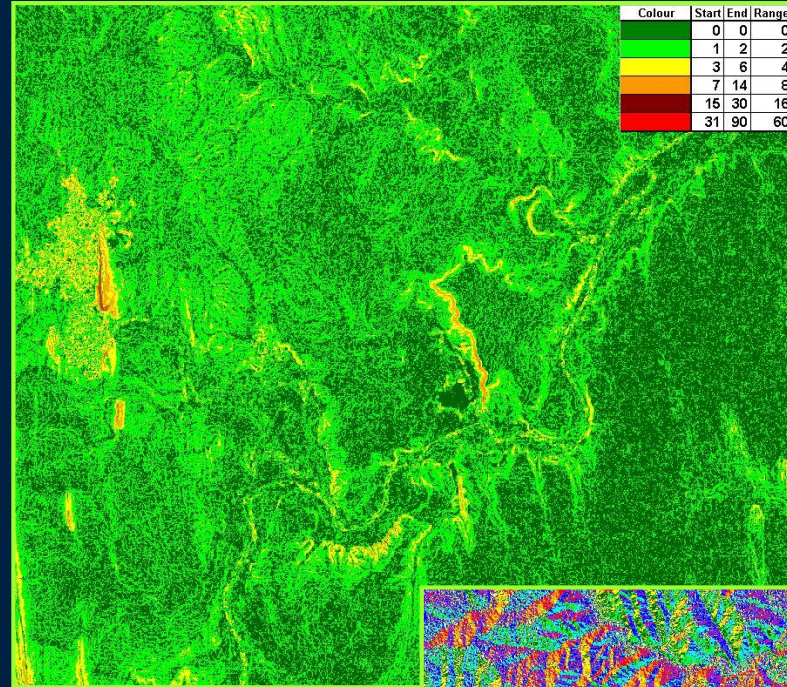


Terrain Analysis

Streamlines

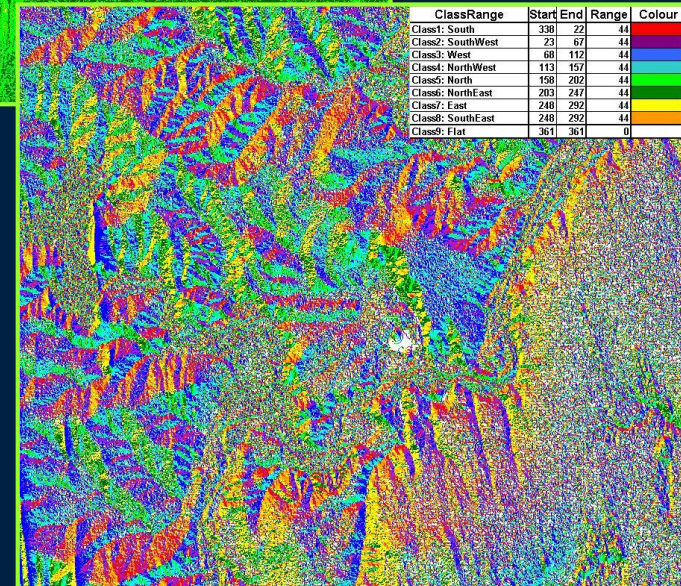


Natural Vegetation

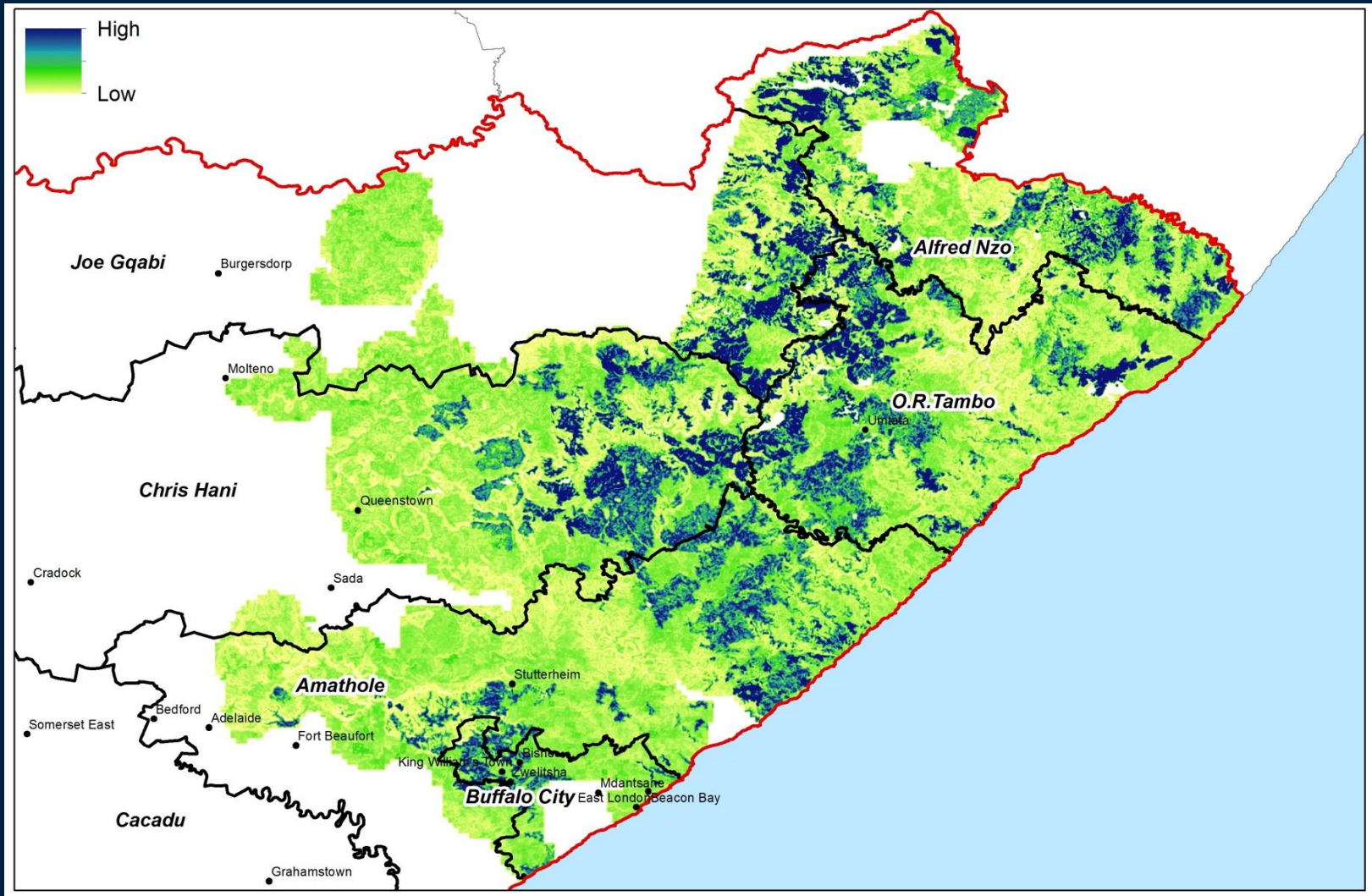


Slope Map

Aspect Ranges

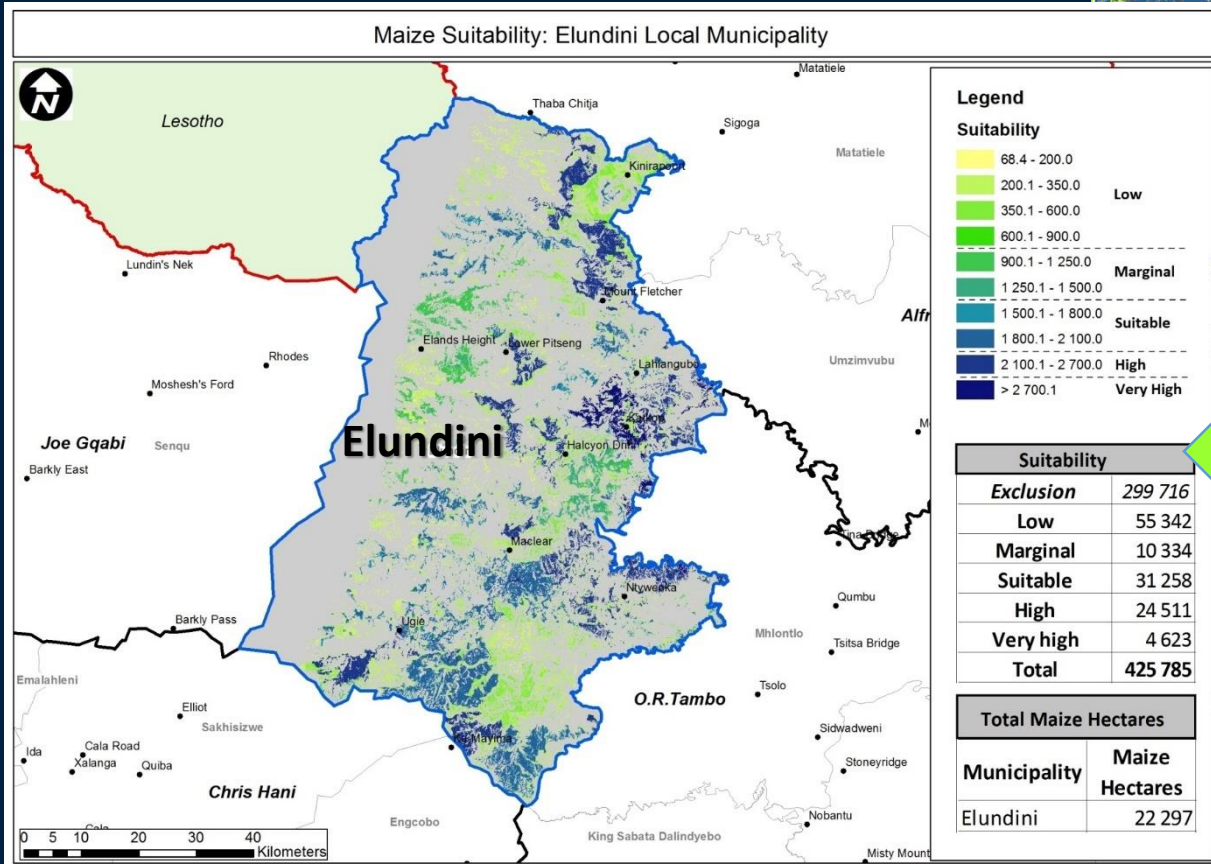
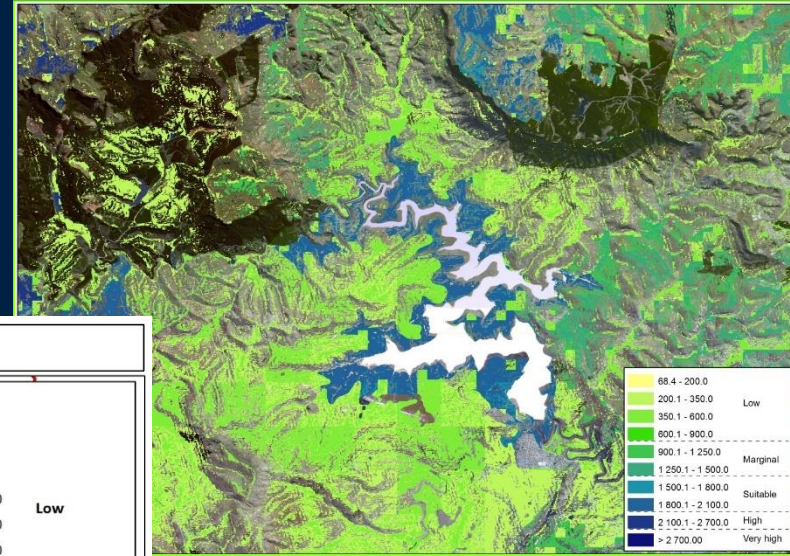


Potential expansion for Eastern Cape



Land suitability

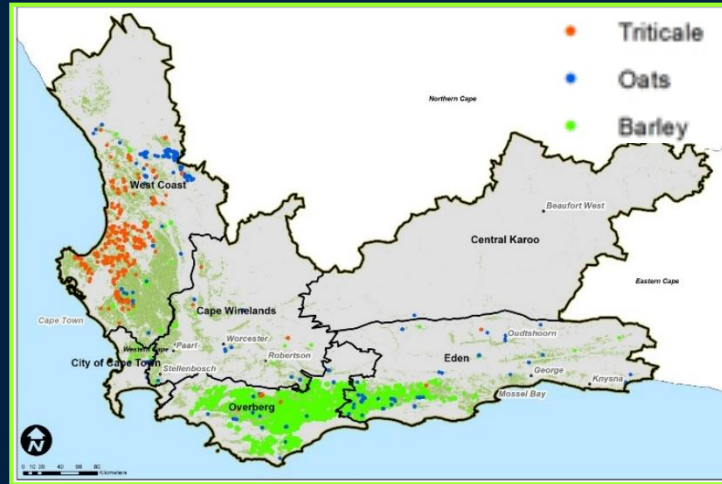
Maize: Elundini Local Municipality



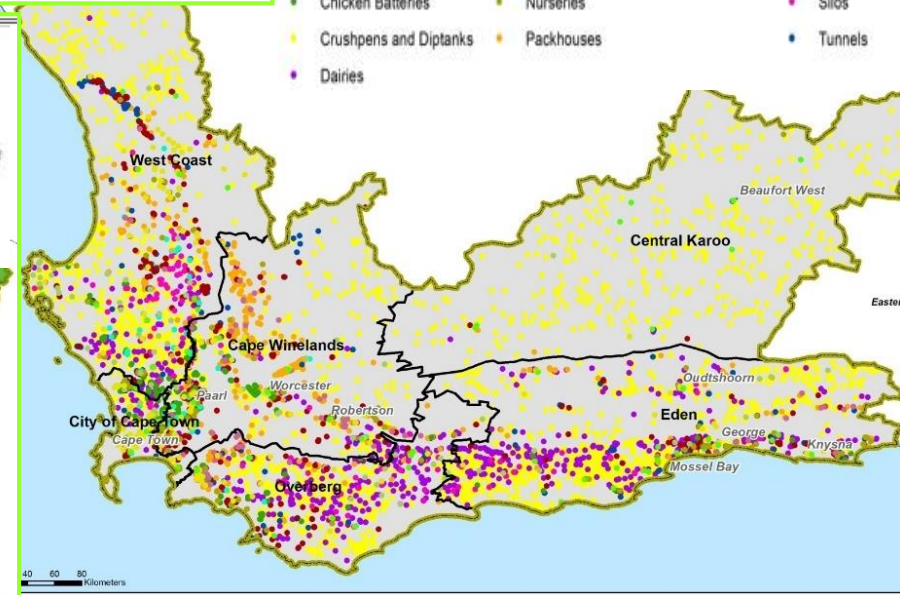
Suitability	E/Cape Ha
Very high	9 029
High	80 785
Suitable	181 066
Marginal	386 988
Low	1 513 429
Unsuitable	3 921 341

Crop production information

Winter Grain

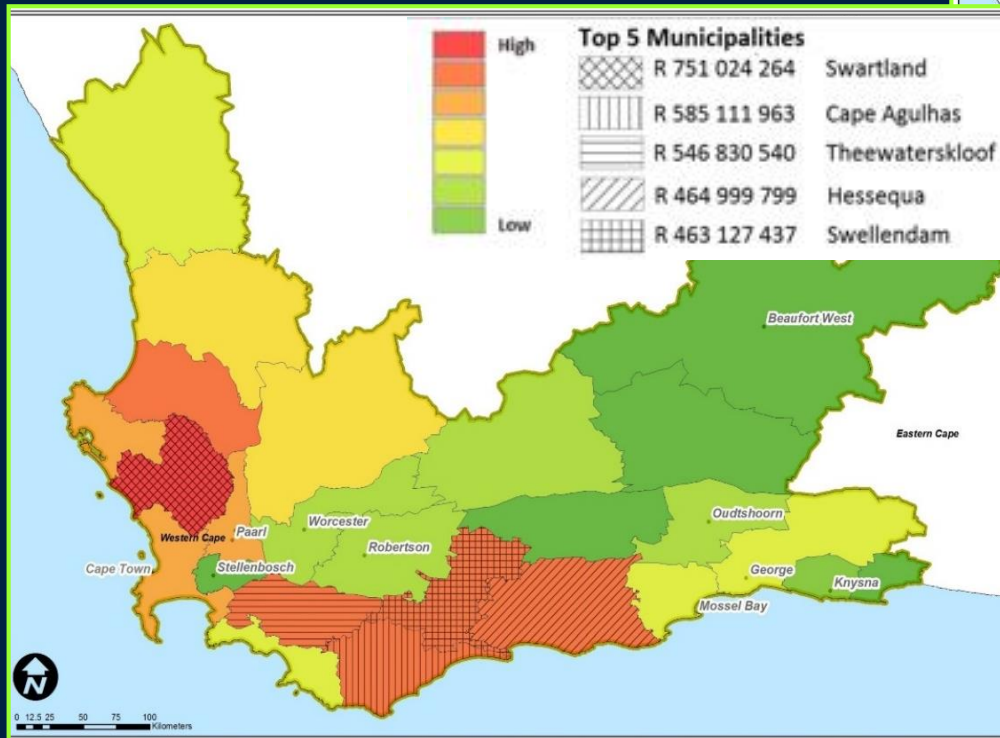


Agri- Infrastructure



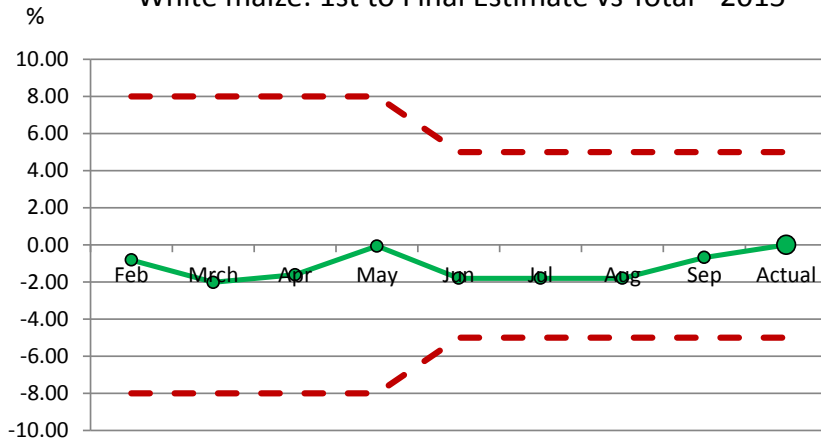
agbiz GRAIN

Total potential value
(Rands) for Grain
& Oilseeds

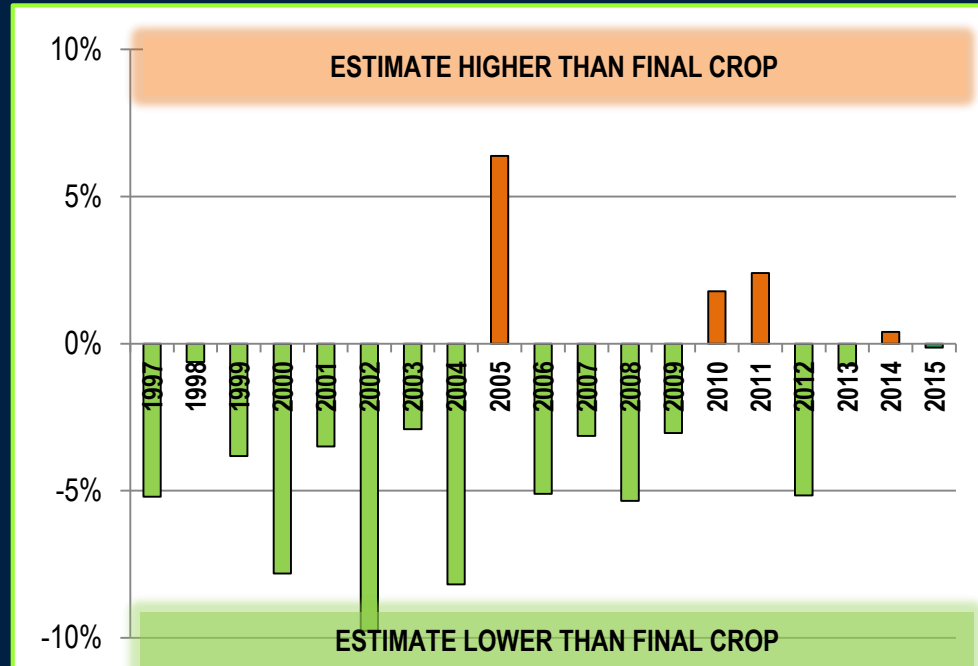
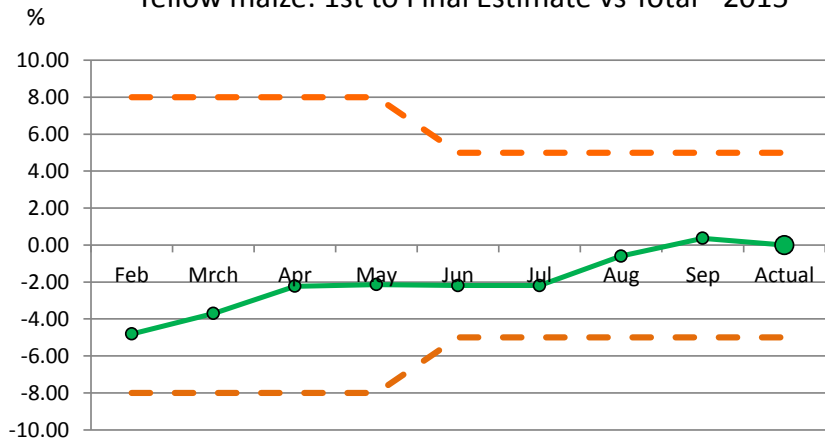


Accuracy of Crop Estimates

White maize: 1st to Final Estimate vs Total - 2015

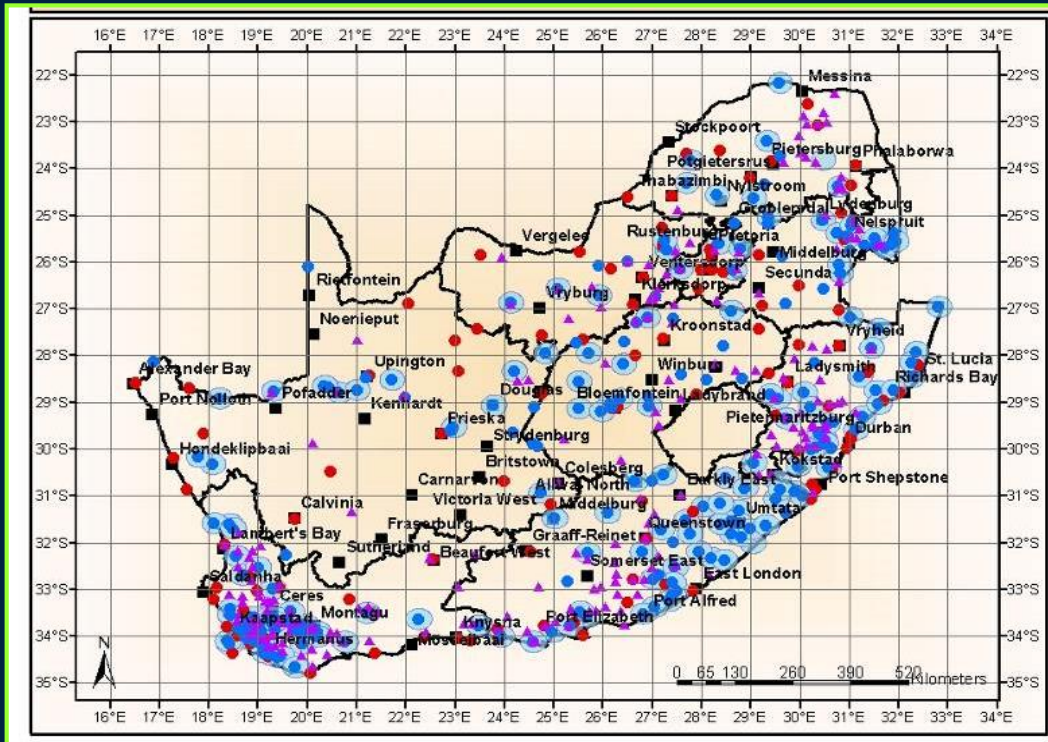


Yellow maize: 1st to Final Estimate vs Total - 2015

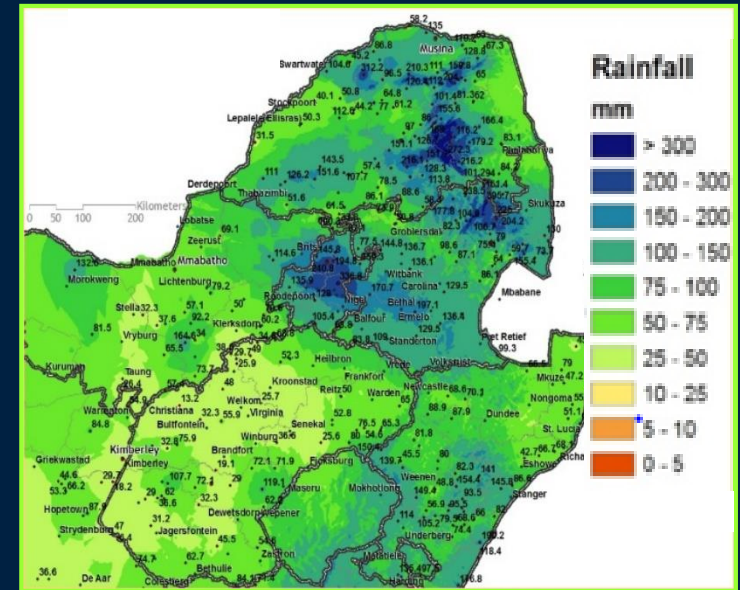


Weather stations

Location of weather stations



Total Rainfall: 1 to 28 March 2016



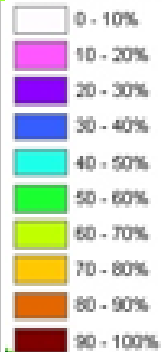
Rainfall Seasonality & Quantity

Legend

Province

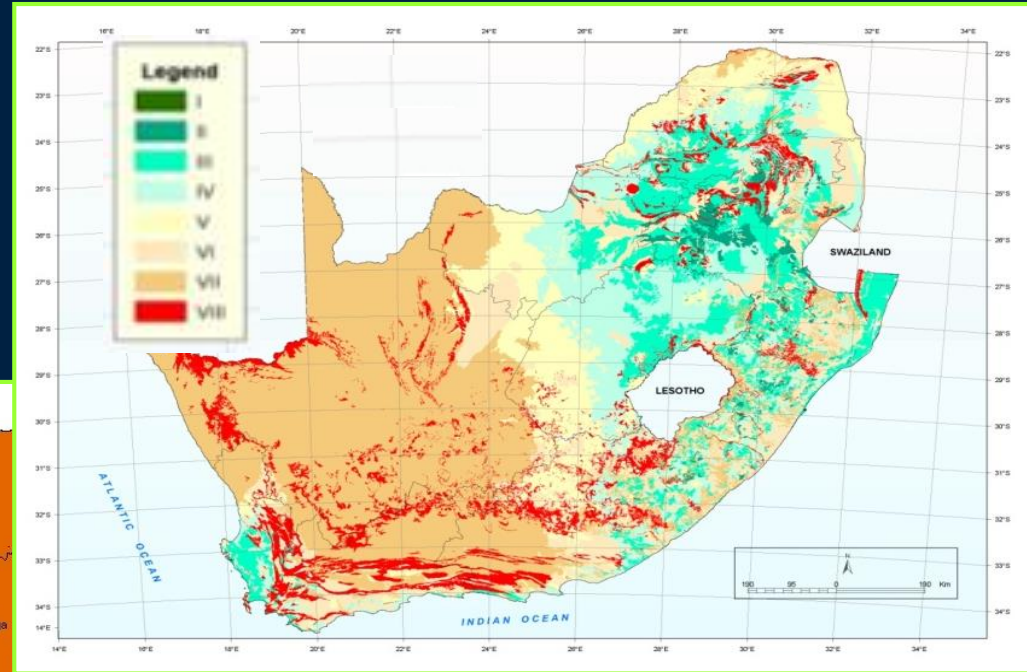
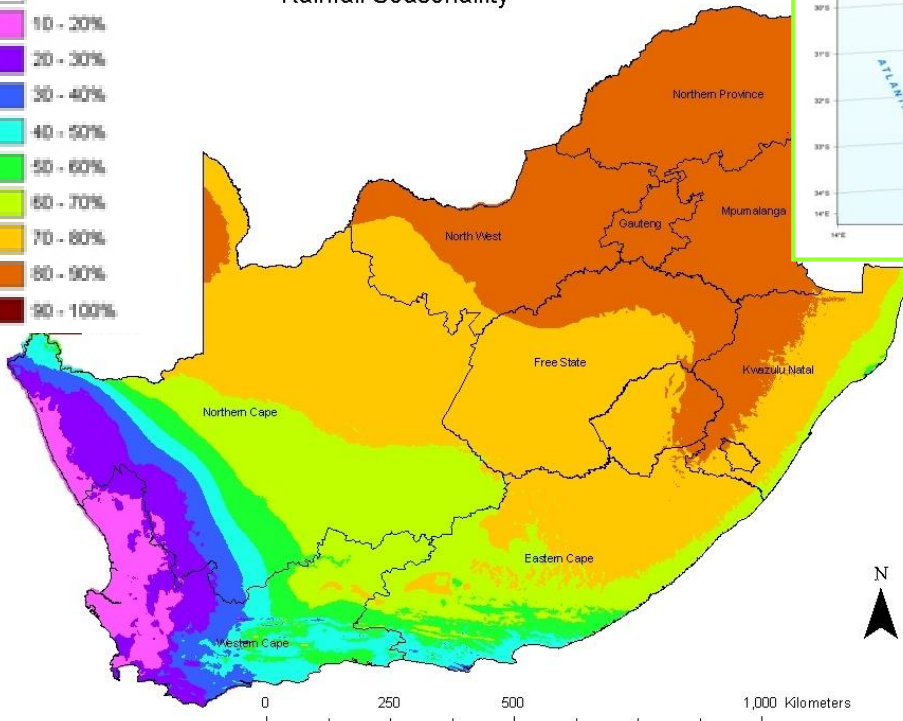
Rainfall

% Rain in Summer



Seasonality

Rainfall Seasonality



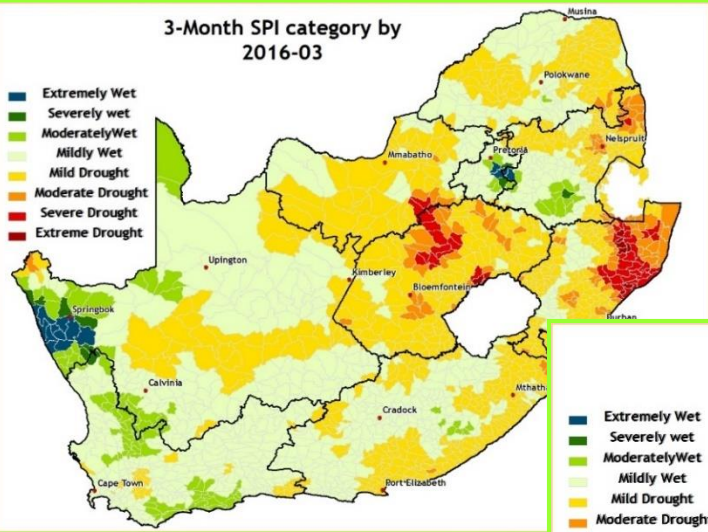
Land capability

Spatialized weather data over long term

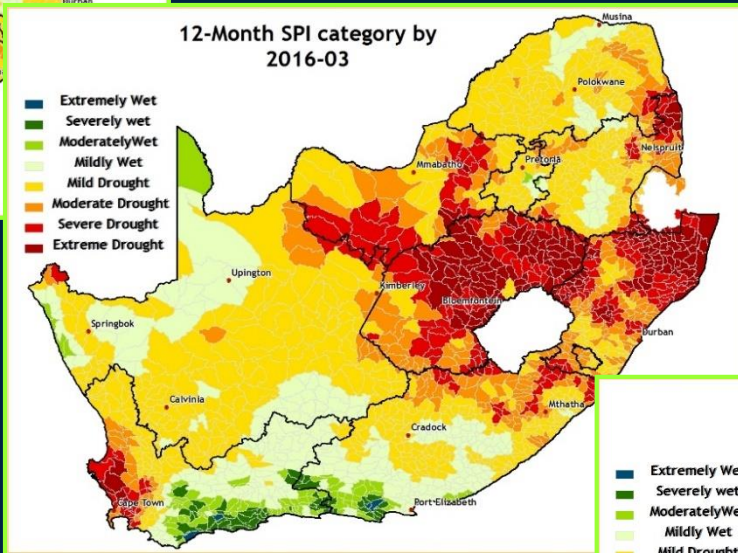
Compare rainfall over extended period

Compare rainfall with long-term average

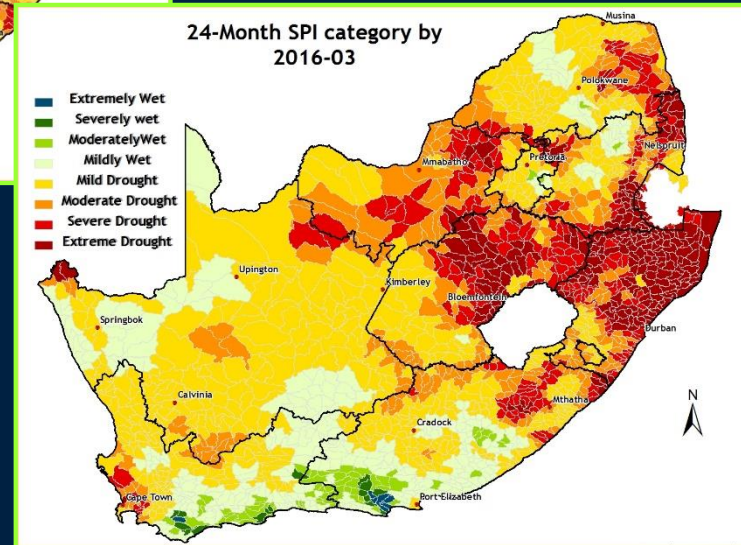
3-Month SPI category by
2016-03



12-Month SPI category by
2016-03

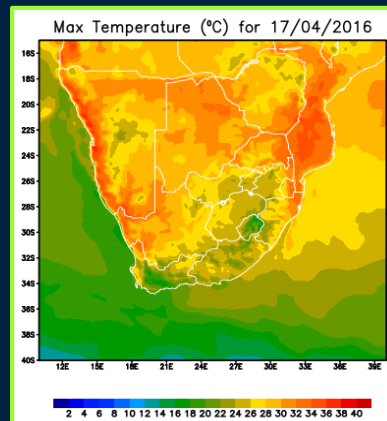
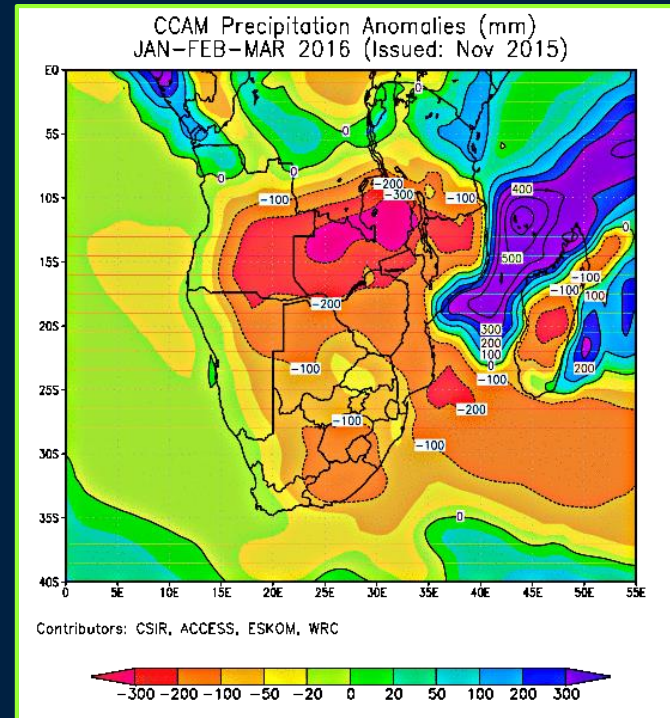
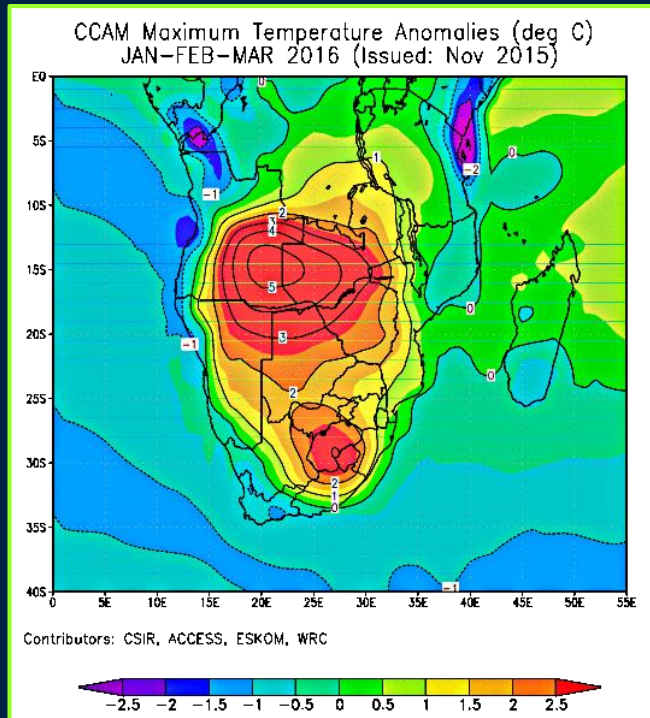


24-Month SPI category by
2016-03



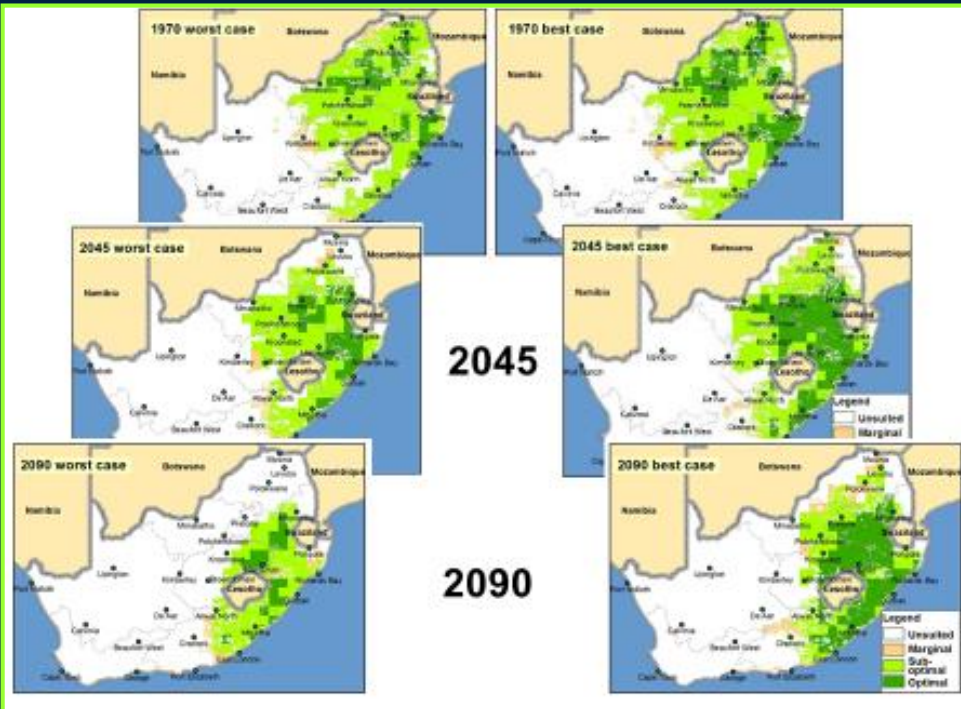
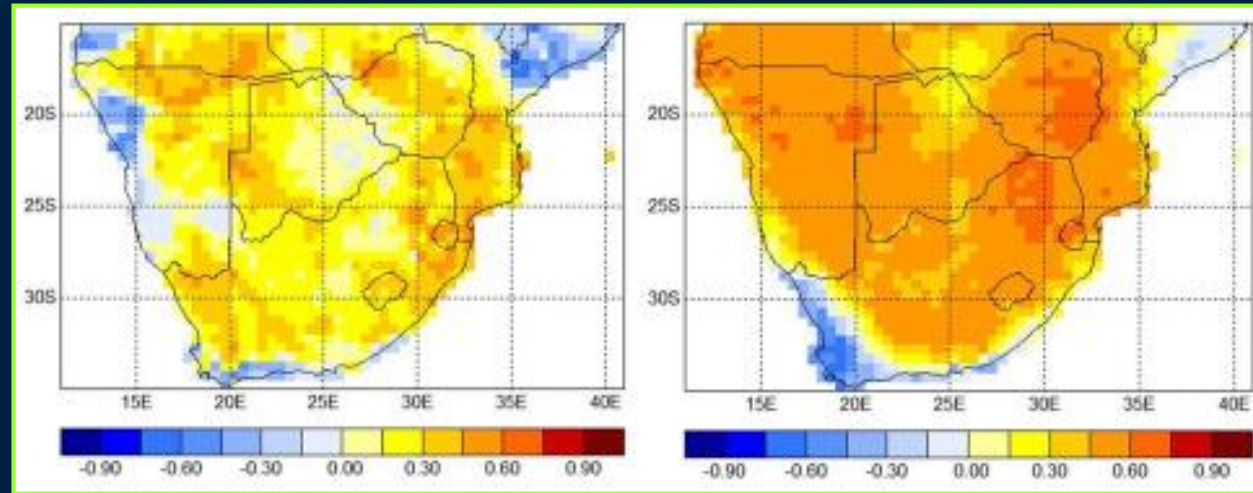
Weather forecasts

Compare temperature and rainfall with long-term average (= Anomalies)



Climate predictions

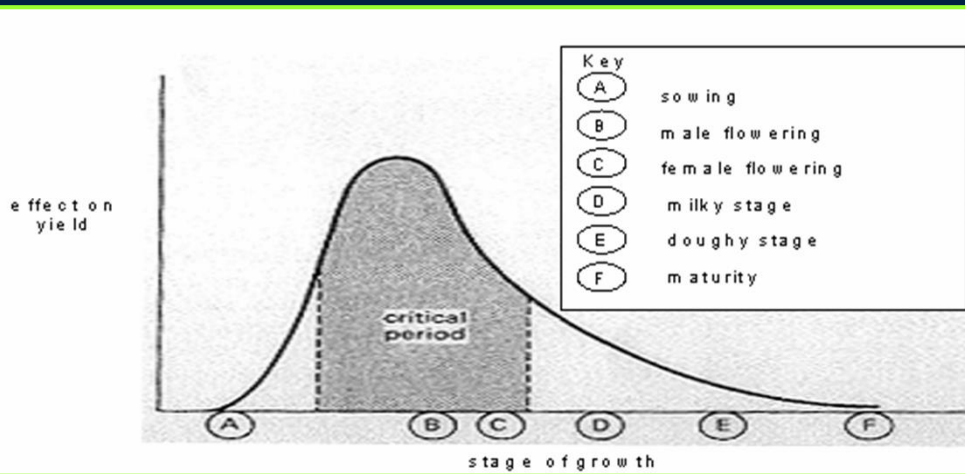
Precipitation &
Maximum temperature
– 1-month lead time



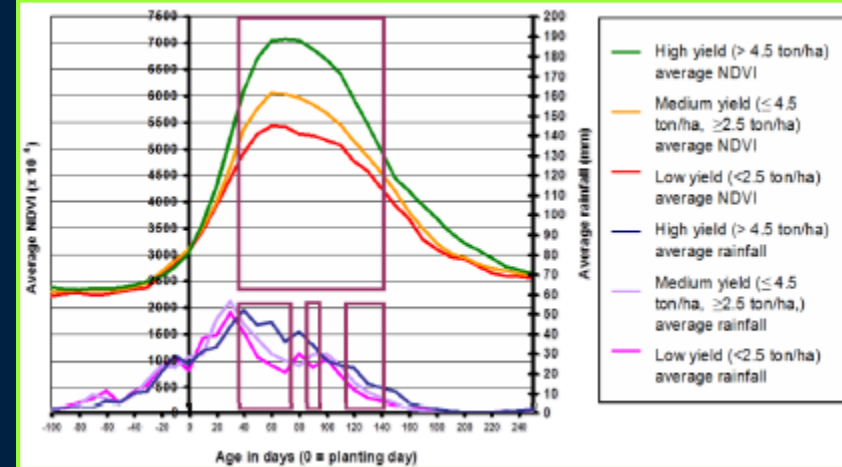
Long term – Climate change
Shifting climate zones

Linking plant growth to climate

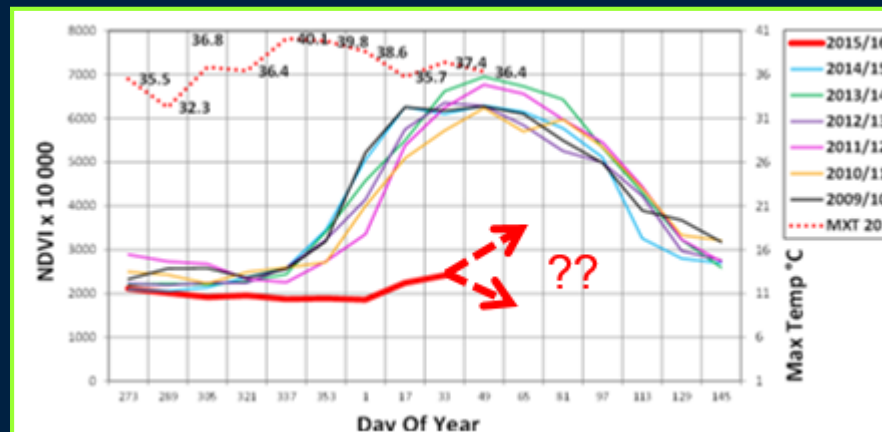
Plant Phenology



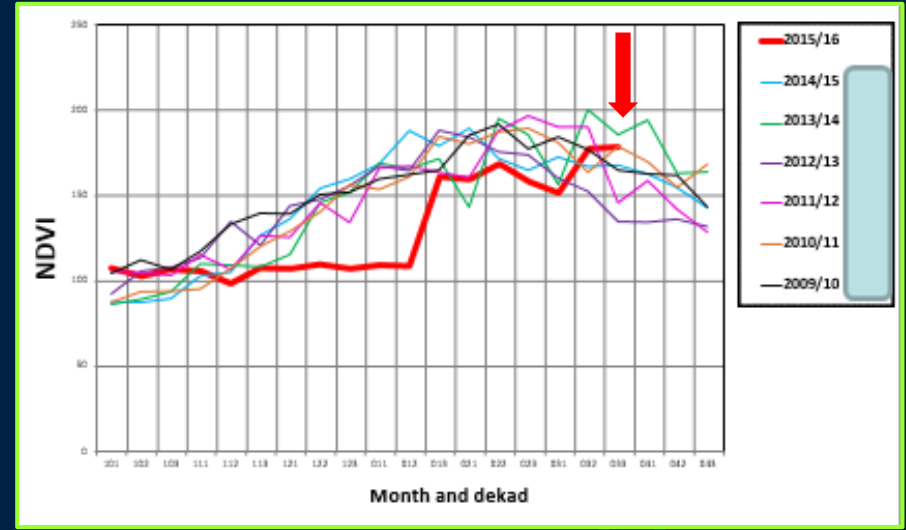
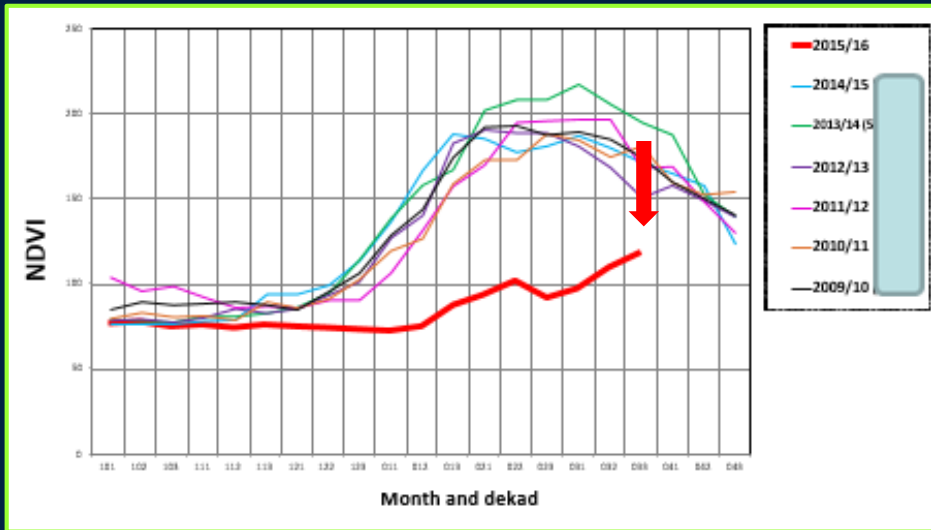
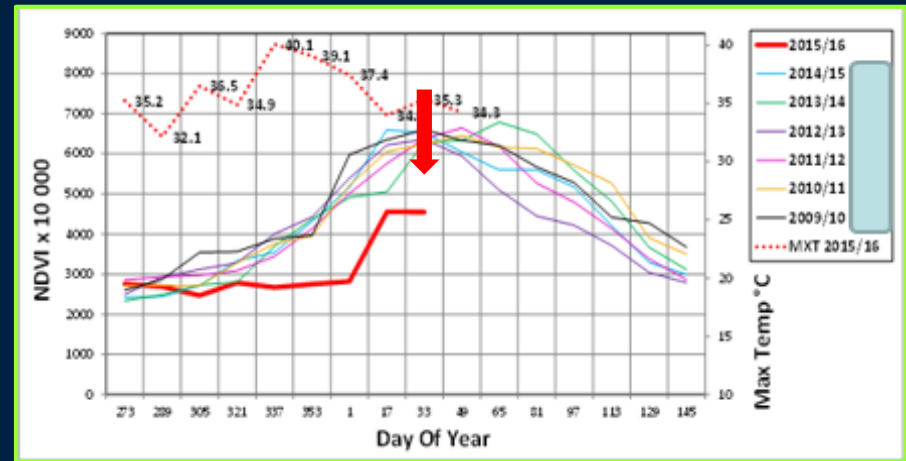
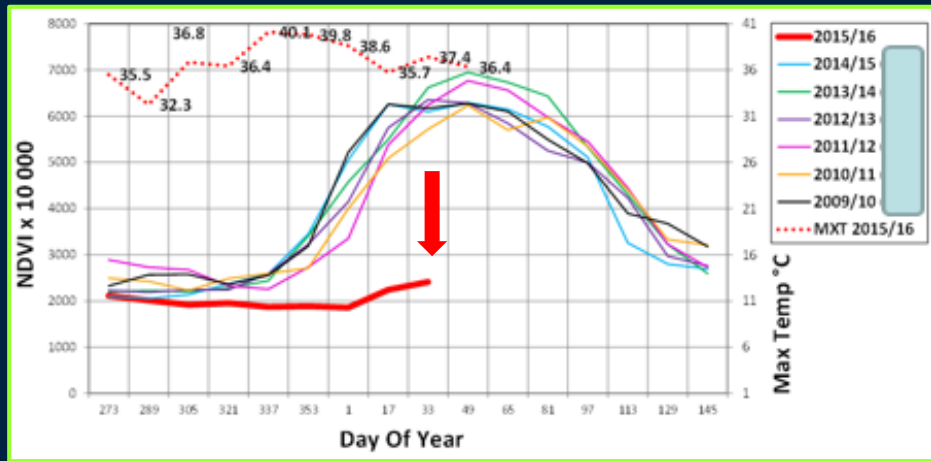
Crop Modelling



Provides an estimate, during the growing season, of maize yield relative to previous seasons



Vegetation Index & Temperature

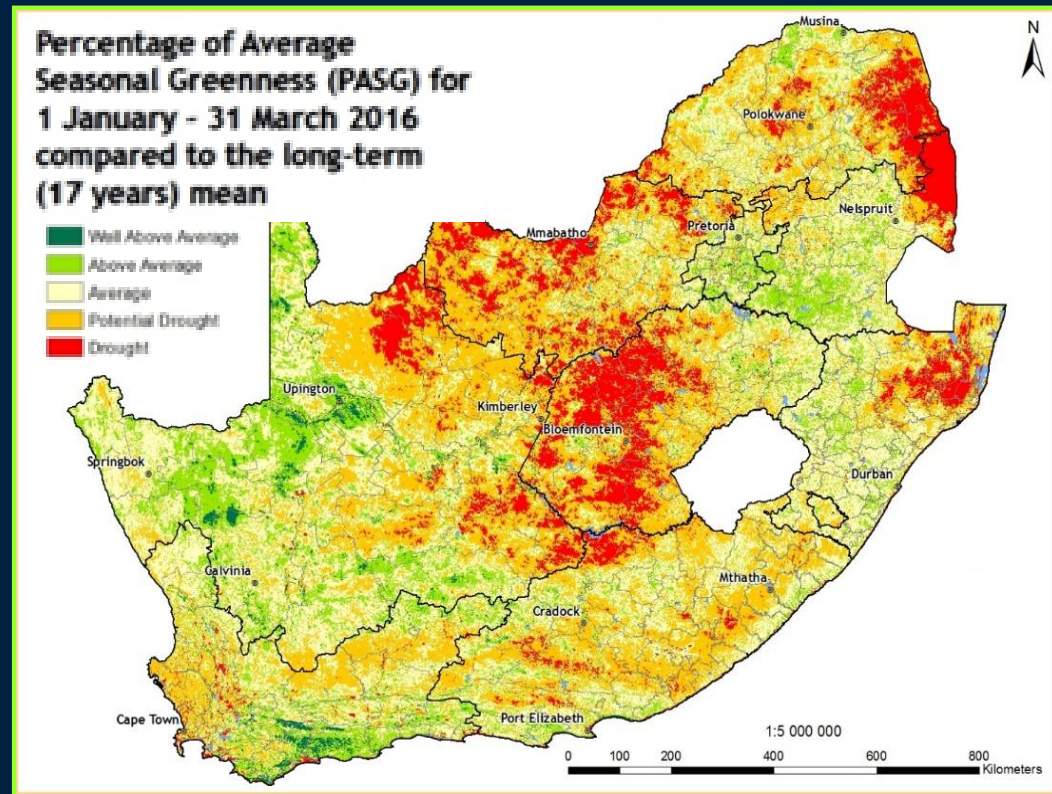


Normalized Difference Vegetation Index

Vegetation / Crop vigour

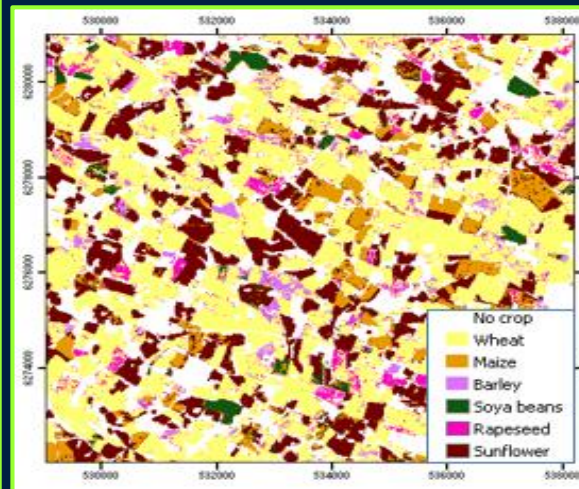
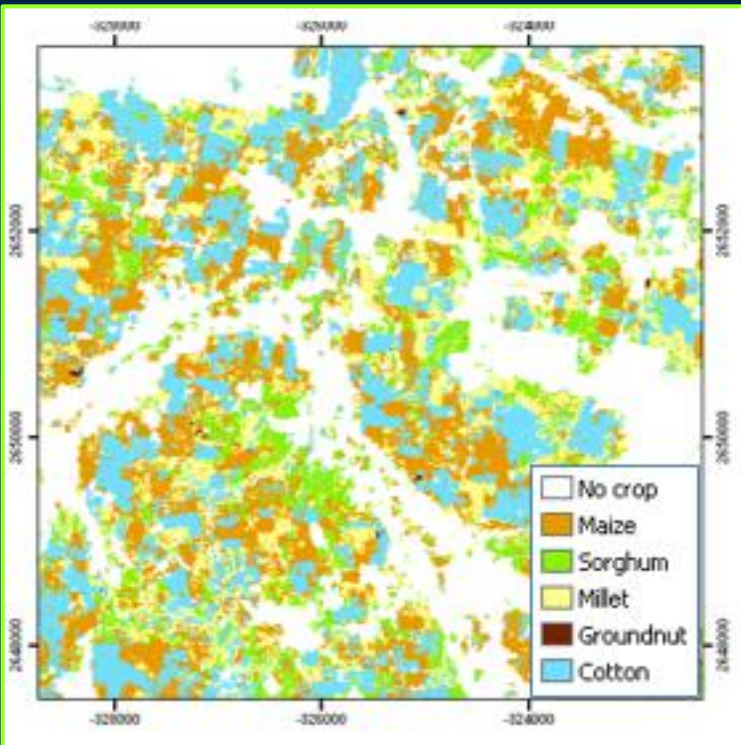
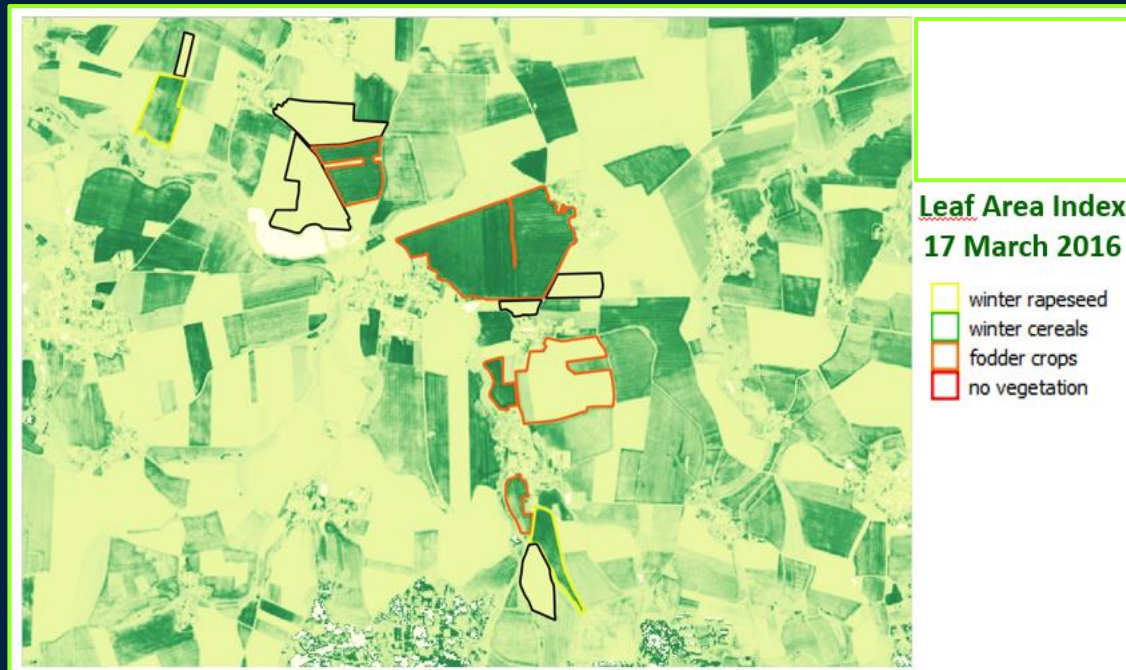
Agro-meteorological plant growth models

- Agricultural applications require quantitative remote data with acceptable **accuracy** and **high resolution**.
- Crop production forecasting requires high accuracy data and reliable remote sensing data.
- Incorporating remote sensing data in crop yield estimations by developing accurate mathematical models between **remote sensing** data with **ground yield** historical information.
- These models assume that there is a positive—linear or non—linear relationship between crop yield and vegetation stage vigour and negative plant stress.

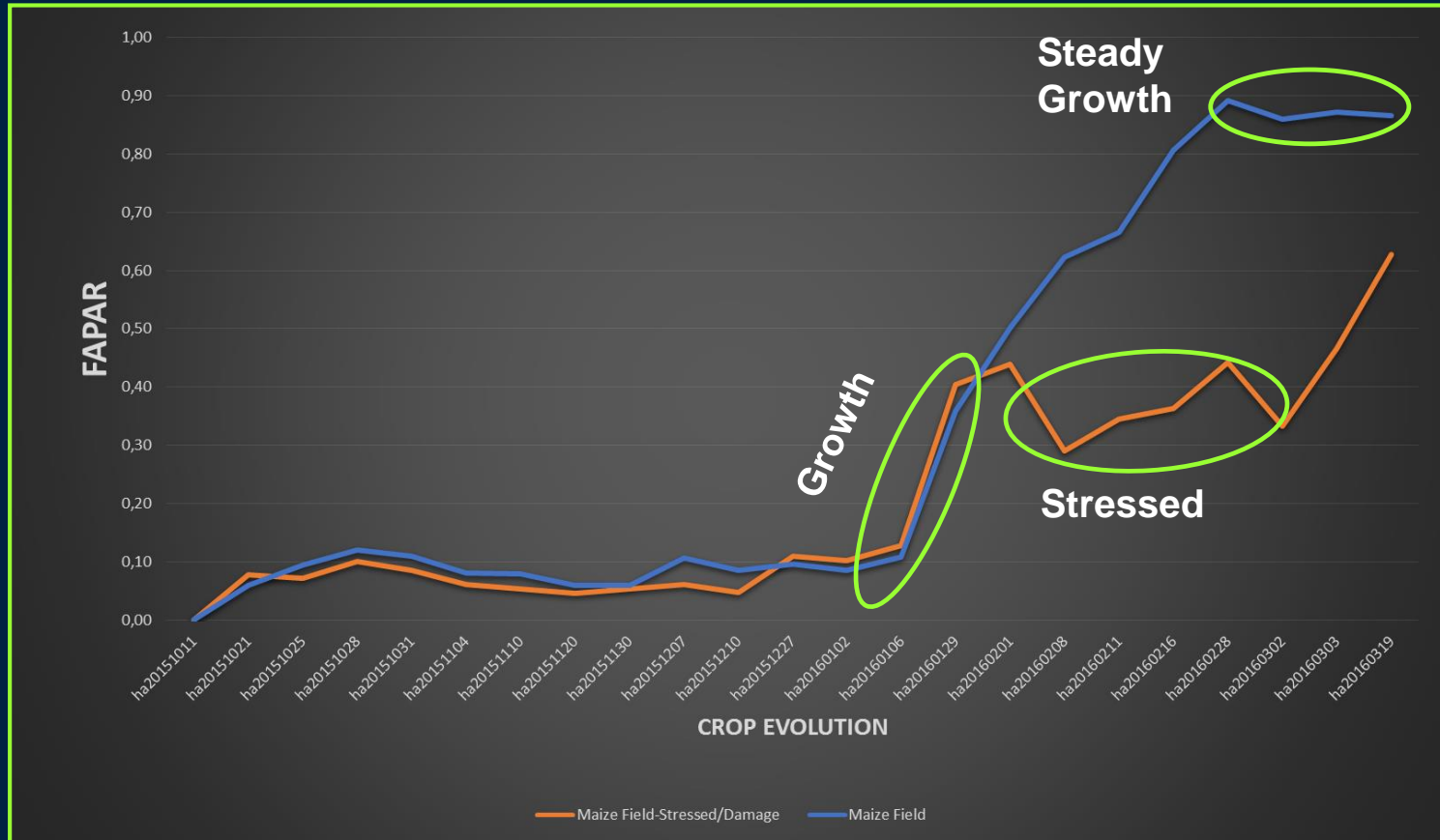


Cumulative effect of weather conditions as a season progresses as reflected in vegetation/crop vigor relative to the long-term mean

Crop identification

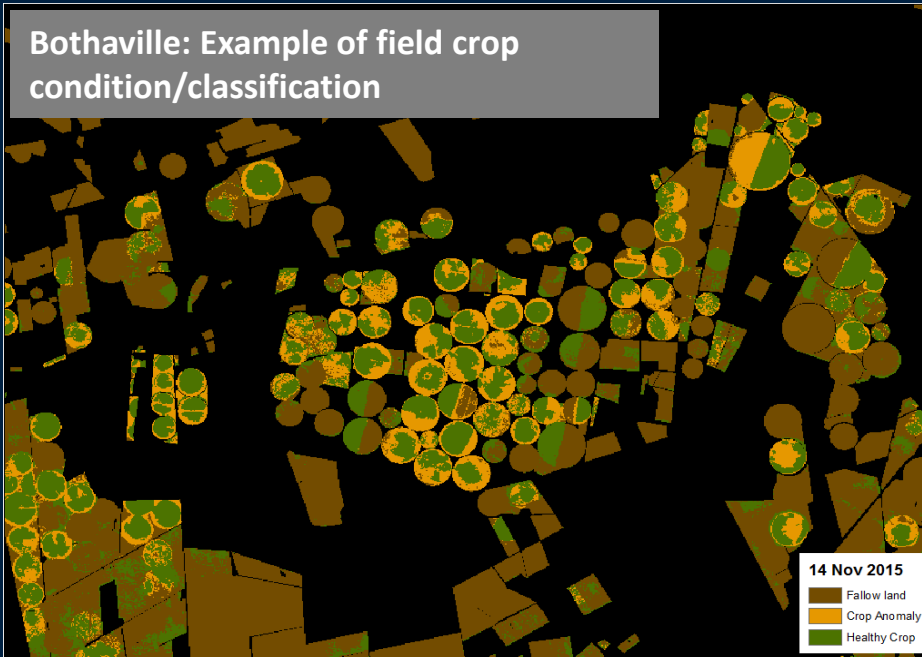


Crop Monitor

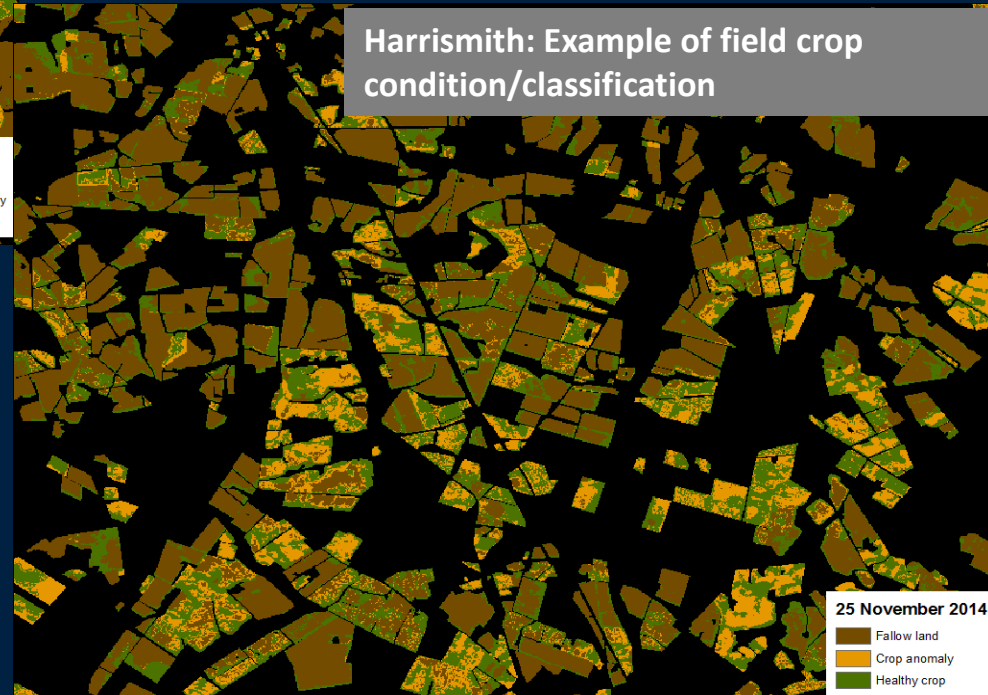


Crop Condition

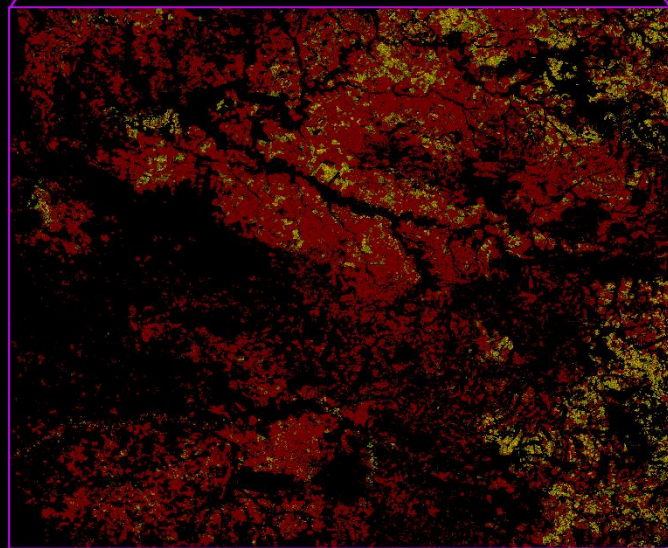
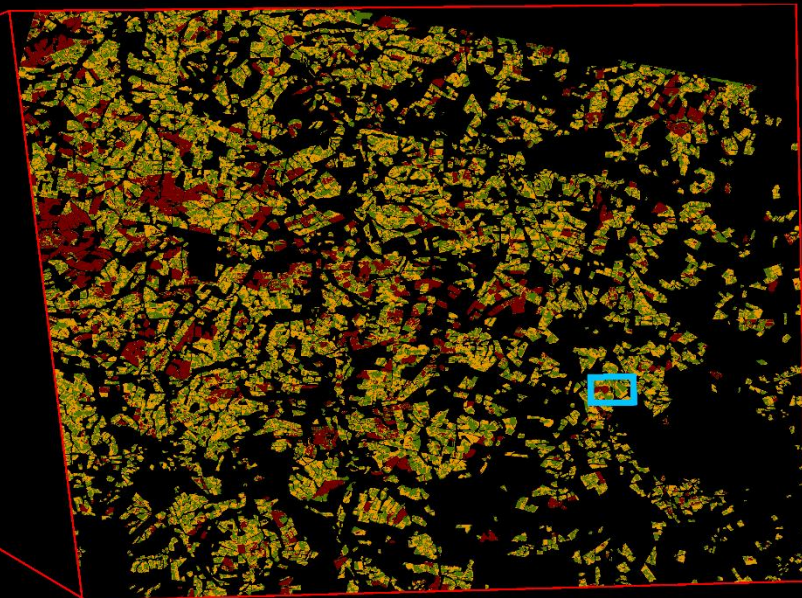
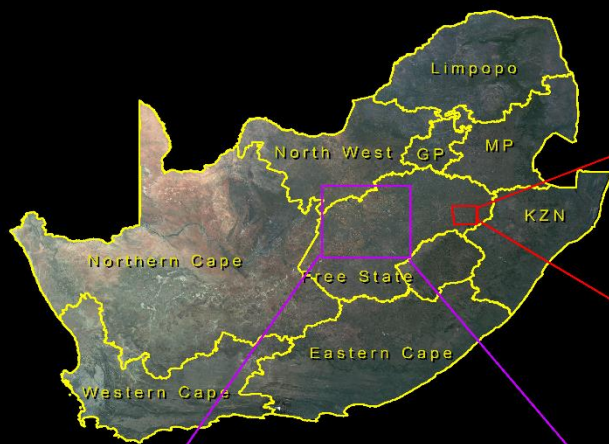
Bothaville: Example of field crop condition/classification



Harrismith: Example of field crop condition/classification



Crop Classification



- Harrismith Site
- Bothaville Site
- Fallow land
- Crop Anomaly
- Heathy crop

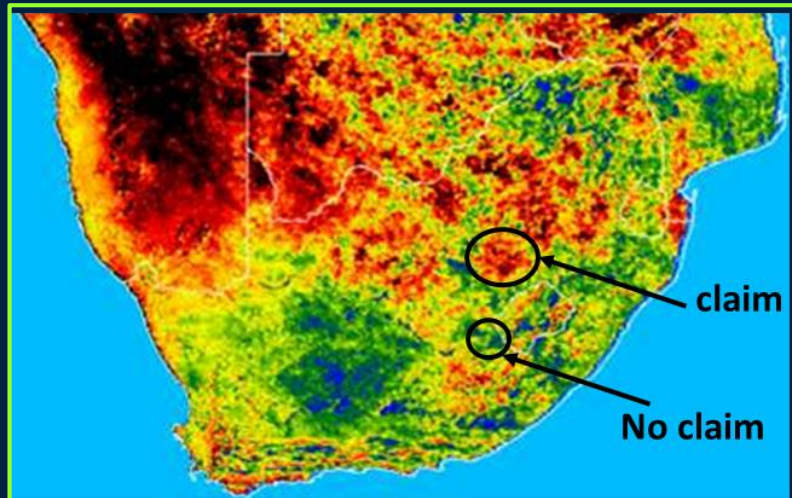
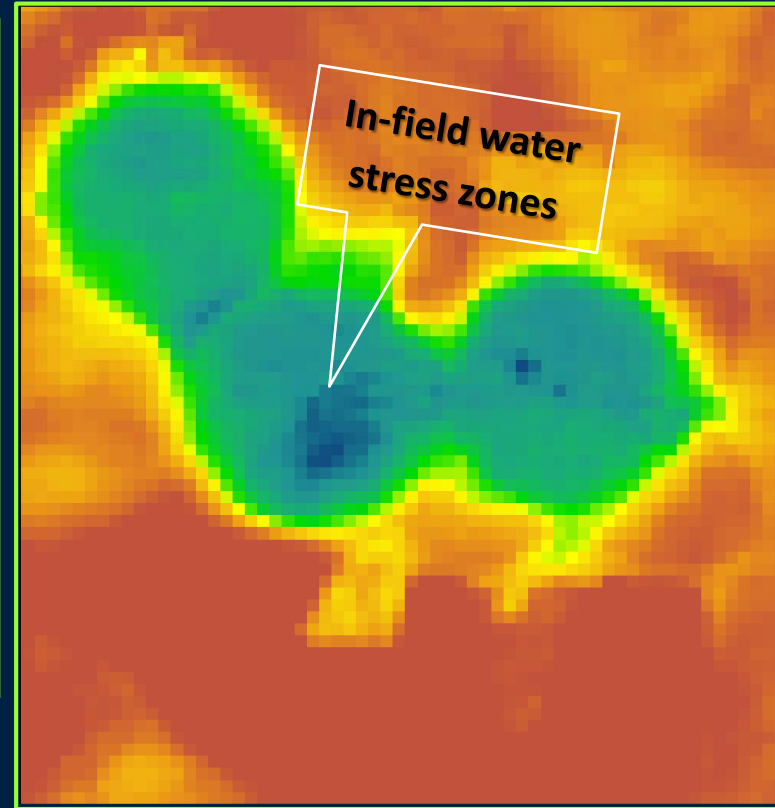
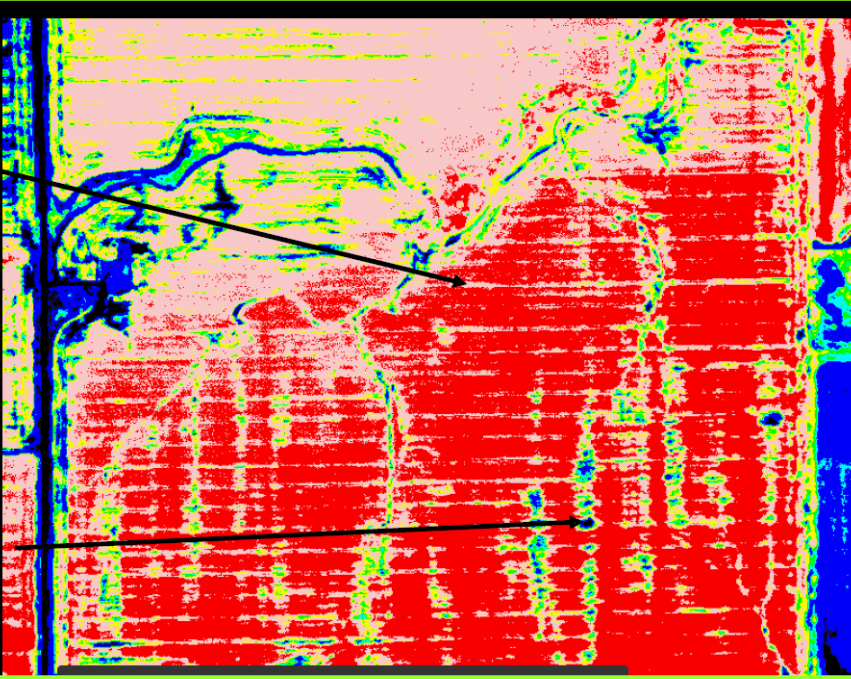


Crop applications

Non-RR
variety

Sprayer
overlap
shorten
plants

Old dead
furrows from
previous
management
Water
collected



Crop insurance

Trait Class	Plant Trait	Index/Method	Applications	Point/ Image	Wavelengths
Pigment constituents	Chlorophyll	NDVI CCCI	.	P	Red, NIR 720 & 790 nm
	Carotenoids	GARI	Chlorophyll concentration/ rate of photosynthesis	P/	550 & 860 nm
Non-pigment constituents	Cellulose	CAI	Bioenergy potential	P	2100 nm
	Nitrogen	NDVI & CCCI	Plant nitrogen status, especially under stress.		670, 720, 790 nm 670 & 770nm; 590 & 880 nm
Photosynthesis	Lignin	Cellulose absorption	Stress, bioenergy	P	.
	Photosystem II activity	PRI	Diurnal radiation use efficiency	P	531 & 570 nm
		Chlorophyll fluorescence	Stress effects on photosynthesis	P/I	.
Water relations	Transpiration or canopy conductance	Canopy temp Crop water stress index	Instantaneous transpiration and hence crop water status	P/I	Thermal IR
		NWI	Crop water status	P	850, 900 & 970 nm
	Canopy water content	NDWI		P	860 & 1240 nm
	Water content	Leaf water thickness	.	P	1300 nm & 1450 nm 1500-1700 nm
Plant Growth	Leaf area index	NDVI	Overall growth	P	Red, NIR
	Plant biomass	NDVI		P	590 & 880 nm; 670 & 770 nm
		NWI		P	850, 880, 920, & 970 nm
Plant Architecture	Canopy Height	Close-range photogrammetry	Light interception, overall growth, lodging resistance	I	Visible or NIR
		Ultrasonic	Canopy height & width	P	(Ultrasonic)
		Depth camera	Canopy height & width, leaf orientation & size	I	Infrared
Phenology	Maturity	Time series of index	Tracking leaf senescence	I	Green, Red
		Time series of fluorescence	Anthocyanin levels	P	
	Flower number	Image analysis	Plant development	I	Visible

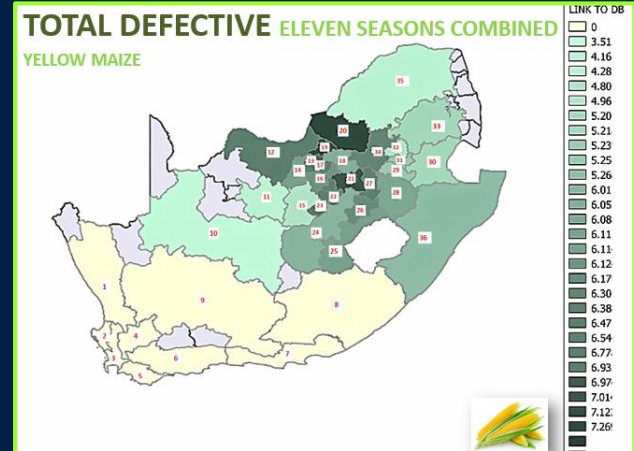
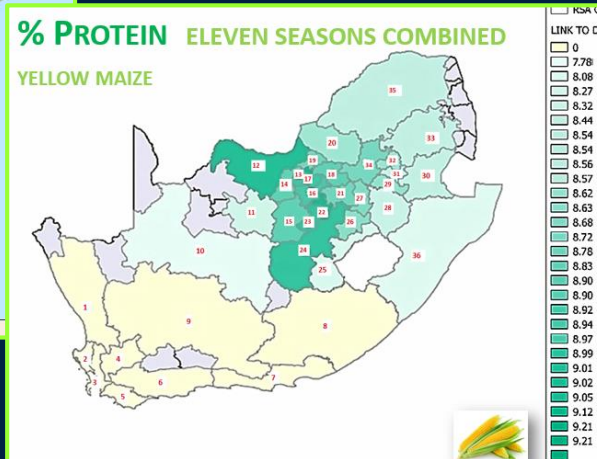
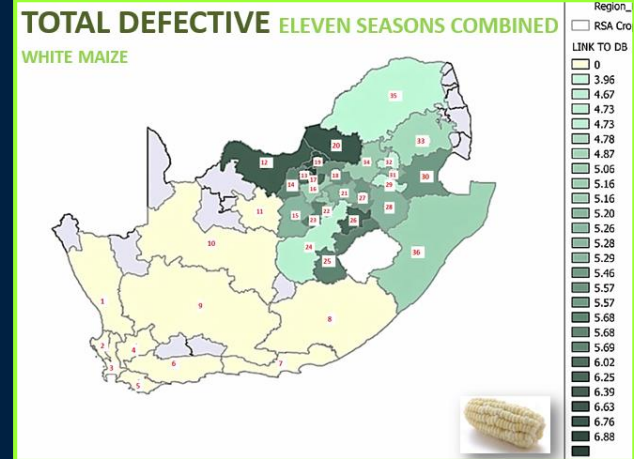
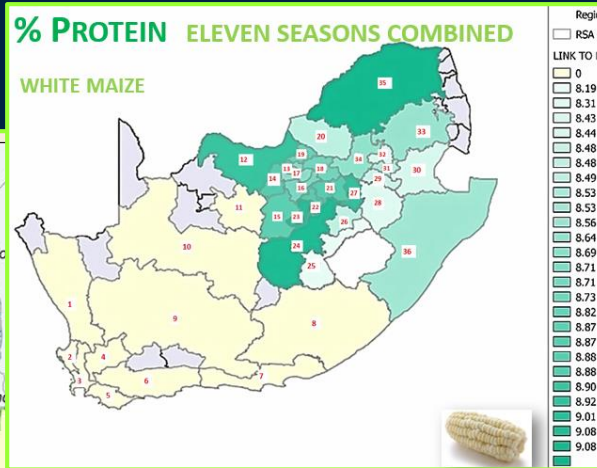
Business applications

End-User	Application
Farmers and cooperatives	Farm level information to optimise productivity
National and provincial departments	Information for compliance monitoring to determine problem areas, disaster management and food security imperatives
Crop insurance companies Satellite-based Index based insurance / micro-insurance	Determine appropriate premiums, verify damage and quantify scope, extent, and magnitude of claims
Financial/lending stock exchange/trading institutions	Crop outlook and risk insurance information

Crop quality information

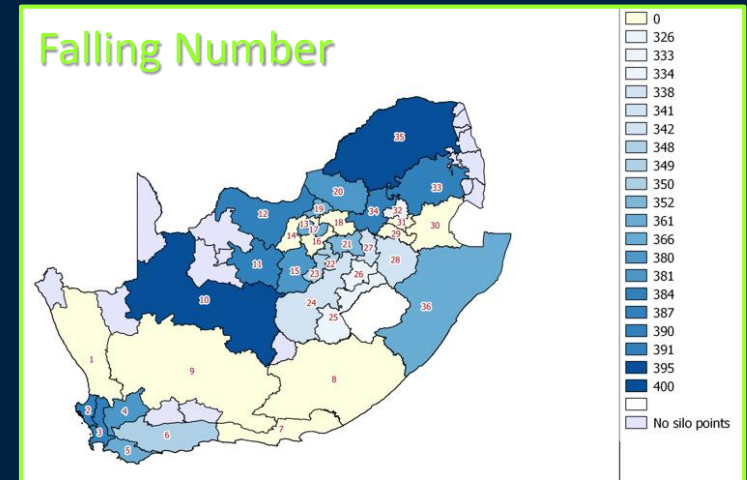
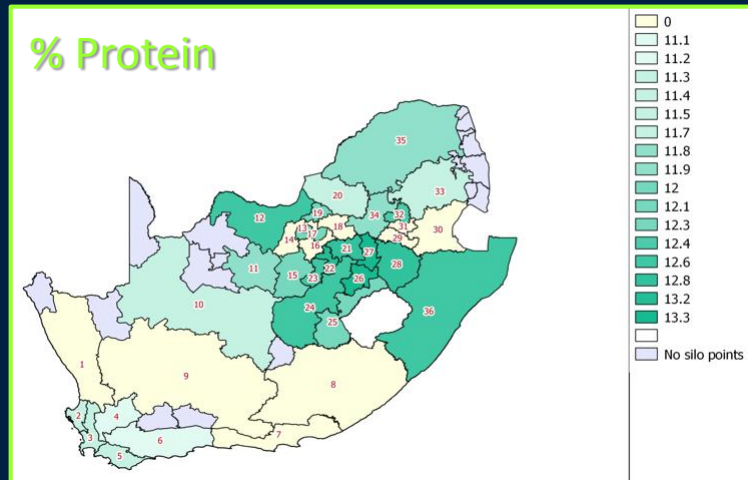
Post harvest

White maize

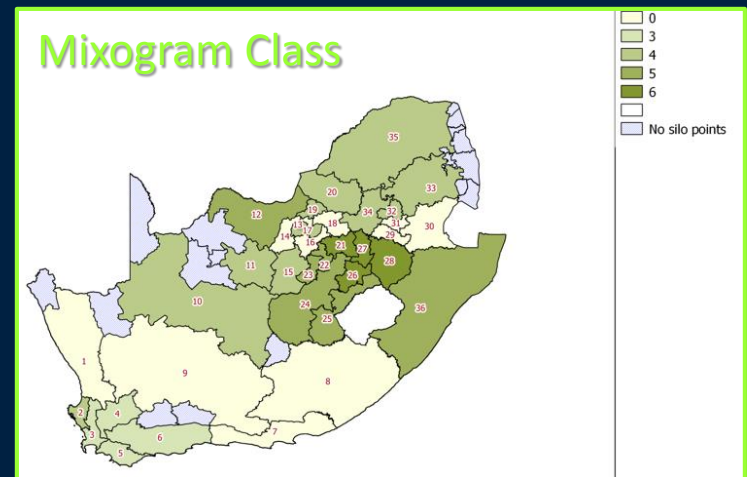
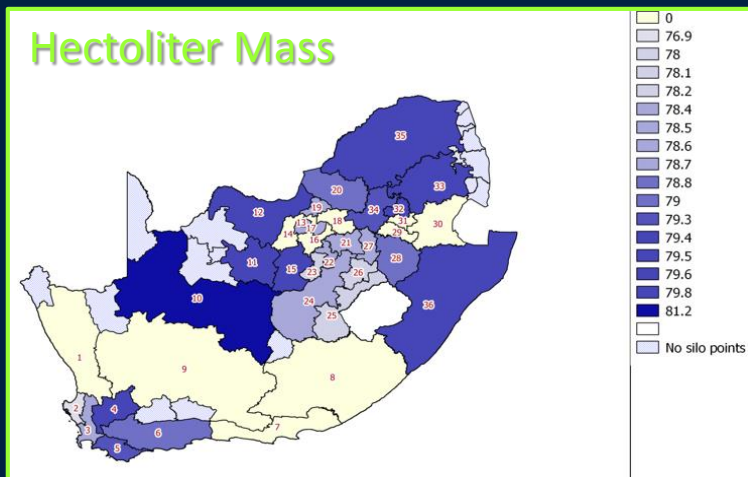


Yellow maize

Crop quality information



Wheat



Big difference between wheat crop quality and maize crop quality.
Maize crop quality is heavily dependent on seasonal variations.
Wheat crop quality is not dependent on season.

Crop quality analysis on delivery

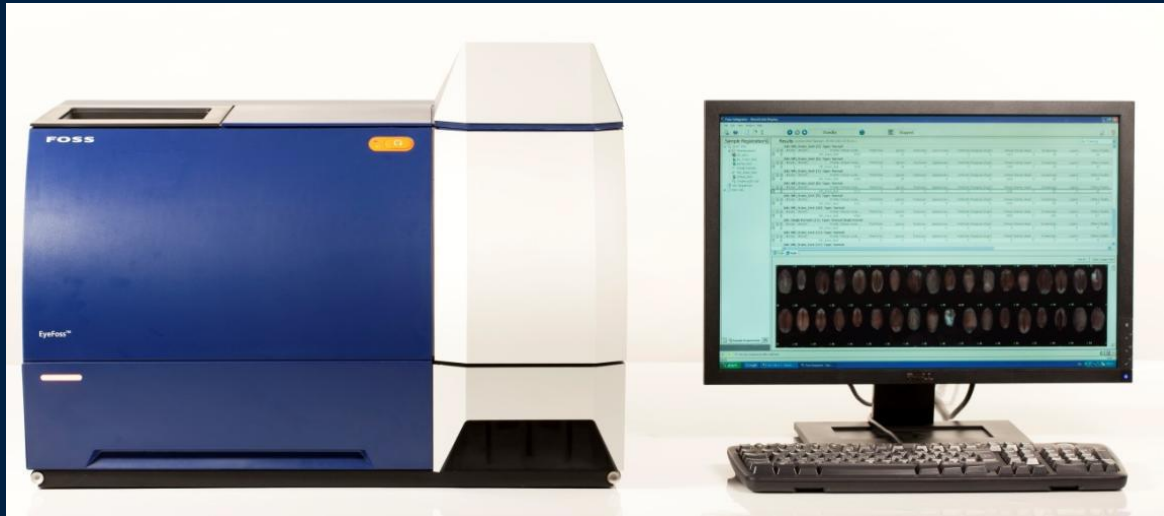


Image Analysis & Spectroscopy on delivery

- Broken grains (BG)
- Grain impurities (GI)
- Sprouted grains (SG)
- Miscellaneous impurities (MI)
- Other cereals present
- Fungi / mildew



True colour image



*Sample image with
mildew area tagged (in
blue) as detected by
Spectral Angle Mapper*

Crop applications

- Timely decision making, asset management
- Data collection about plants, soil & growing conditions
- Close monitoring of plant & livestock health
- Cost saving due to greater precision of inputs
- Economic
- Environmental
- Labour saving
- Unique data
- Flying
- pictures
- Images
- Georeferenced images
- Georeferenced infrared images
- 3d topographical ortho-corrected imagery
- Infrared to NDVI
- 3D topography
- Multispectral or hyperspectral
- Crop Stress
- Data Recording
- Insurance
- Equipment Issues
- Crop Scouting
- Tile Planning
- Land Shaping
- Plant Identification
- Population
- Vegetation Health
- Beyond the Visible Near-Infrared
- Thermal-Infrared
- Single Band Analysis
- Multiple Band Analysis
- 3D information
- Per Plant measurements
- Real Follow-thru on data observations
- Develop Informed Scouting Plan
- Increase Scout Efficiency
- Quantify Issues
- Size and Location of Stressed Area
- Identify Zones
- Create Custom Treatments
- Track Progress of Health
- Compare Plant to Plant
- Historical Records
- Monitor Crop Progression
- Claim Records
- High Resolution Yield Map
- Make Marketing Decisions
- Plan Harvest Logistics
- Anticipate Insurance Claims
- Topographic Surveys
- Estimate Water Shed
- Estimate Cut/Fill
- Recreate 3D Imagery
- Measure Crop Canopy (hail, wind damage)
- Evaluate Crop Stage vs. Height
- Identify Field Features
- Biomass Estimations
- Filter Colour and Elevation
- Identify Objects
- Count Objects
- Calculate Spatial Density
- Time series analysis (reflectance)
- Mapping crop stress (nutrients, water, pests) and yield prediction
- Invasive species detection and monitoring
- Crop mapping/GMO identification/phenotype studies
- Water quality evaluation (suspended solids and chlorophyll)
- Integration of local and large scale DEMs
- Biomass estimation
- Large area
- High resolution (25cm – 100cm)
- Modular
- Proven Technology
- Low cost of operation
- High resolution (4 – 10cm)
- Highly deployable
- Modular (NIR or Visual camera)
- Survey Control & Accuracy

Tech-enabled business trends

Trend 1: Distributed co-creation moves into the mainstream

Trend 2: Making the network the organization

Trend 3: Collaboration at scale

Trend 4: The growing 'Internet of Things'

Trend 5: Experimentation and Big Data

Trend 6: Wiring for a sustainable world

Trend 7: Imagining anything as a service

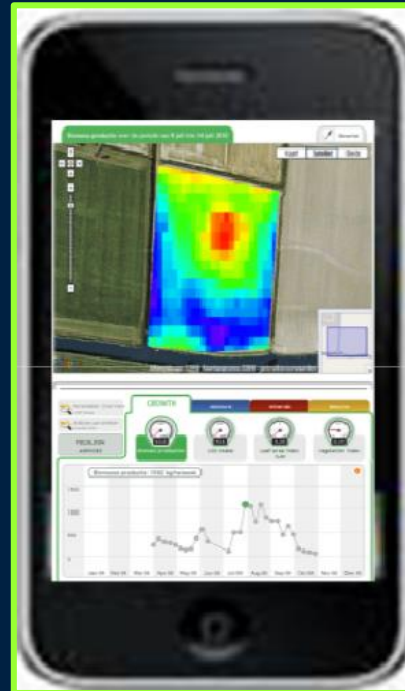
Trend 8: The age of the multisided business model

Trend 9: Innovating from the bottom of the pyramid

Trend 10: Producing public good on the grid



FUTURE: Field robots & UAV



agbiz GRAIN

Thank you

www.agbizgrain.co.za

