Yield estimate in the operational Crop Monitoring System
And
The contribution of Sen2Agri products (10m NDVI & LAI)

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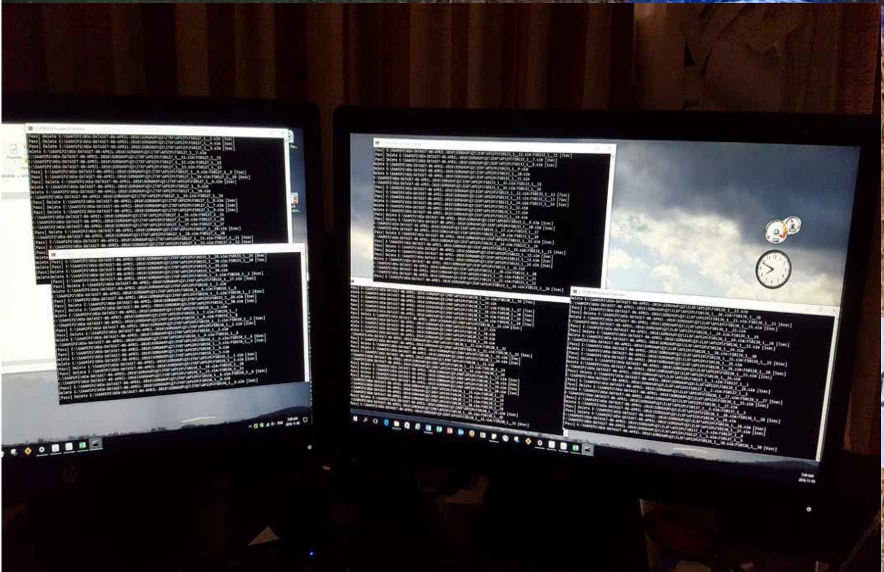

Yield estimation currently done in the operational crop monitoring system

	AREA	YIELD	PRODUCTION
A line	NCSC: PICES Telephonic (subjective) survey	NCSC: Objective yield	SAGIS (end of season)
B line	DAFF	Crop-Modelling (IDSS-YES)	SANSOR
C line	Agric Risk Specialists DPO Fertiliser Companies	Financial Institutions Forums Agbiz-grain	PDAs SACOTA Traders/ Reports

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Objective Yield Survey

Maize

Three Provinces:
- Mpumalanga (April)
- Free State
- (May)
- North West
- (May)

700 Fields

Use 20 Numerators

Wheat

Two Provinces:
- Western Cape (September)
- Free State (October to November)

660 Fields

Use 15 Numerators

The objective of the NCSC is to determine the yield of a **Province** not a field !

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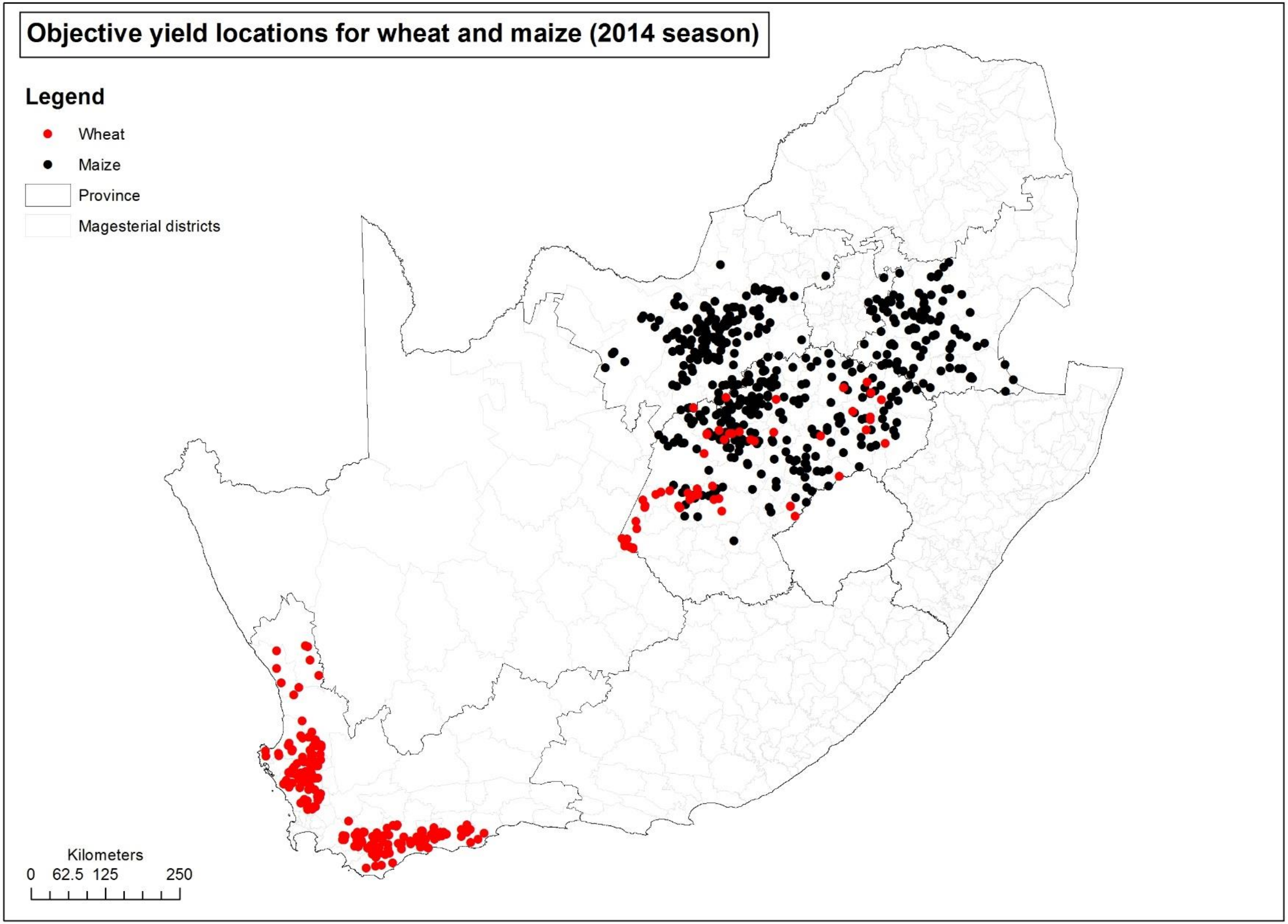
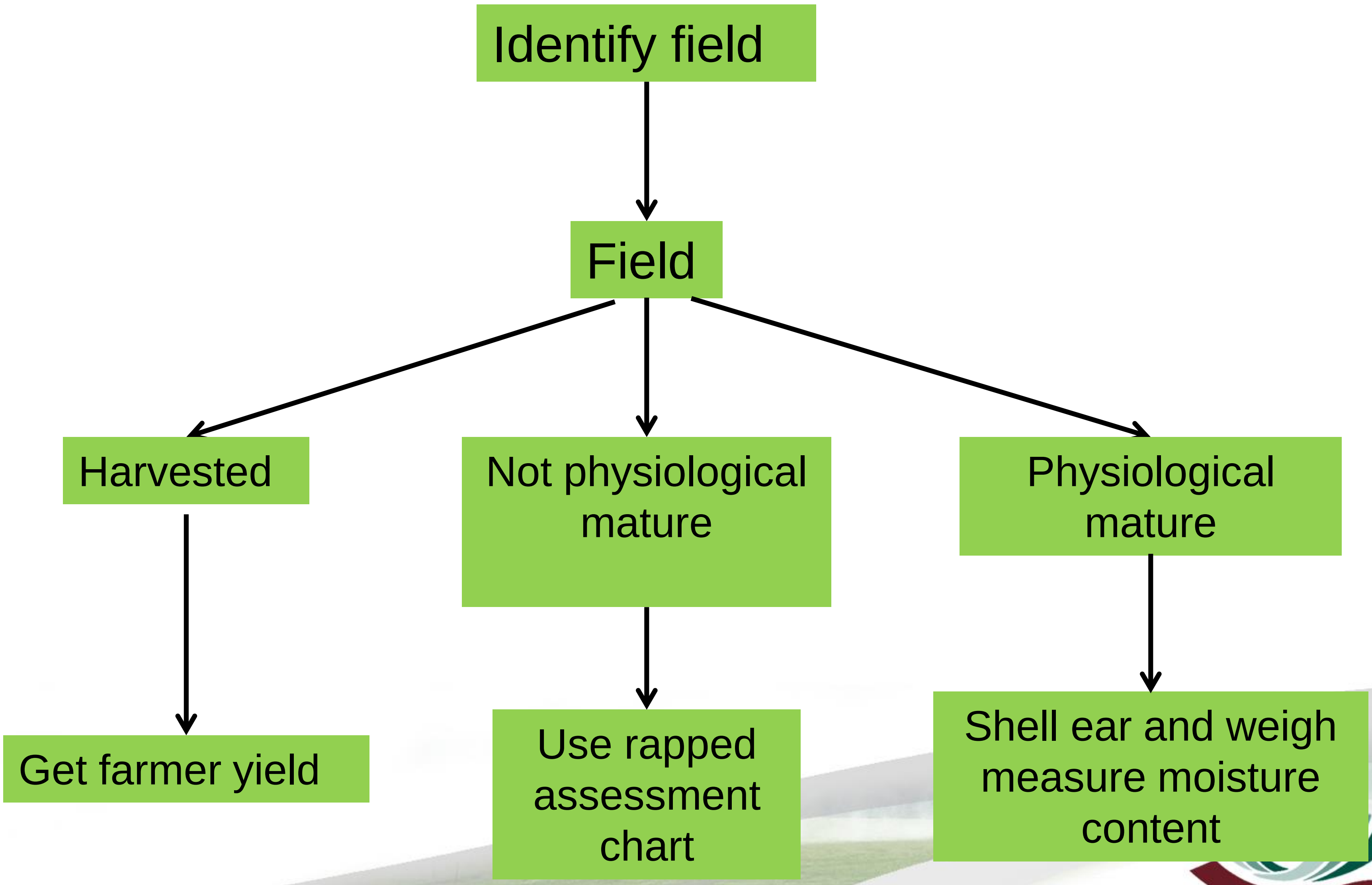

Objective yield locations for wheat and maize (2014 season)
Legend
Wheat
Maize
Province
Magesterial districts
Kilometers
0 62.5 125 250

Objective Yield Survey – Steps - Maize



Rapped Assessment Method

- First Point of Entrance
  - Walk random number of Steps along the Field
  - Walk random number of of Steps in to the Field
- Record the GPS Coordinates
- Measure the Row Width
- Measure 10 Meters along a row
- Count the number of Ears over 10 m
- Count the number of Plants over 10m

Rapped Assessment Method

Maize at Physiological Maturity:

- Harvest the AVG Ear (11 Ears)
- Count the Kernel Rows
- Count The Kernels per Row
- Place Ear in Plastic Bag
- Mark Plastic Bag
- GPS Number
- Point Number

Measure:

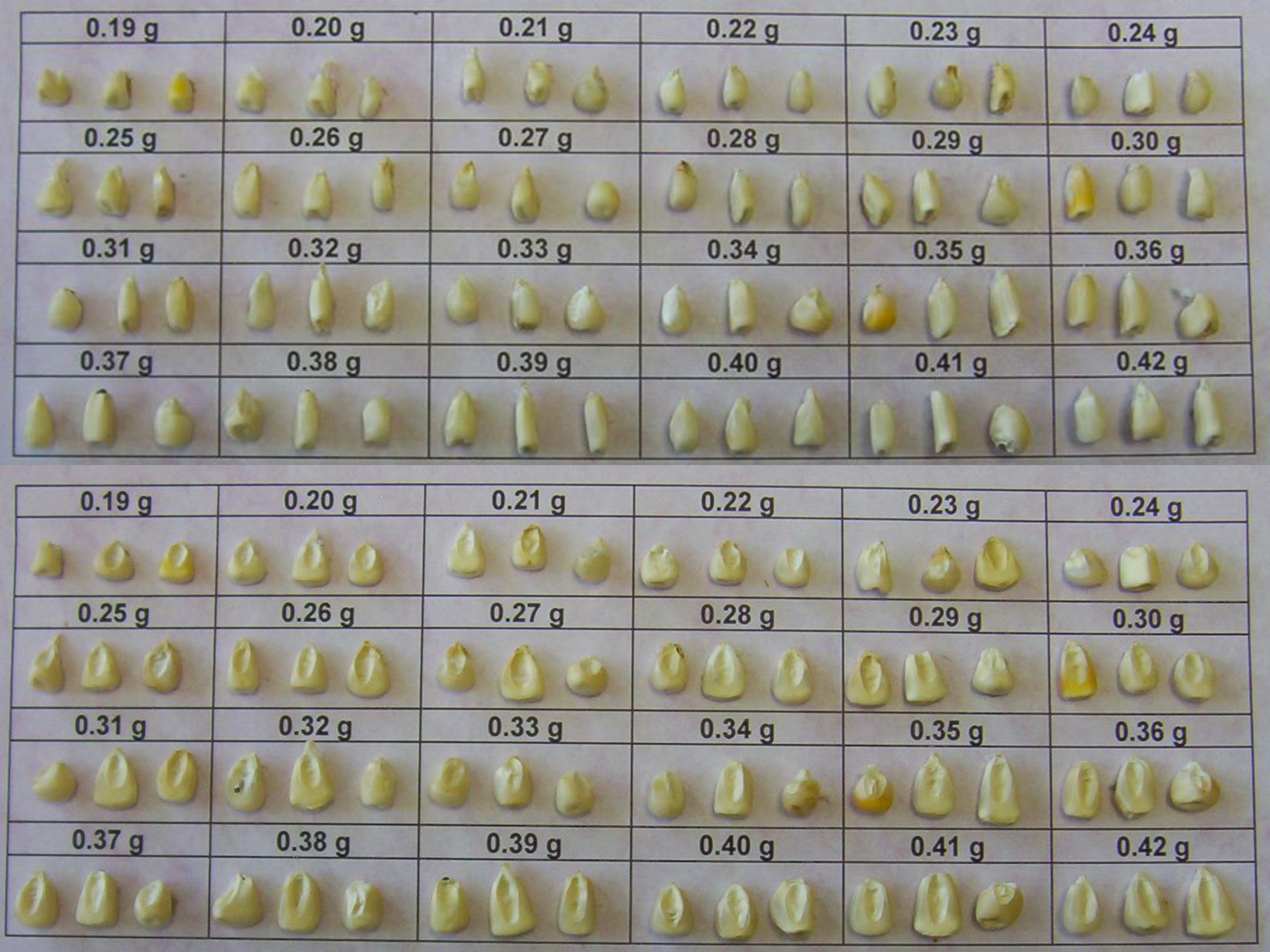
- Moisture Percentage (< 30%)
- Grain Mass


A
6
etrex

Rapped Assessment Method

Maize before Maturity:

- Harvest the AVG Ear (11 Ears)
- Count the Kernel Rows
- Count The Kernels per Row
- Harvest average kernel
- Compare to chart
- GPS Number
- Point Number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After the Survey

- After survey data gets quality checked (human error).
- Formulas applied to calculate yield.
- Summarized to provincial level.

- Results are passed on to Crop Estimates Committee.

Methodology also suitable to establish own yield for field/farm

Yield estimates using a crop model

- **Crop models in some or other form have always been part of the maize crop estimates system.**
- **The initiative to use crop models for large area estimates was started in 1982/83 by evaluating the South African PUTU model and the CERES-maize model (De Vos and Mallett, 1987).**
- **Since 1995 the CERES maize model has been used for drought monitoring and forecasting of maize yields in the Free State Province (van den Berg and Potgieter, 1997; van den Berg and Manley, 2000).**
- **Since 2001, the CERES-maize model, which is now known as the Crop Systems Model (CSM) of DSSAT is used to estimate maize yields for six to eight provinces.**

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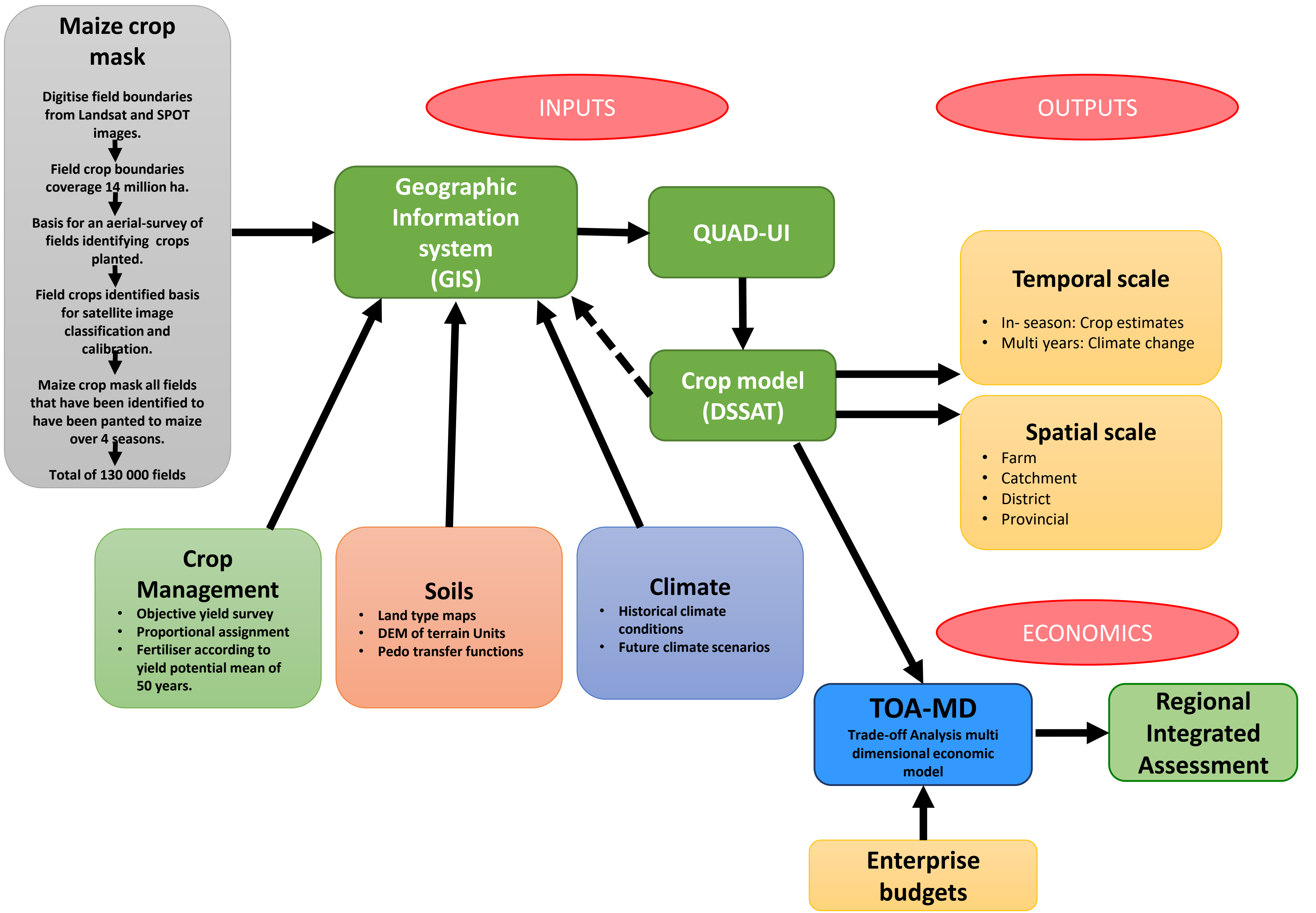
Framework

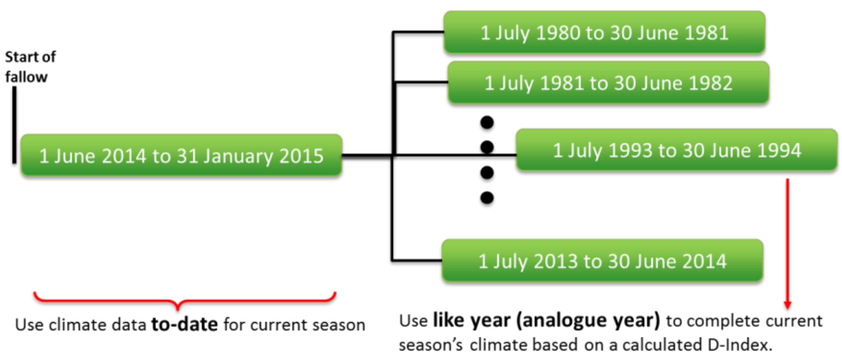


Maize crop mask
Digitise field boundaries from Landsat and SPOT images.
Field crop boundaries coverage 14 million ha.
Basis for an aerial-survey of fields identifying crops planted.
Field crops identified basis for satellite image classification and calibration.
Maize crop mask all fields that have been identified to have been panted to maize over 4 seasons.
Total of 130 000 fields
INPUTS
OUTPUTS
Geographic Information system (GIS)
QUAD-UI
Crop model (DSSAT)
Temporal scale
In- season: Crop estimates
Multi years: Climate change
Spatial scale
Farm
Catchment
District
Provincial
Crop Management
Objective yield survey
Proportional assignment
Fertiliser according to yield potential mean of 50 years.
Soils
Land type maps
DEM of terrain Units
Pedo transfer functions
Climate
Historical climate conditions
Future climate scenarios
ECONOMICS
TOA-MD
Trade-off Analysis multi dimensional economic model
Regional Integrated Assessment
Enterprise budgets

Climate: Input

Short term predictions (in season)

Single season up-to-date and projected climate using an analogue model (Crop estimates)



Climate data for the season to date

Historic climate data base

Results submitted to the CEC
February to May
8 Provinces

Long term predictions (climate change)

Two historic climate data sources were used:

- **National scale**: Data from the University of KwaZulu-Natal. Based on quinary catchments (1950-1999) used 1980-1999.
- **AgMERRA**: Climate Forcing Datasets for Agricultural Modelling, NASA. Used 2000-2010.

Future climate data based on Global Circulation Models (GCMs) with no downscaling using mean and Daily Variability as the future creation method.

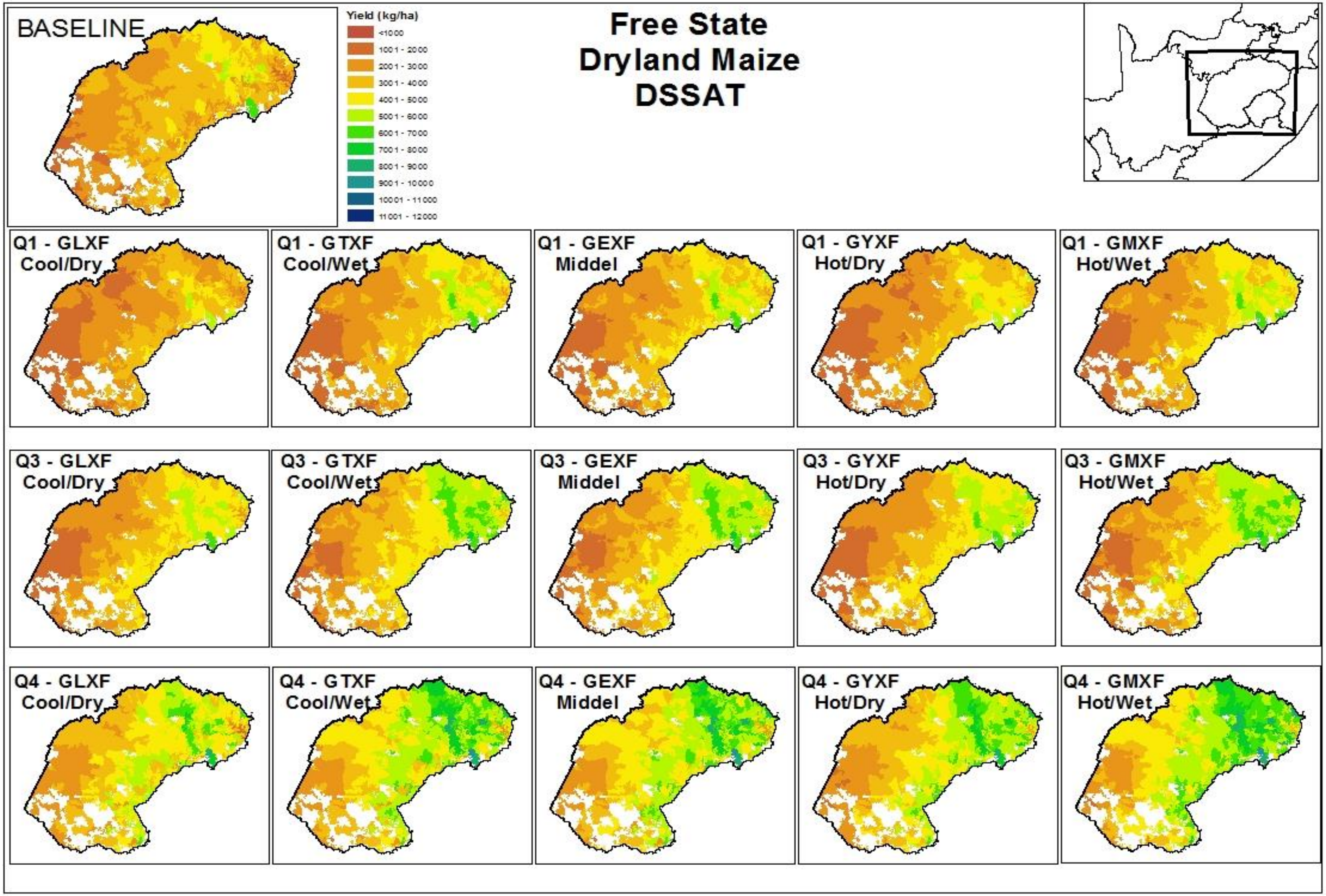
Data contained daily:

- minimum and maximum temperature,
- precipitation and
- solar radiation.

Historical Climate Conditions
1980-2010
CO_2 360 ppm

Future Climate Scenario's
2040-2070
CO2 571 ppm
RCP 4.5 and 8.5

- GCM's: CCSM4, IPSL-CM5A-LR, IPSL-CM5A-MR, NorESM1-M and HadGEM2-AO.
- Mid-century (2040-2070) under RCP4.5 and 8.5.
- Baseline CO_2 level 361 ppm and future 571 ppm.



Average maize yield (kg/ha) per quinary catchment for each of the 5 climate scenarios for Q1 (RCP4.5), Q2 (RAP4) and Q3 (RAP4 & Adaptation) modelled using DSSAT.

How Sen2Agri products (LAI and NDVI) can assist in spatializing/estimating yields across South Africa.

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Objective yield surveying (OYS)

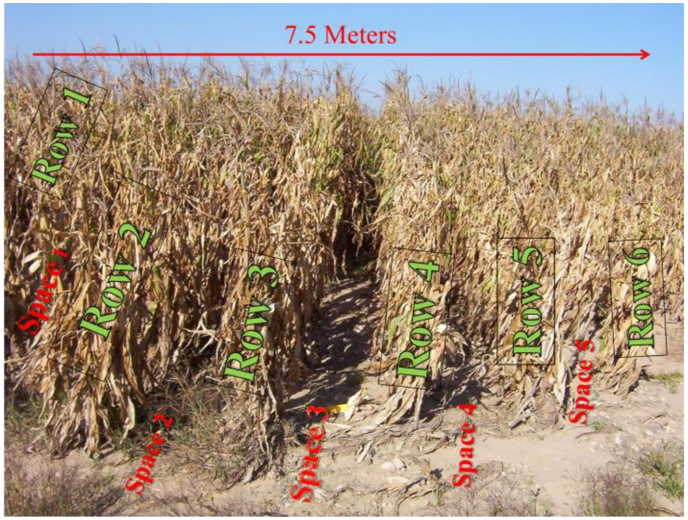
Physical in-field measurements of crop yield parameters

Positive:

- Most accurate method
- Data collected can be used for "ground truthing"

Negative:

- Expensive
- Time consuming
- Limited number of locations can be sampled
- No forecasting – only near end of season

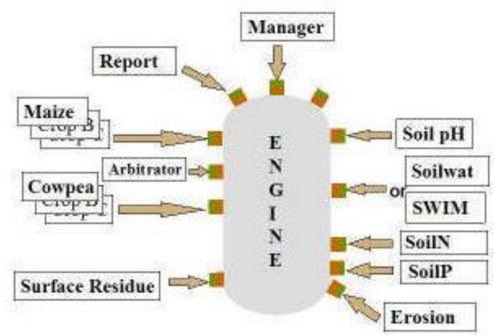


Crop Modelling

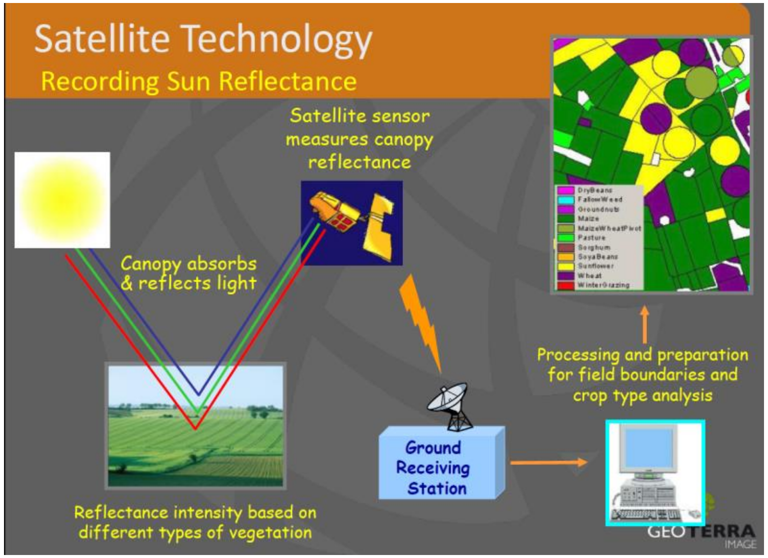
Simulation of crop yields using simulation models

Positive:
- Once set up easy to execute (calibration)
- No spatial restrictions
- Most crops have some or other crop model
- Almost an unlimited number of simulations can be made
- “What if” scenarios can be analysed
- Climate forecast can be applied

Negative:
- Requires detailed soil information (i.e. depth, soil water holding capacity, organic C, etc.)
- Requires plant management information (planting date, fertiliser use, row width, plant population, surface residue, etc.)
- Requires crop phenology information (flowering date)
- Requires up-to date climate information
    - Minimum and maximum temperature
    - Rainfall
    - Solar radiation



Remote sensing



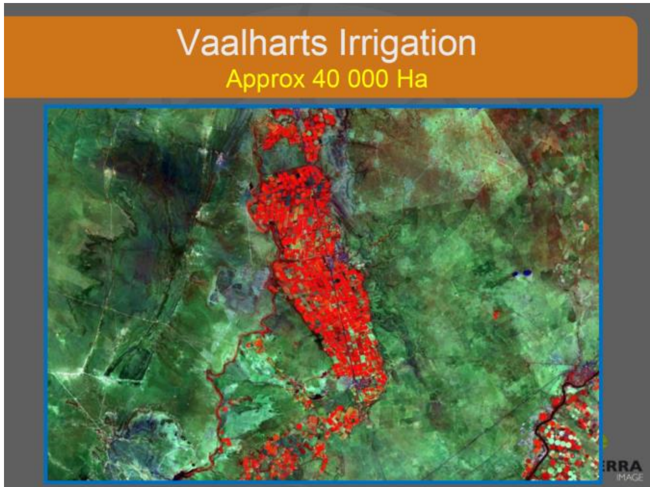
Using satellite images to calculate yield

Positive:

- Once set up easy to execute (calibration)
- No spatial restrictions

Negative:

- Cloud cover
- Training to identify the small fields and crops
- Require "ground thruthing" data for calibration
- Resolution of pixel and time interval between satellite orbits
- Forecasting?



How Sen2Agri products (LAI and NDVI) can assist in spatializing/estimating yields across South Africa.

Each of the methods have their own strengths and weaknesses.

Solution:

Combining the strengths of each method to strengthen the other:

- Objective yield survey for "ground thruthing" data for satellite imagery.
- Objective yield survey for information on crop management for crop model.
- Satellite imagery for information on planting date (planting densities) for crop model inputs.
- Satellite imagery for survey planning e.g. Objective yield survey.
- Satellite imagery to develop crop masks (crop type classification) for crop yield modelling.
- Crop models calculated LAI can be used to verify Sen2Agri products.
- Crop model yield estimates can be used to verify yields based on NDVI's.

- The Sen2Agri products are useful to **upscale** point based crop models and calculate yields at different scales.
- The Sen2Agri products can assist in **increasing** the yield **accuracy** of the current crop yield forecasting system.

Thank You