# Multi-spectral, High Resolution Remote Sensing Imagery in Agricultural Management and -Sciences

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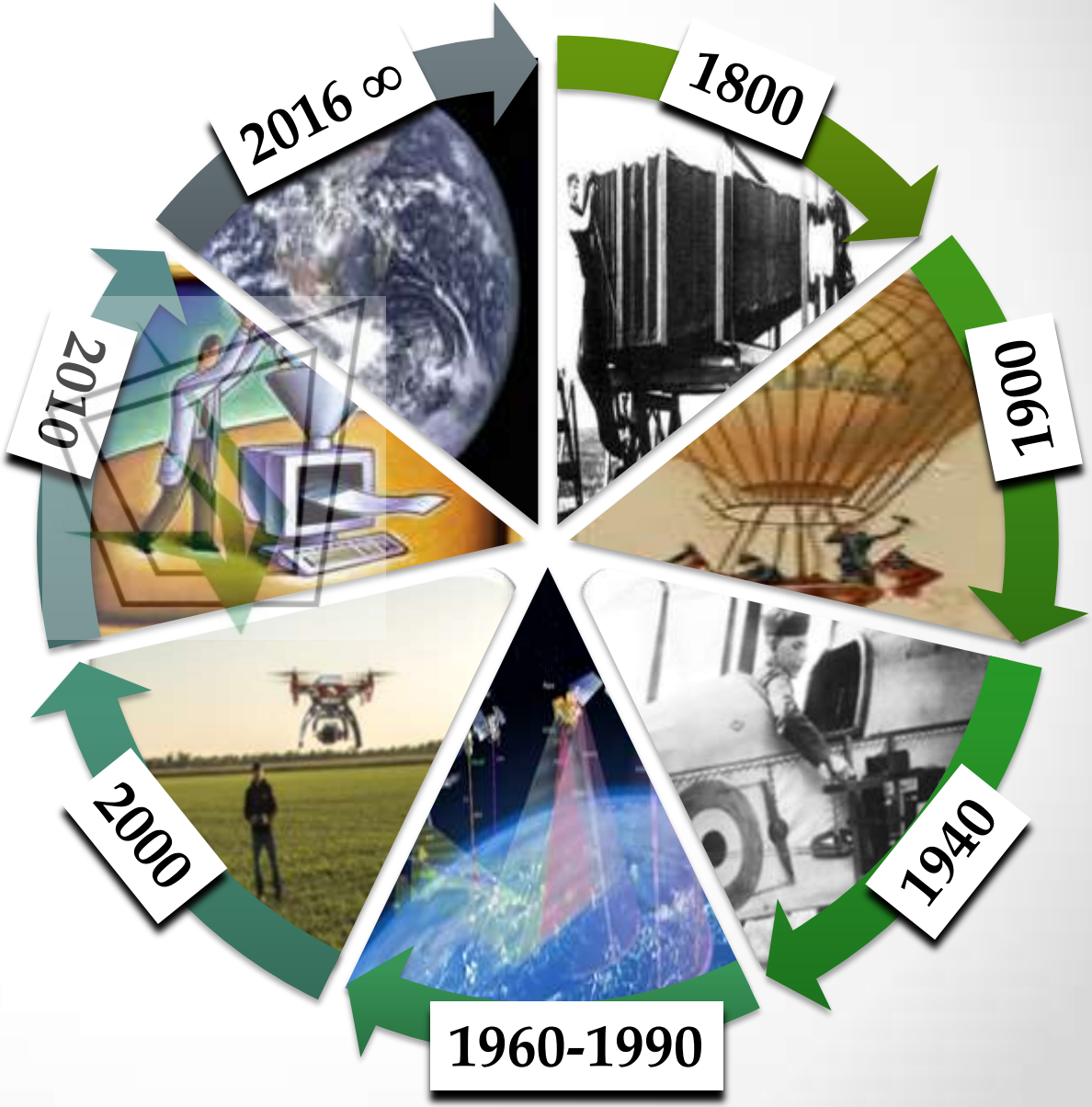
agriculture, land reform & rural development

Department:
agriculture, land reform & rural development
NORTHERN CAPE PROVINCE
REPUBLIC OF SOUTH AFRICA

# Remote Sensing Technology

- Remote sensing/earth observation technologies are evolving at a rapid rate;
- Better resolution available from satellites;
- Imagery more accessible but expensive.



# Remote Sensing in Agriculture

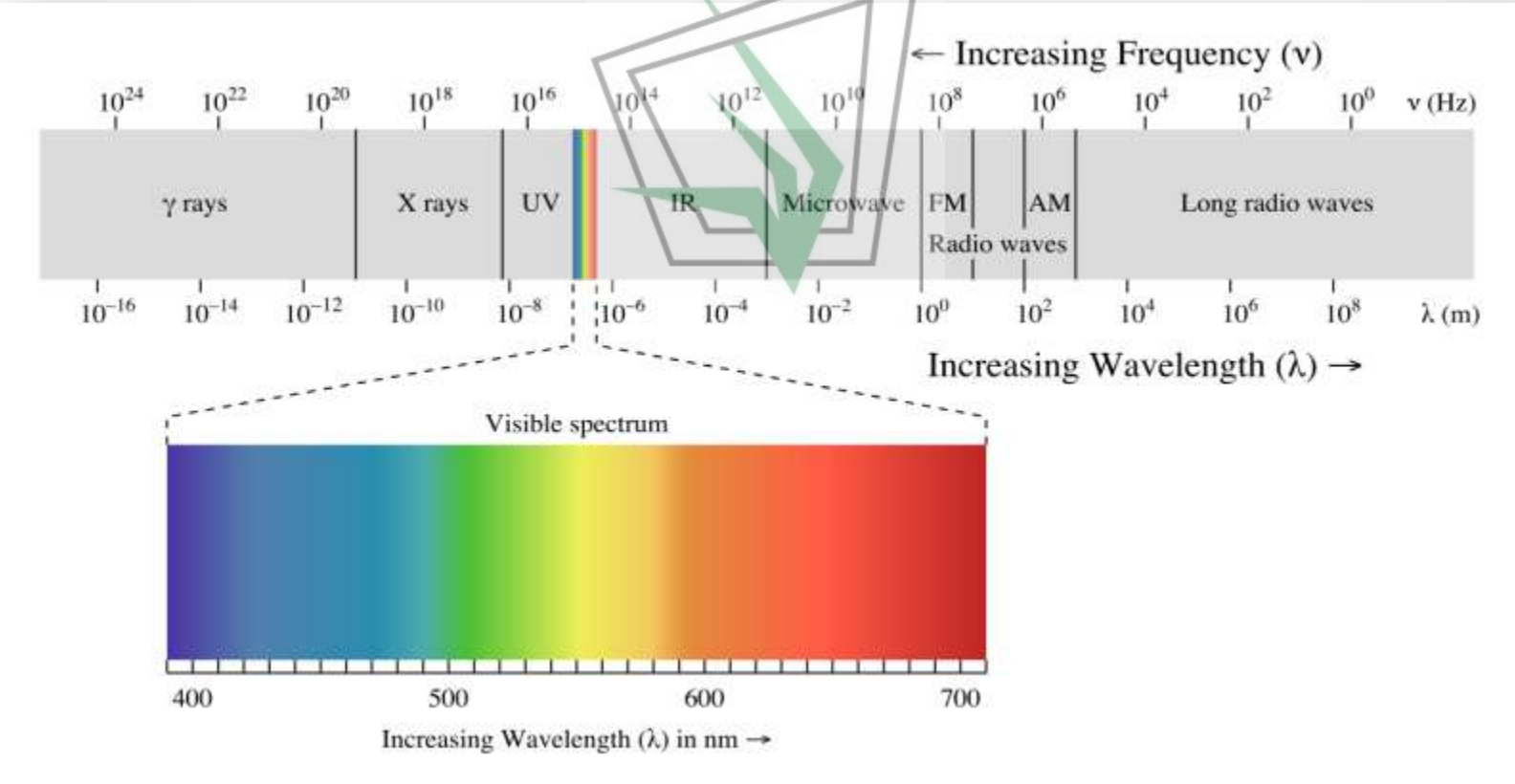
- Nature and scale of agriculture makes remote sensing an ideal tool for monitoring management inputs and response:
  - Activities are carried out over large spatial regions;
  - Agriculture is strongly affected by anthropogenic activities and management;
  - Timely and accurate monitoring information is required;
    - Remote sensing is accurate and geo-referenced;
    - Fast output of results;

# Remote Sensing in Agriculture

- Crop and species classification;
- Vegetation cover/plant population;
- Vegetation condition;
  - Stress, health, nutrient status;
- Yield/productivity.

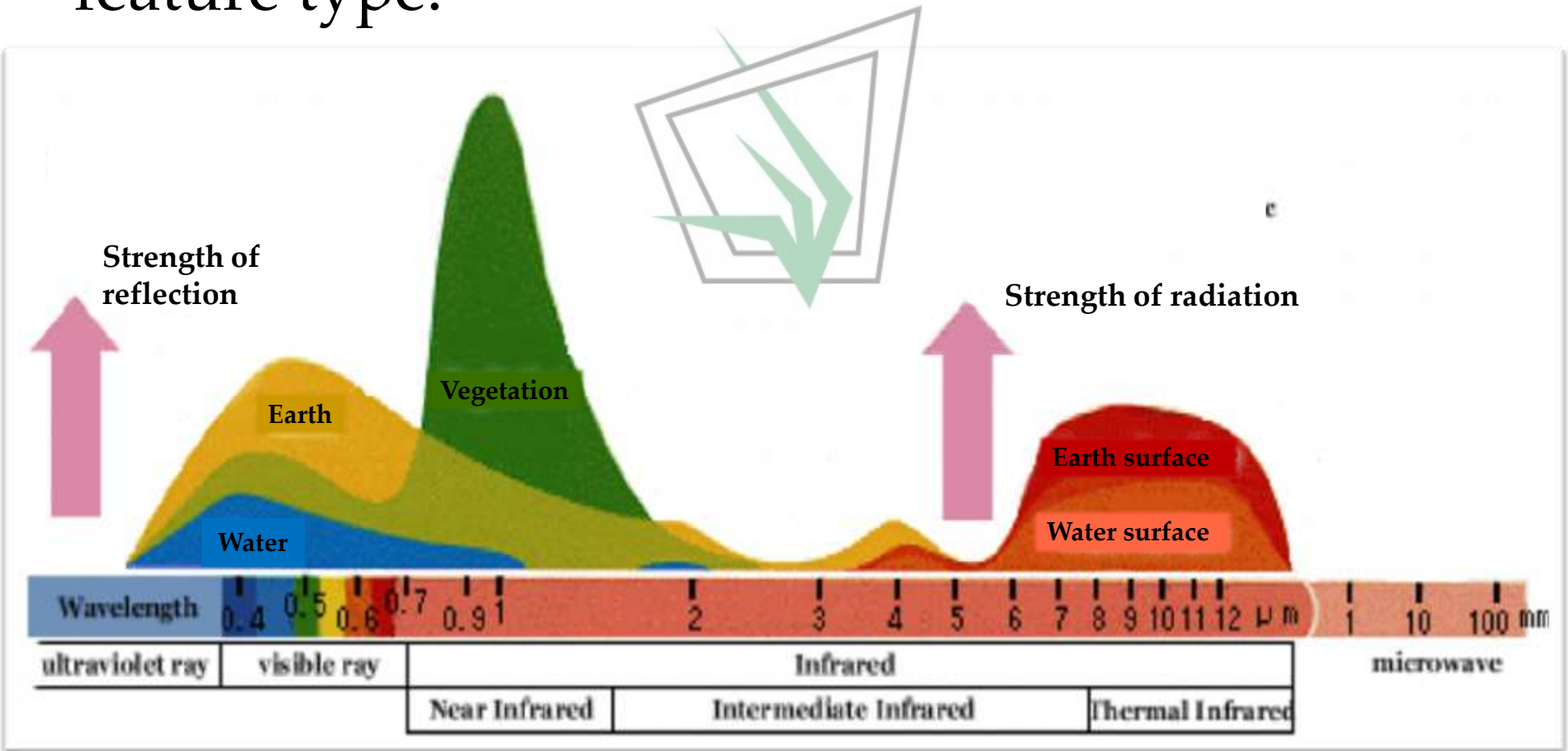
# Remote sensing – Vegetation monitoring

- Utilises vegetation's **reflectance pattern** of light, that was absorbed from the electro-magnetic spectrum (EMS).



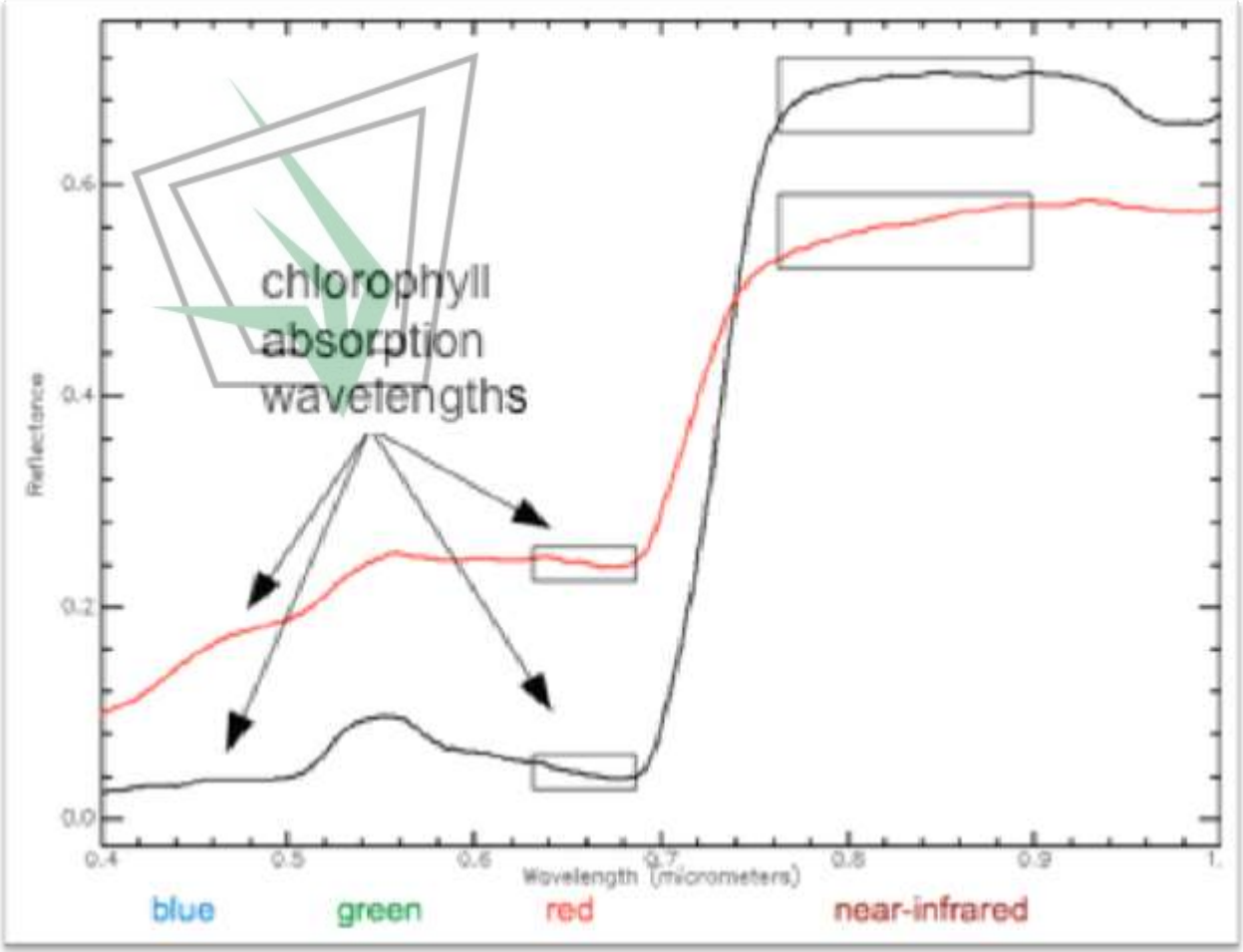
# Spectral signatures

- The reflection pattern is known as a spectral signature and is unique for each plant specie or feature type.



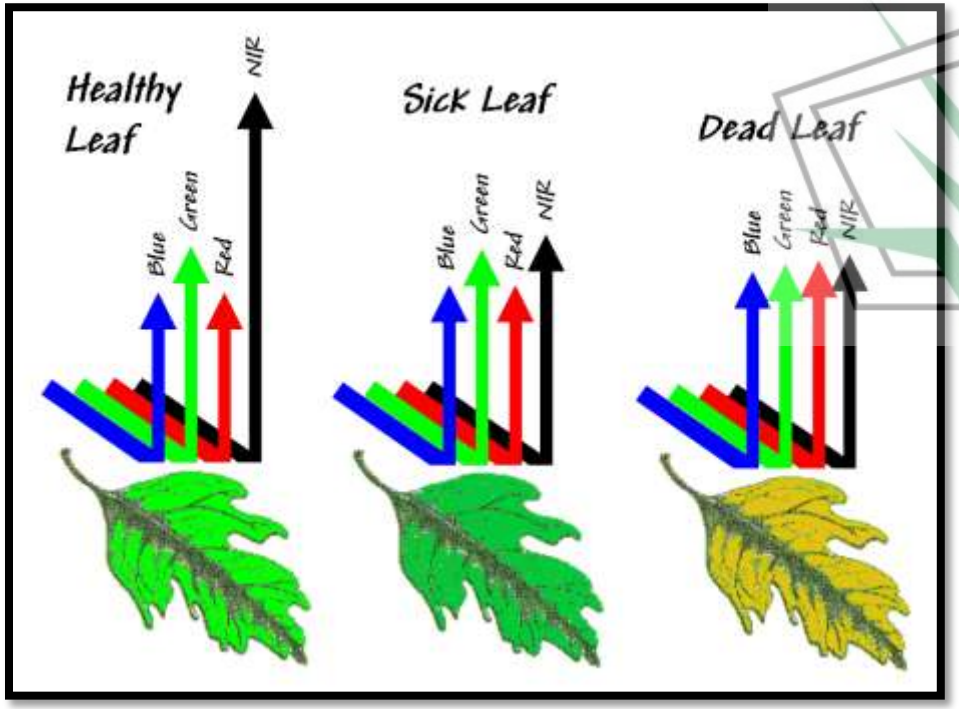
# Spectral signatures

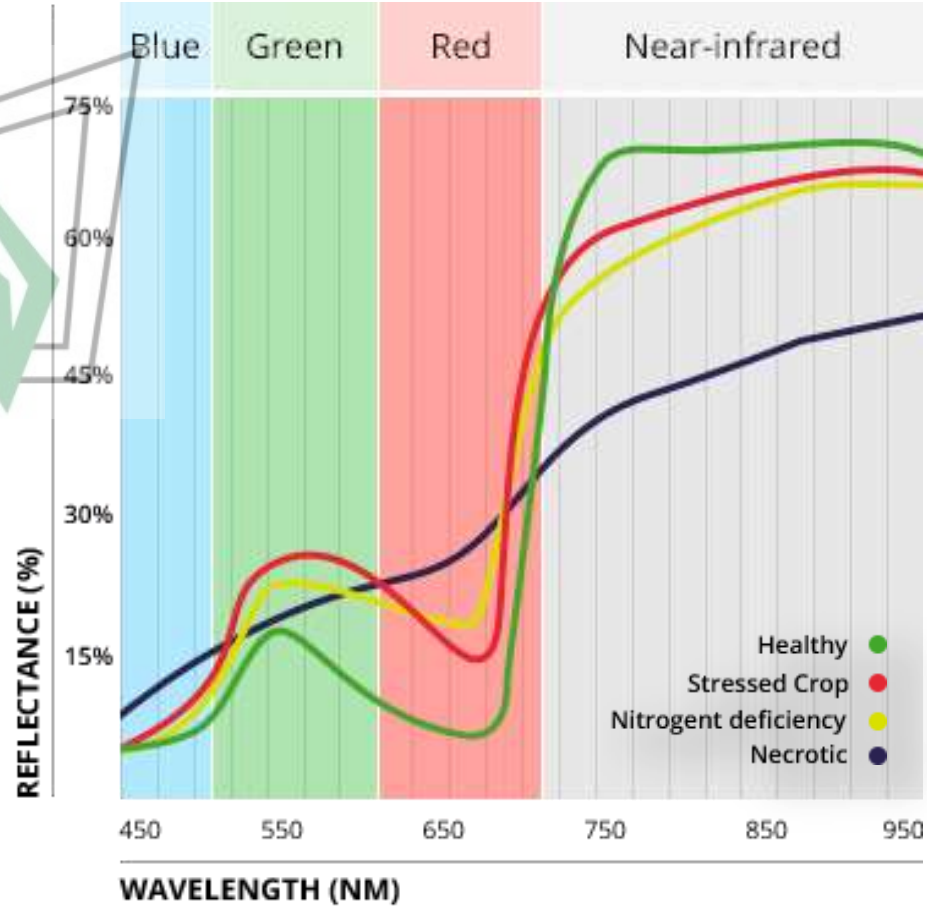
- Reflectance of vegetation is very low in the blue and red regions of the EMS;
- Slightly higher in the green region and;
- High in the near infra-red region.



# Spectral signatures

- Lower chlorophyll in vegetation will lead to lower absorbance of light in the red region with subsequent higher **reflectance**.

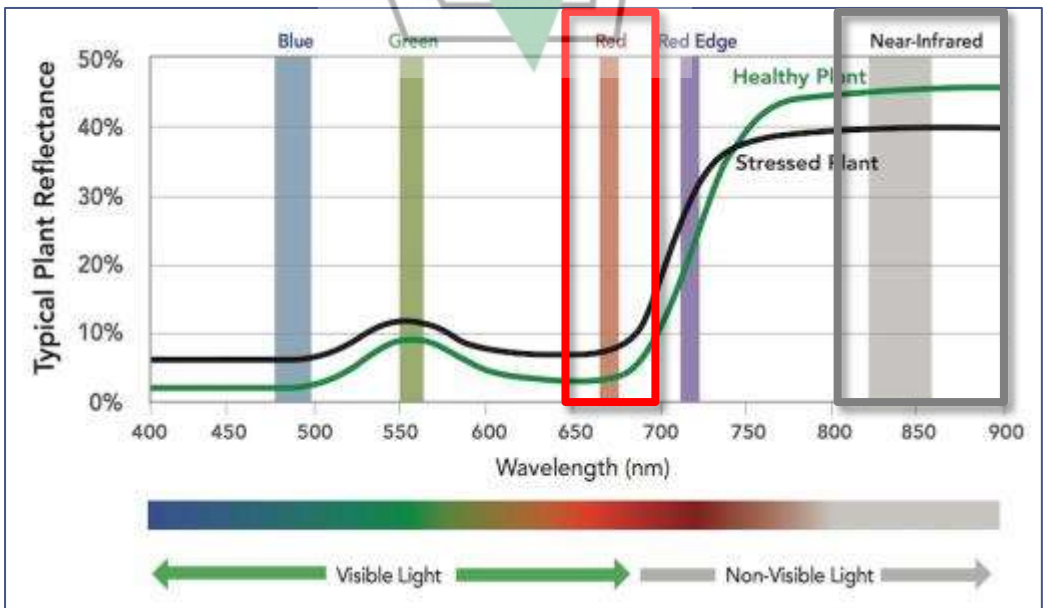


# Vegetation condition indices

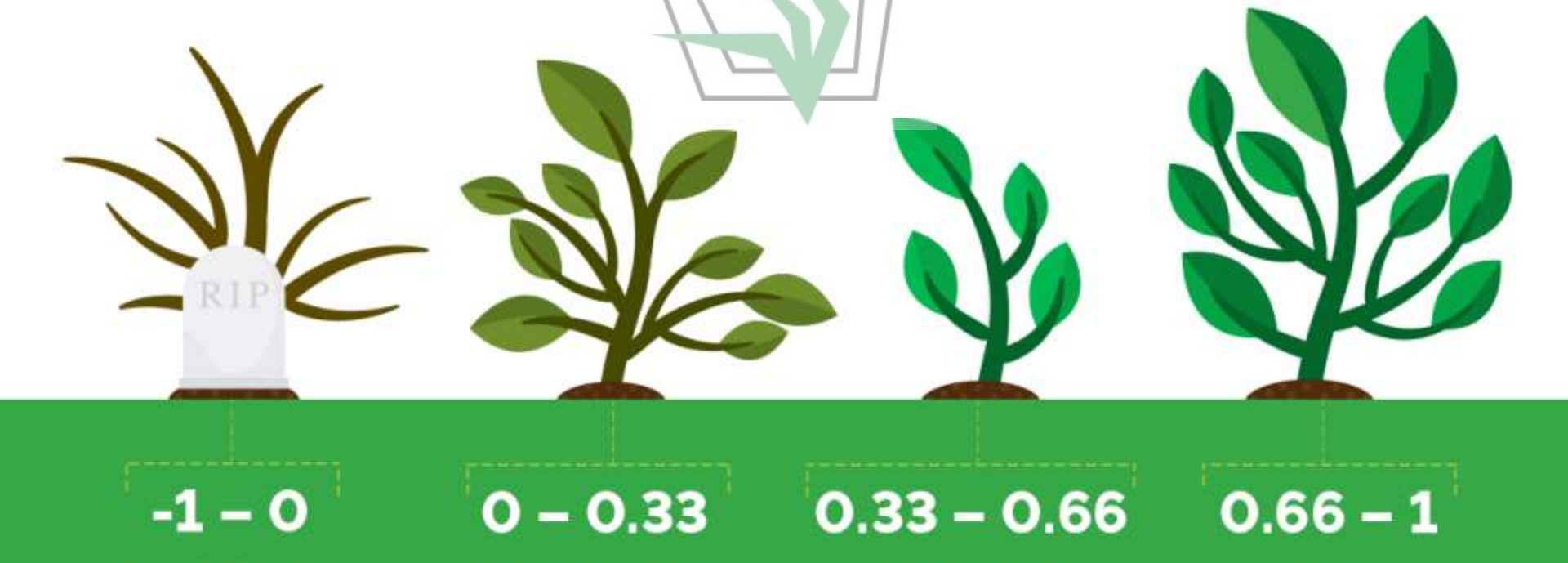
- Many indices can be calculated from spectral reflectance values;
- Normalized Difference Vegetation Index (NDVI) is widely used.

$$NDVI = \frac{NIR_{(\lambda = 700–1300\ \mathrm{nm})} - R_{(\lambda = 550–700\ \mathrm{nm})}}{NIR_{(\lambda = 700–1300\ \mathrm{nm})} + R_{(\lambda = 550–700\ \mathrm{nm})}}$$



# Vegetation condition indices

- NDVI value between -1 and 1
  - An NDVI close to 0 corresponds to no vegetation, water or man made object.
  - NDVI value close to +1, indicates the highest possible density of green leaves.



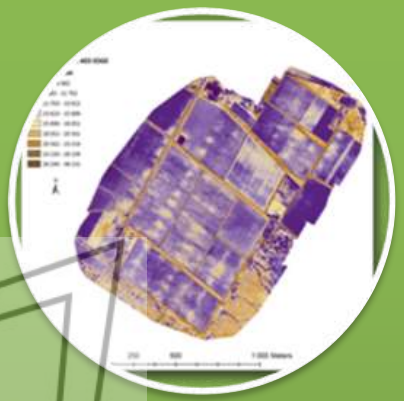
# Workflow

Define study area


Image processing

Analyses of spectrum of reflected light

Algorithms (e.g. NDVI)

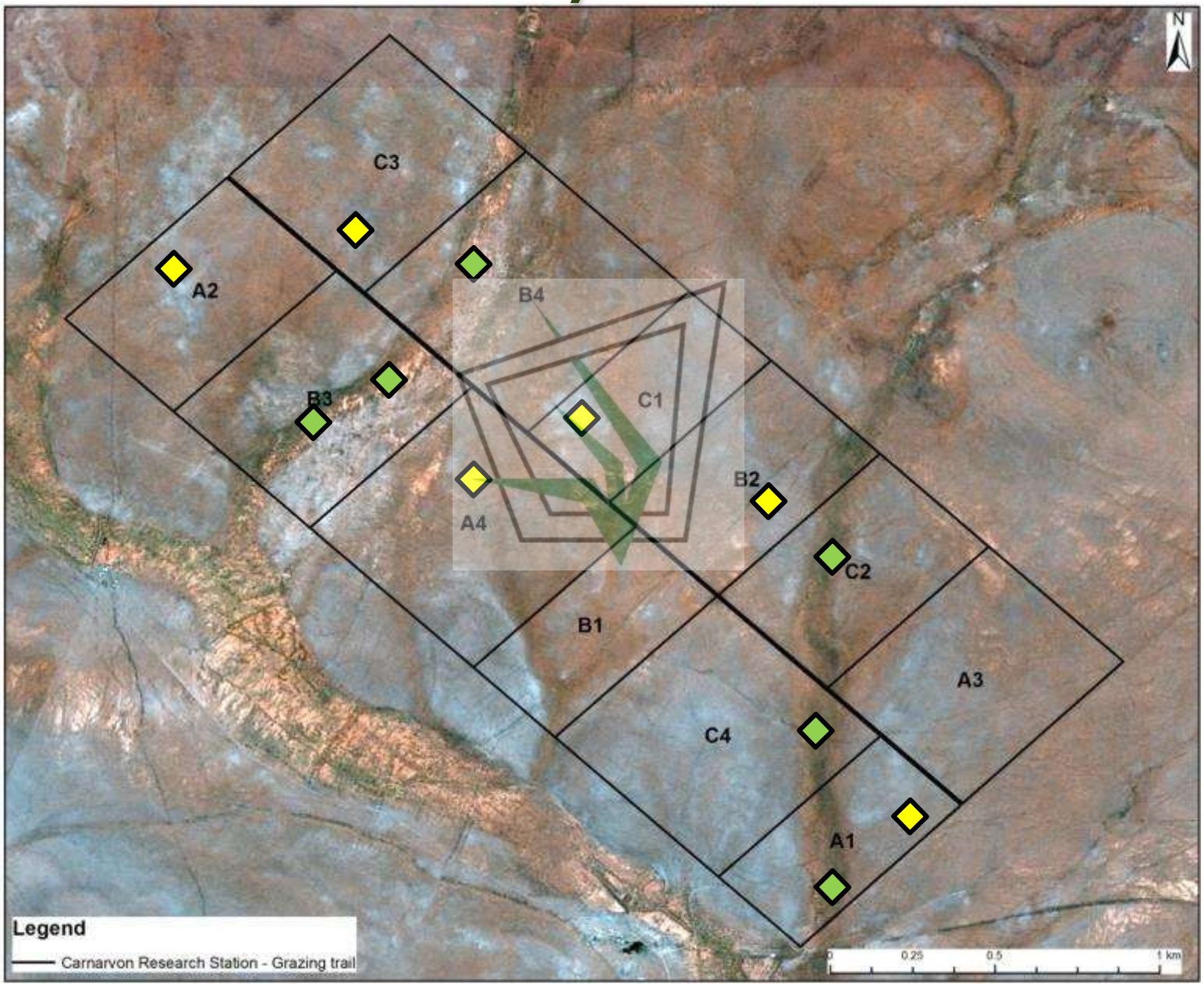


Identify potential problems of farmland (diseases, nutrient deficiencies, weeds, environmental stresses)


In-field verification

Actions taken

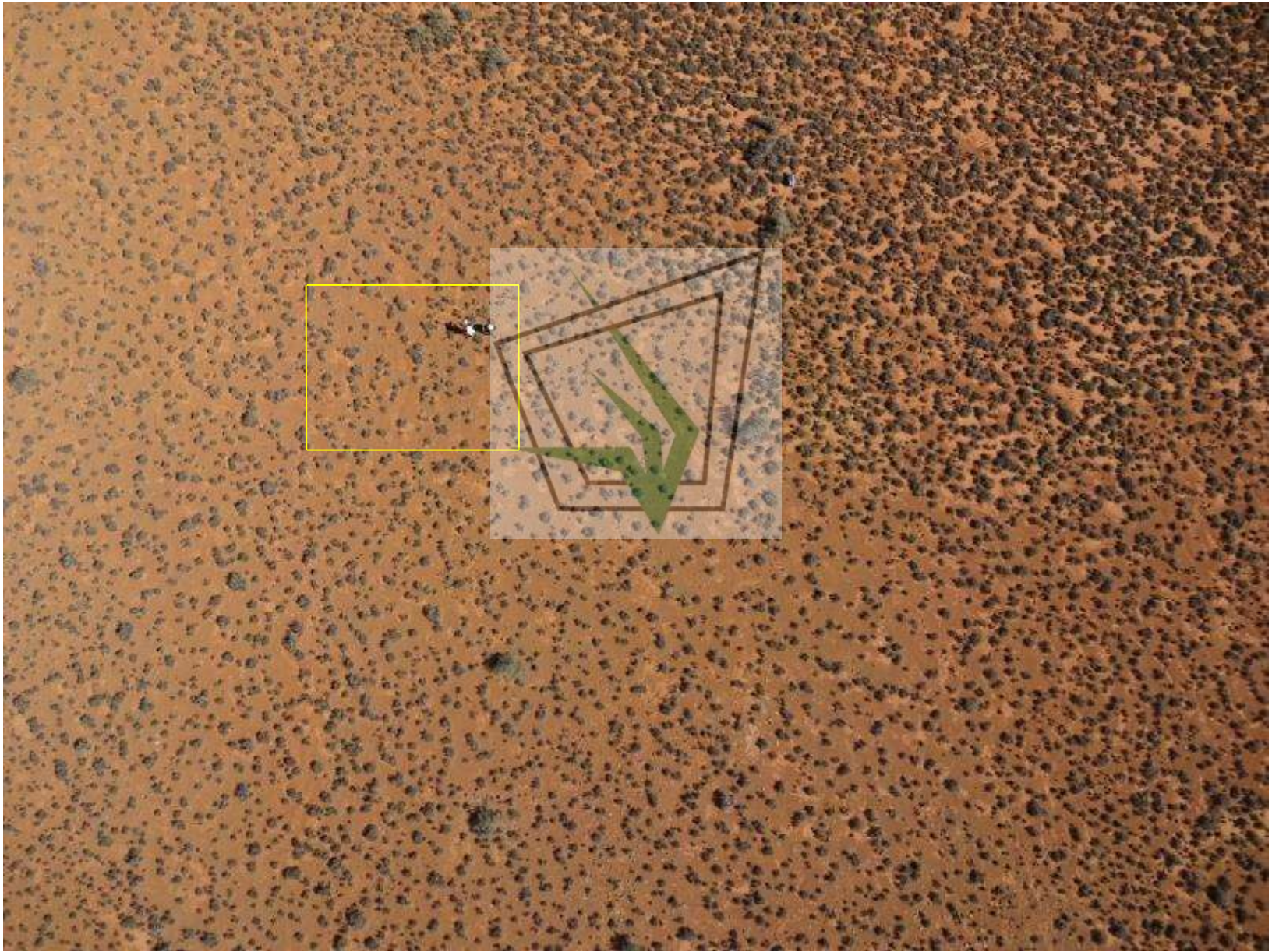
# Study sites


N
C3
A2
B4
B3
C1
B2
A4
C2
B1
A3
C4
A1
Legend
Carnarvon Research Station - Grazing trail
0
0.25
0.5
1 km

# Study sites

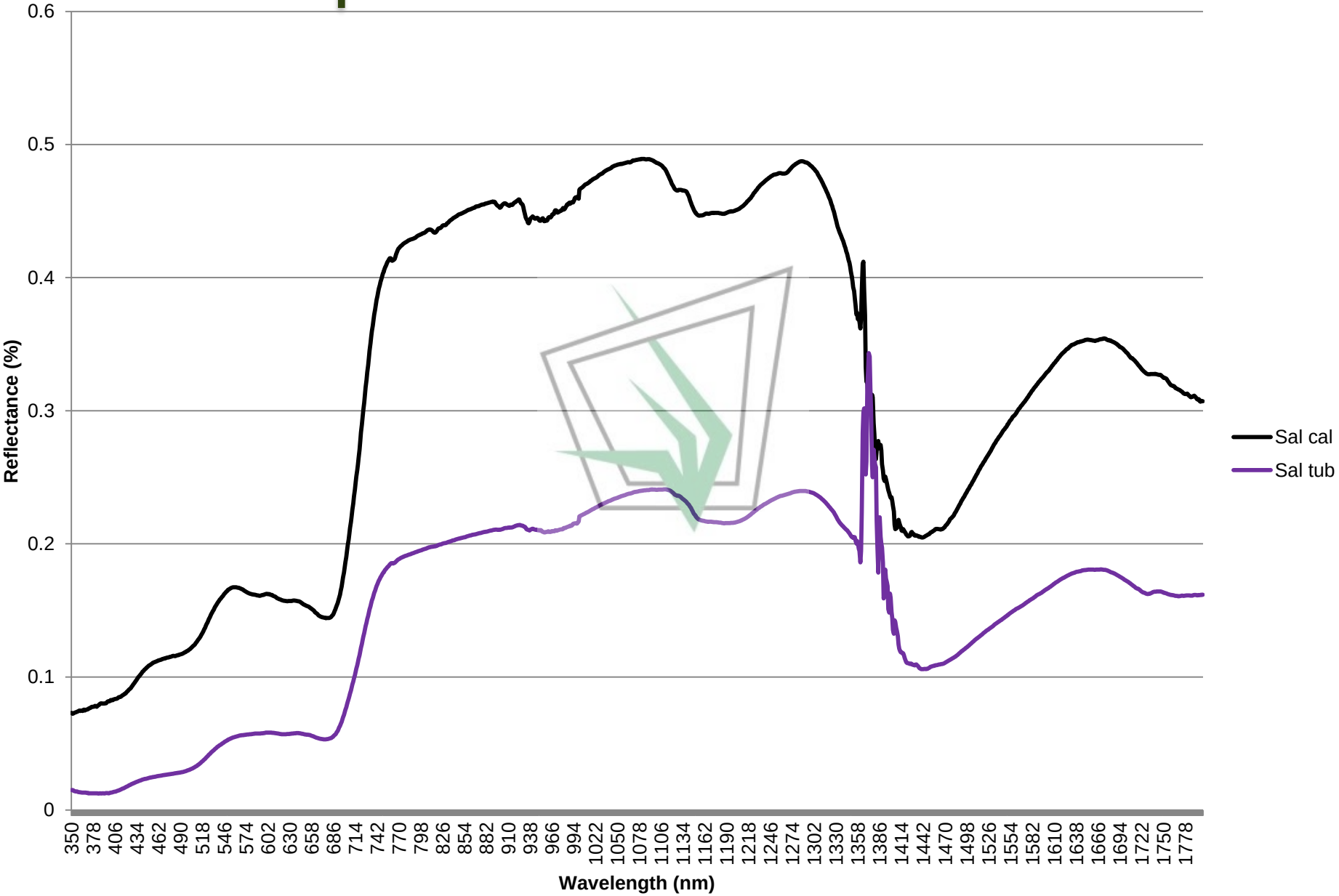
# Study sites

# Species identification and GPS coordinates



# Spectroradiometer

# Spectroradiometer data



# UAV assessment

- Unmanned aerial vehicle (UAV) fitted with a multi- and hyperspectral sensor

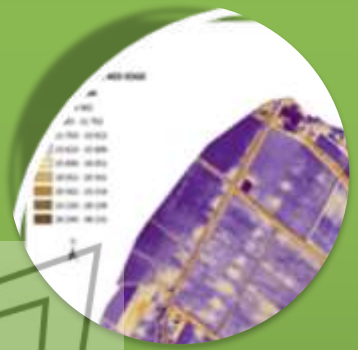

# Workflow

Measure reflectance of crop remotely

NIR and RE sensors

Analyses of spectrum of reflected light

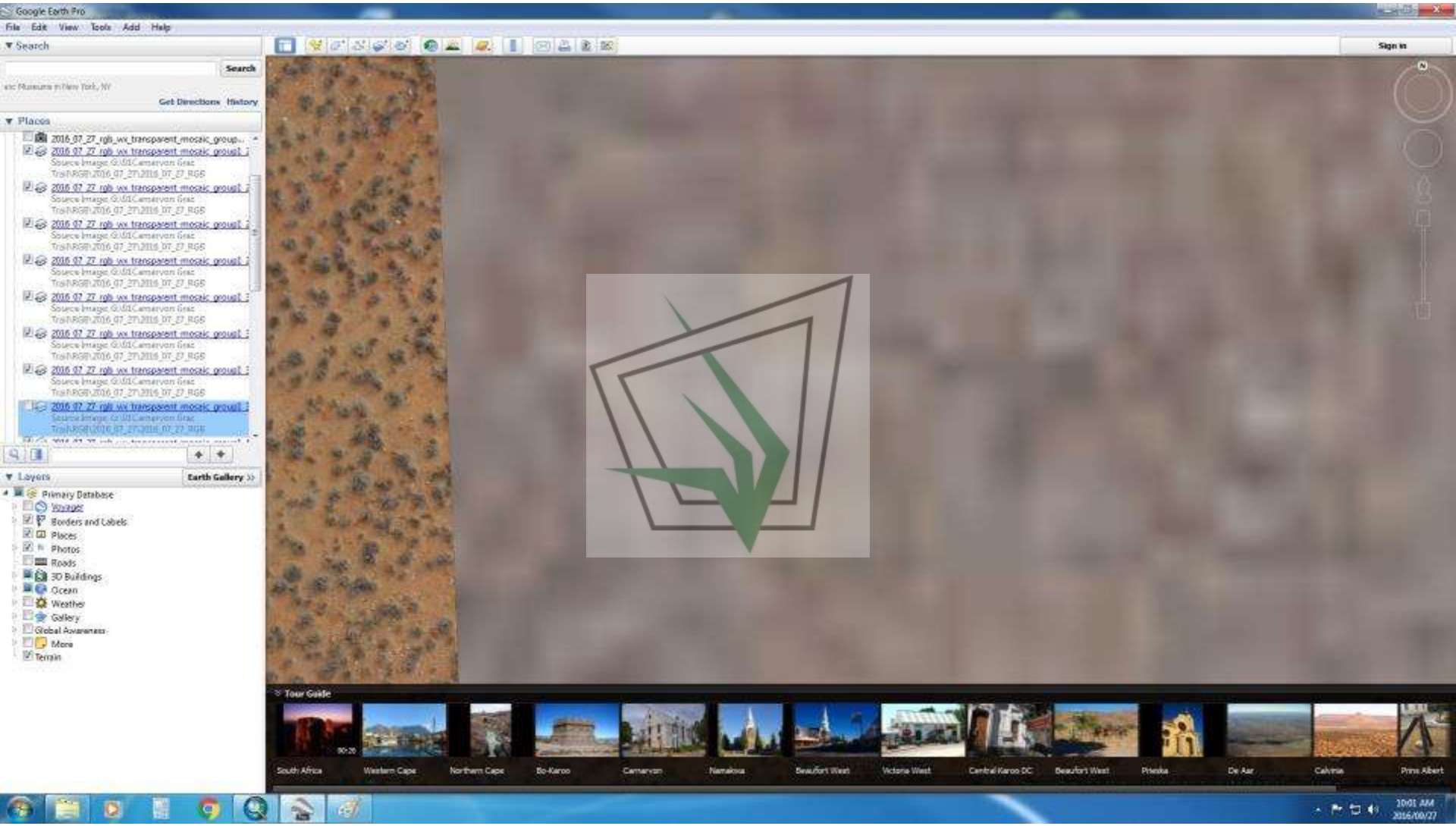
Spectral signatures and Algorithms (e.g. NDVI)



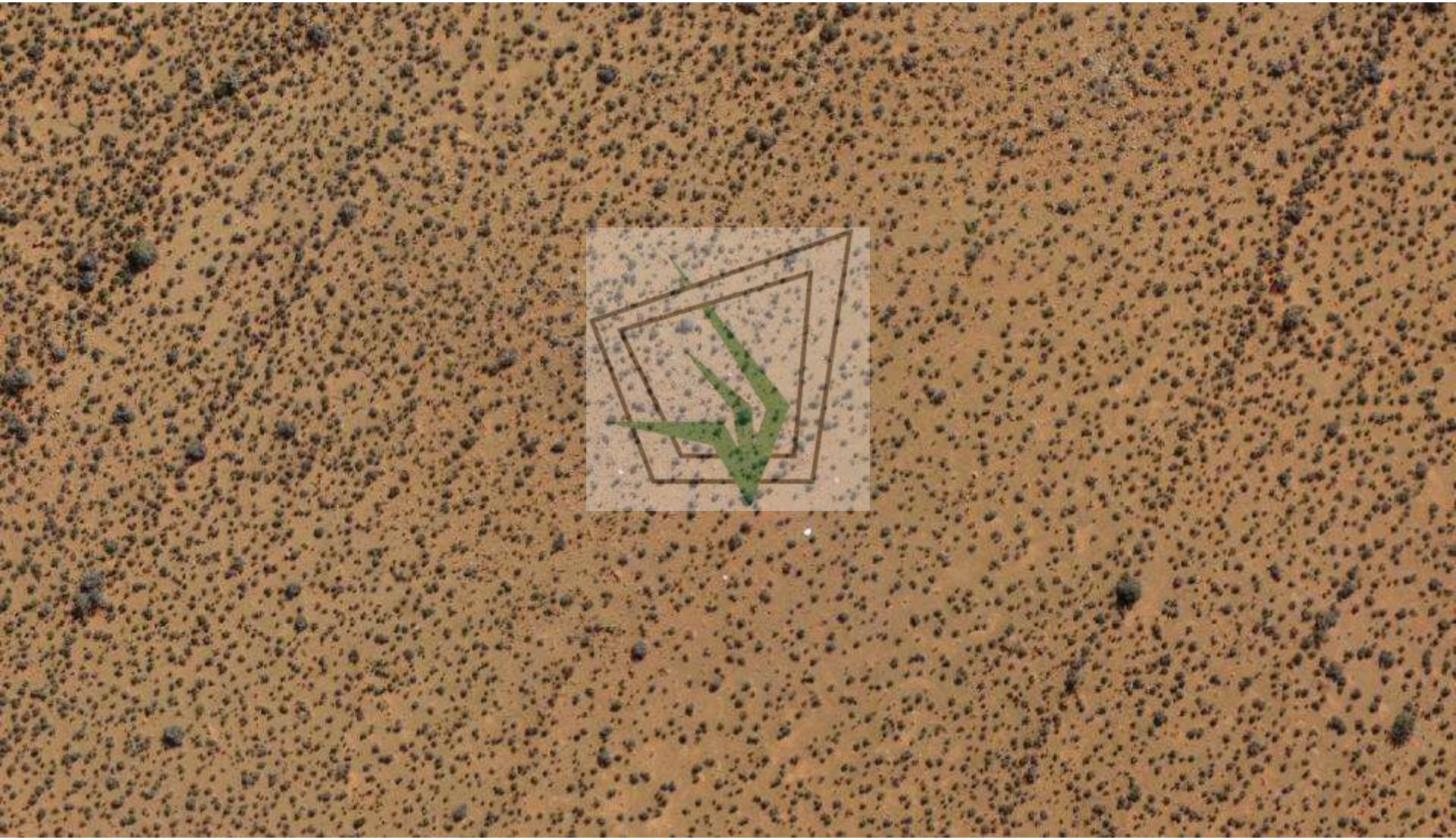
Identify potential problems of farmland (diseases, nutrient deficiencies, weeds, environmental stresses)

In-field verification

# Image quality of UAV vs Satellite



# UAV data



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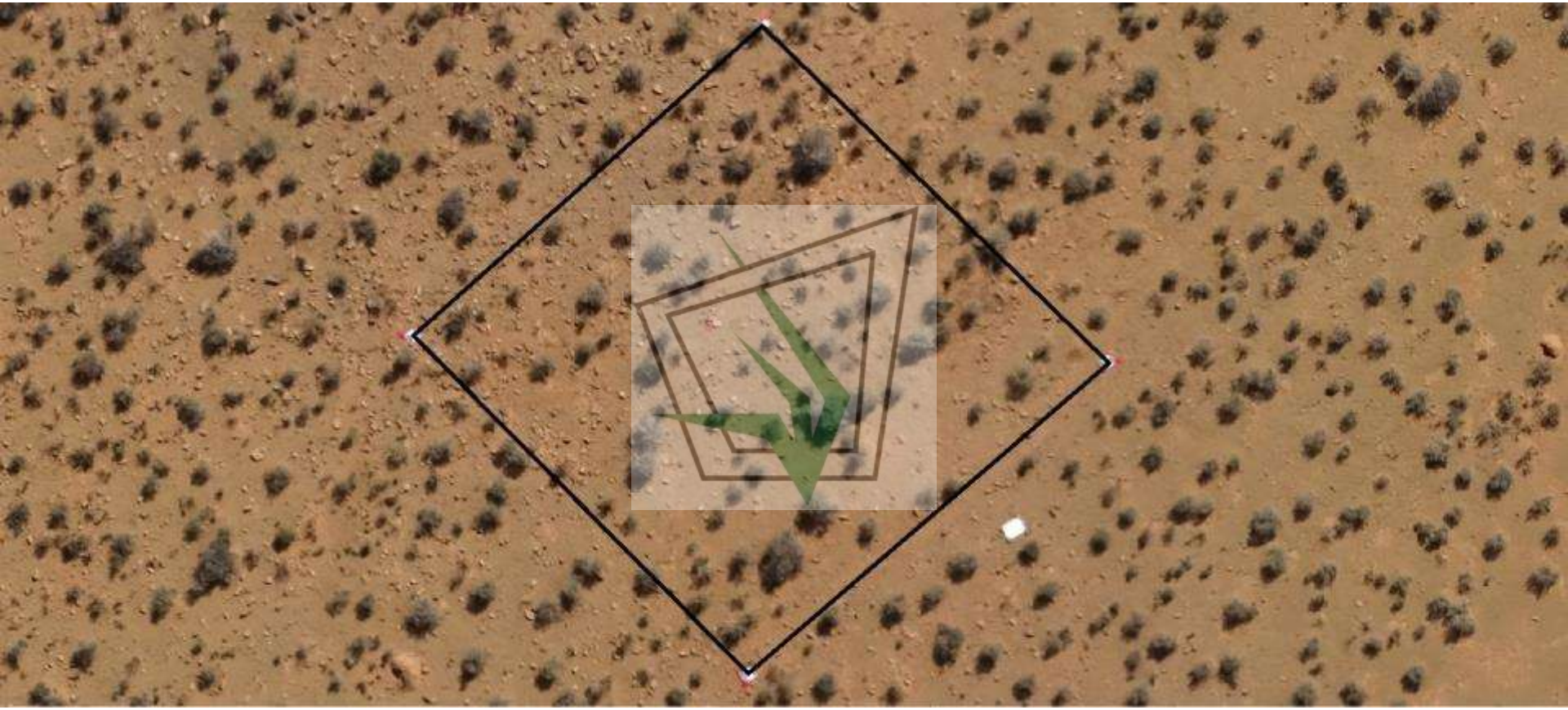

# UAV data

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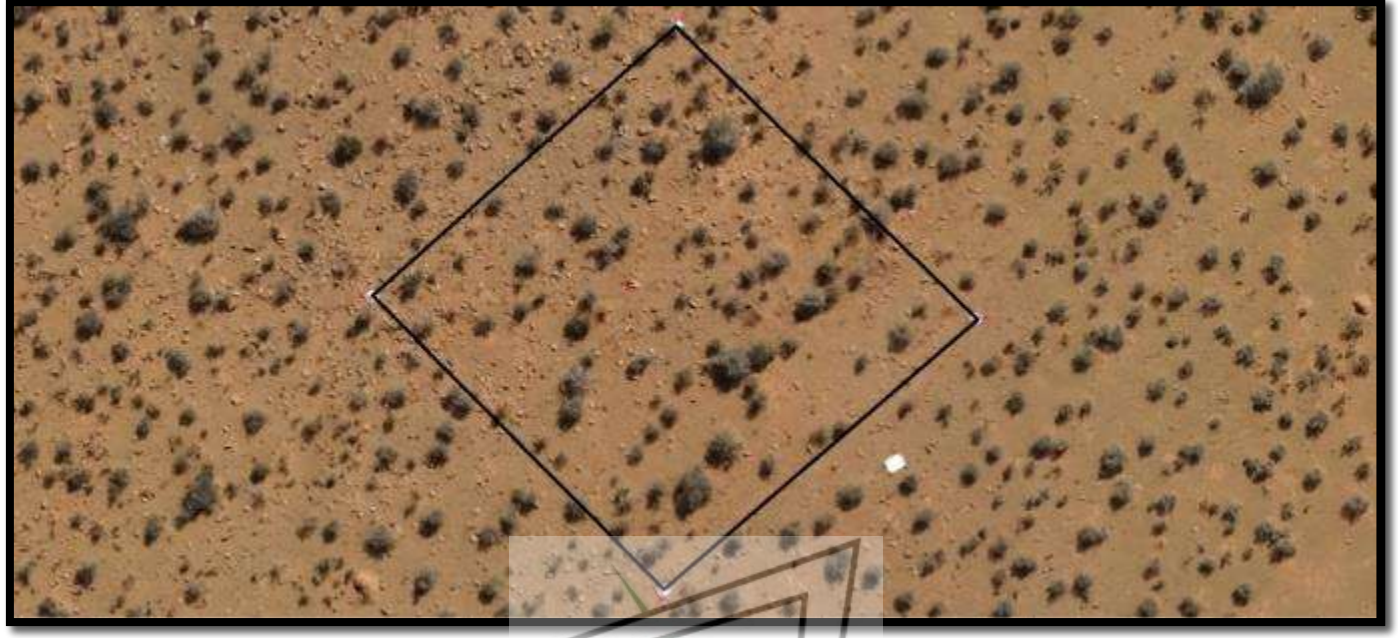

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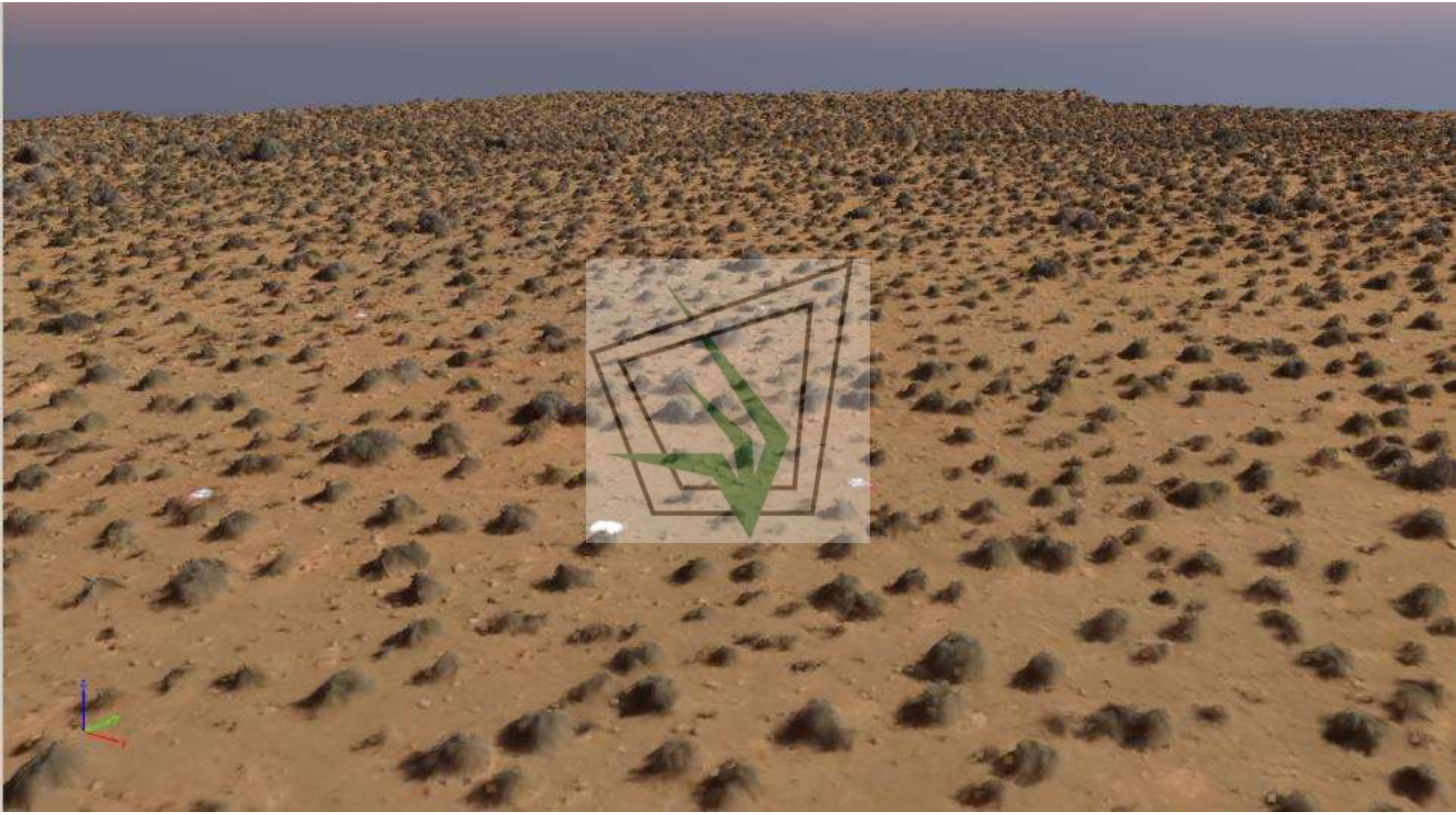

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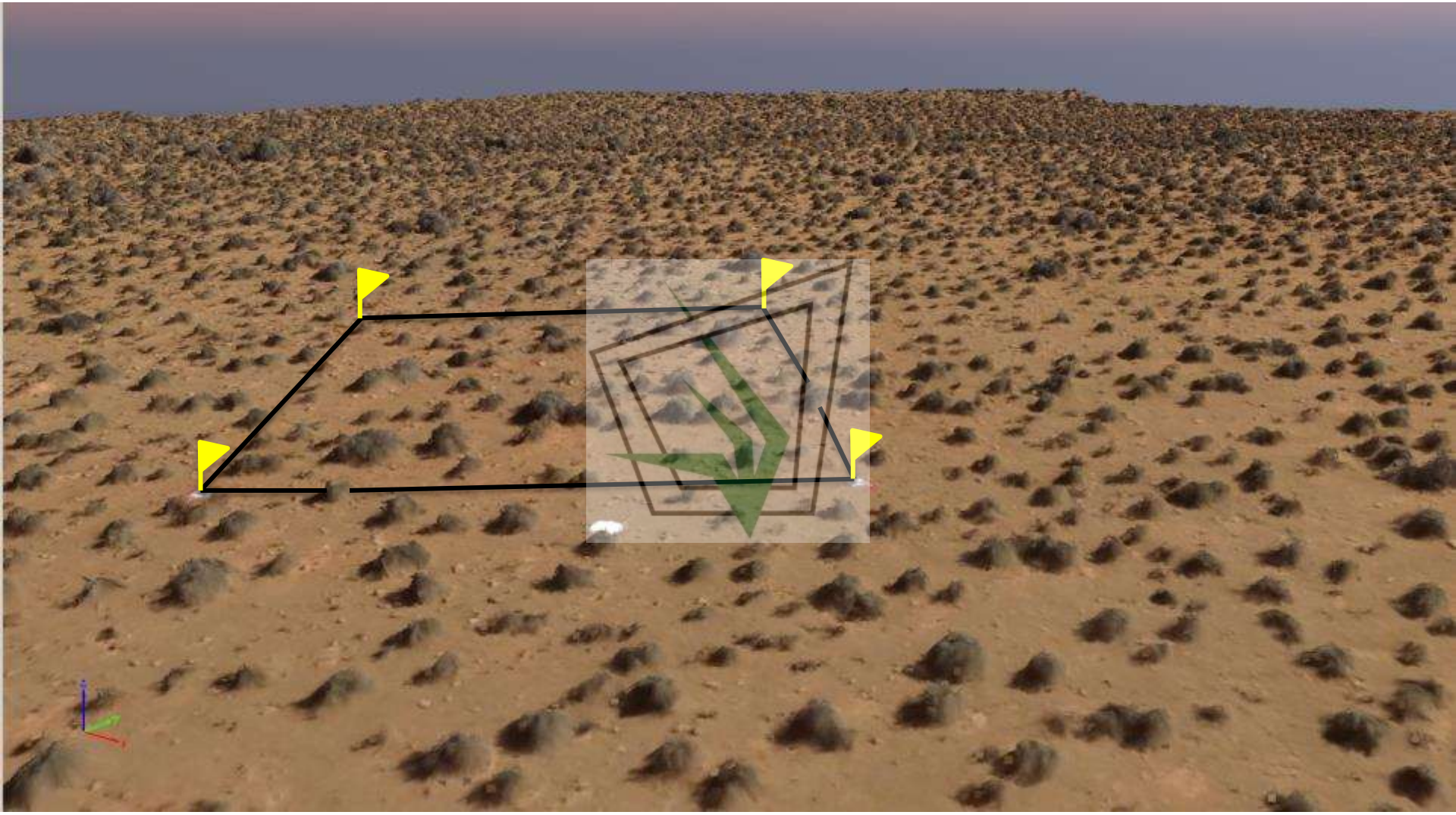


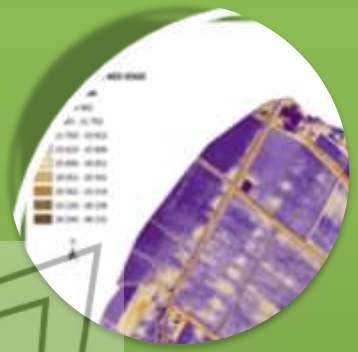
# Workflow

Measure reflectance of crop remotely

NIR and RE sensors

Analyses of spectrum of reflected light

Algorithms (e.g. NDVI)



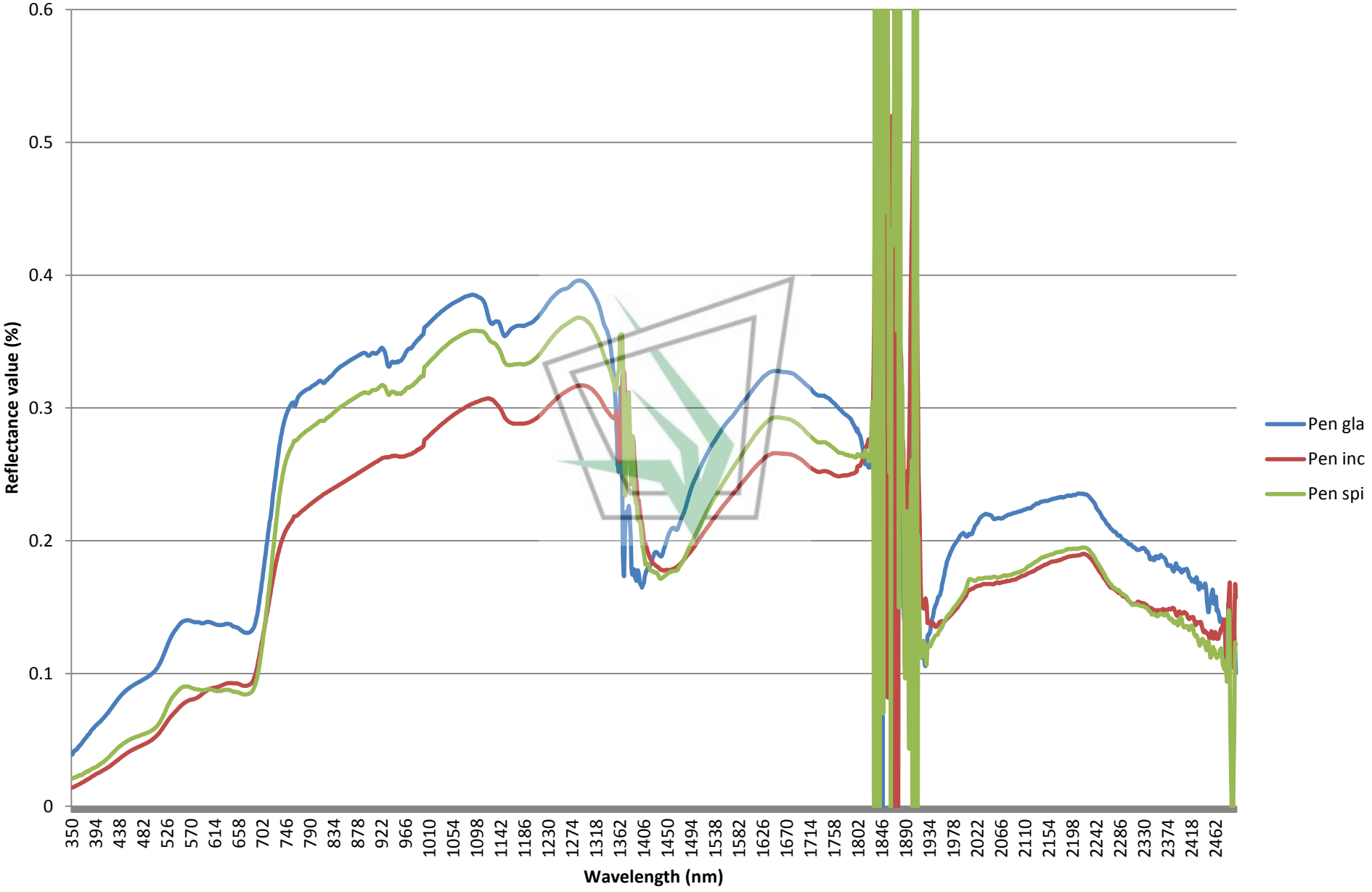
Results: Determine plant density and species composition

Identify potential problems (diseases, nutrient deficiencies, weeds, environmental stresses)

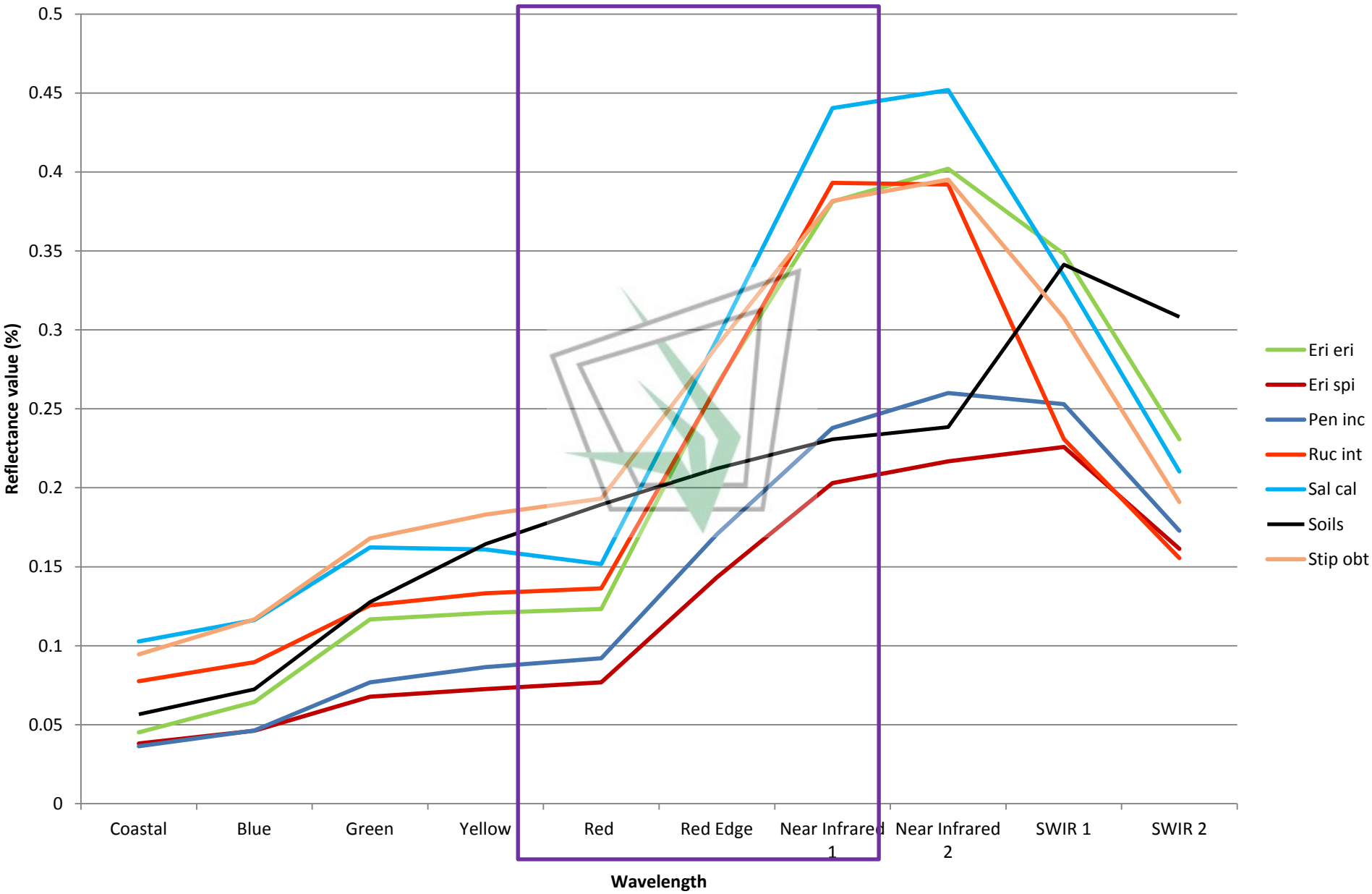
In-field verification

# Spectral signatures

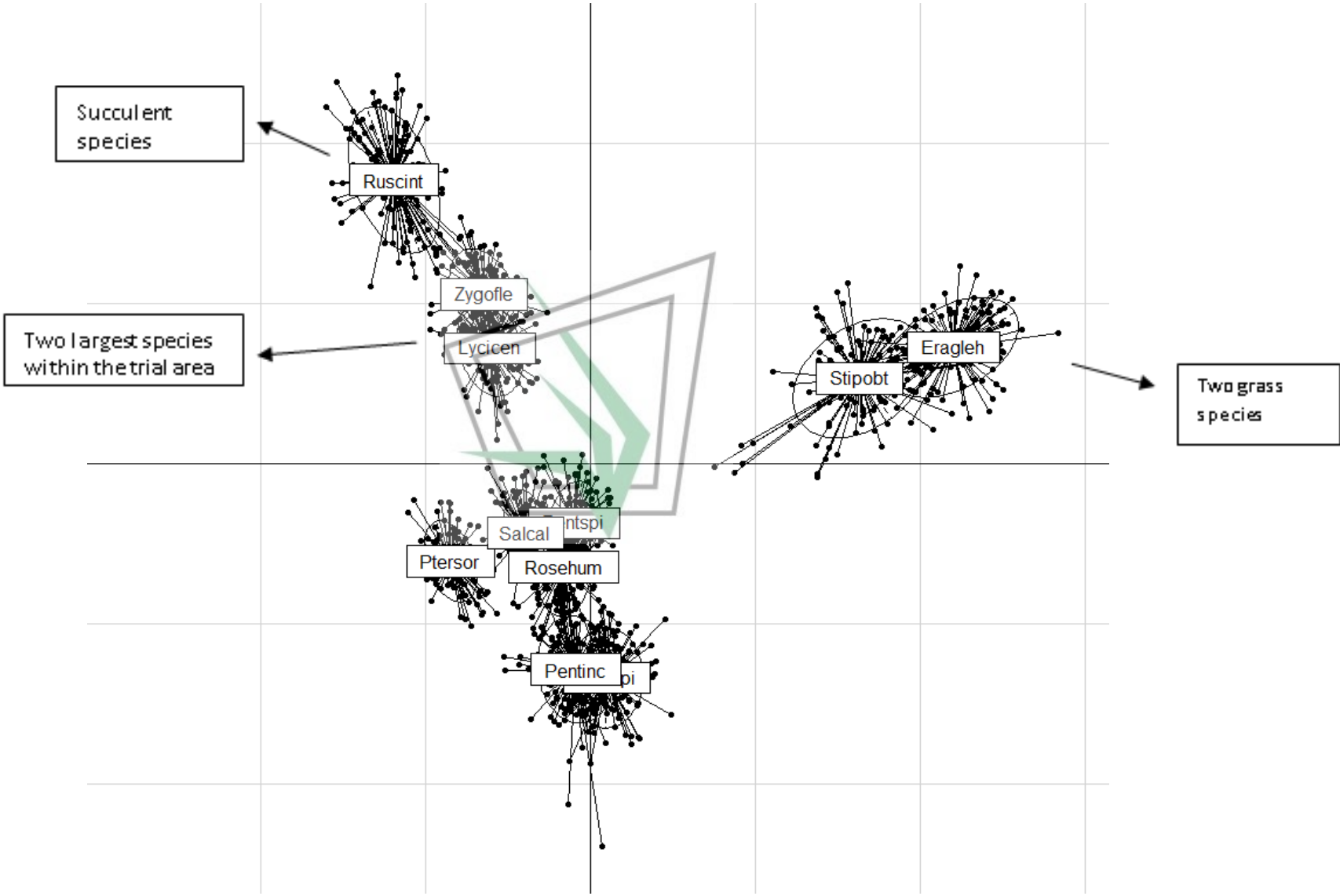
# Spectral signatures



# Spectral reflectance analysis



# Discriminatory factor analysis



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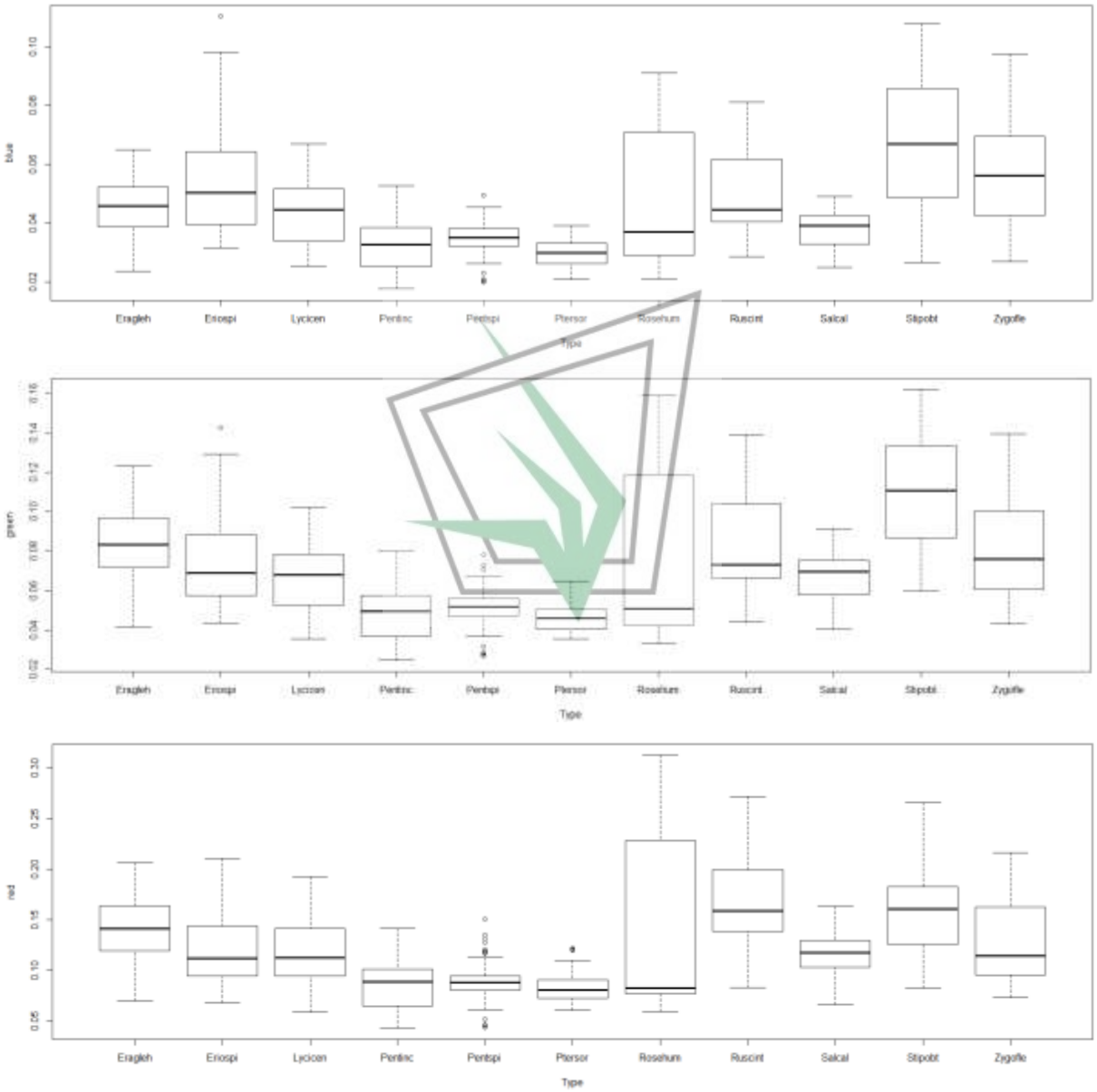

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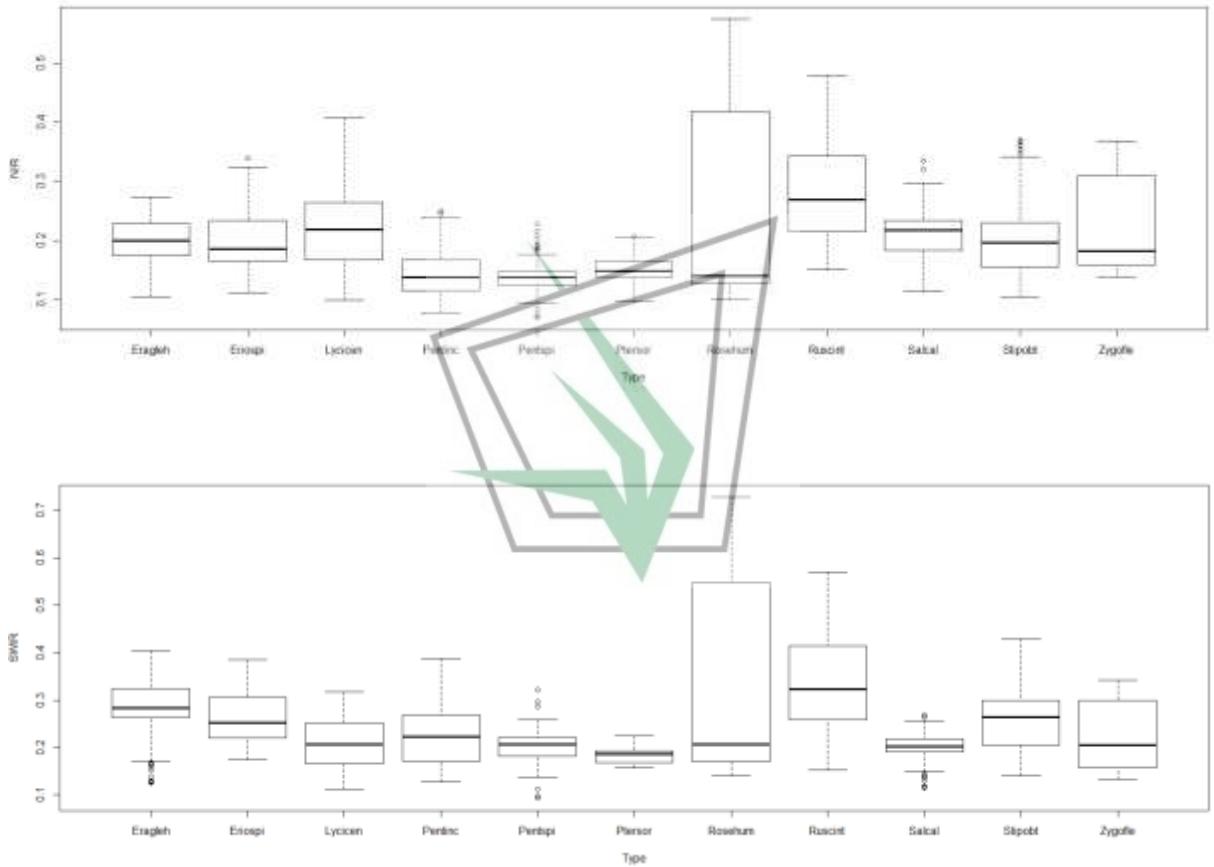

# *Image classification*

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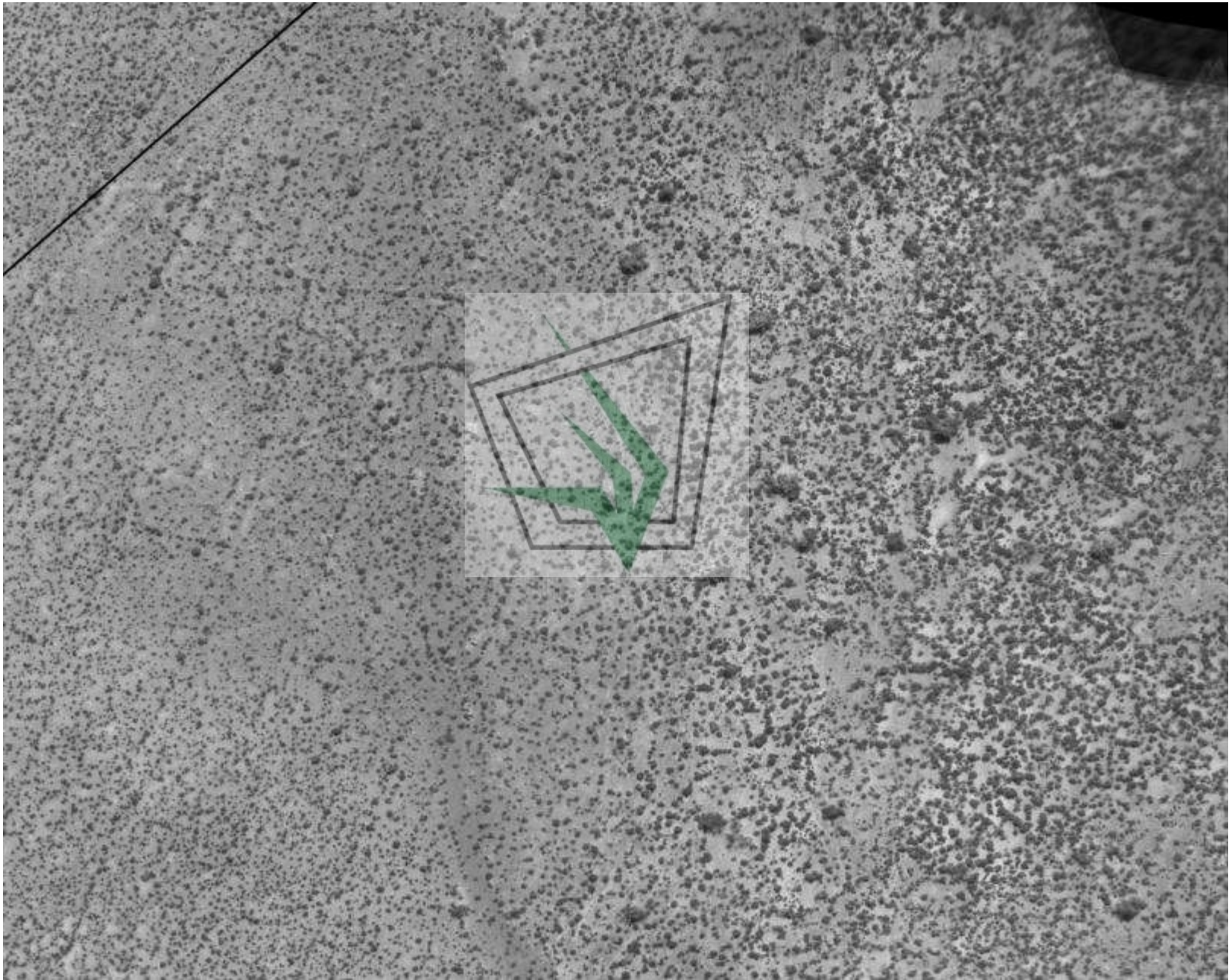

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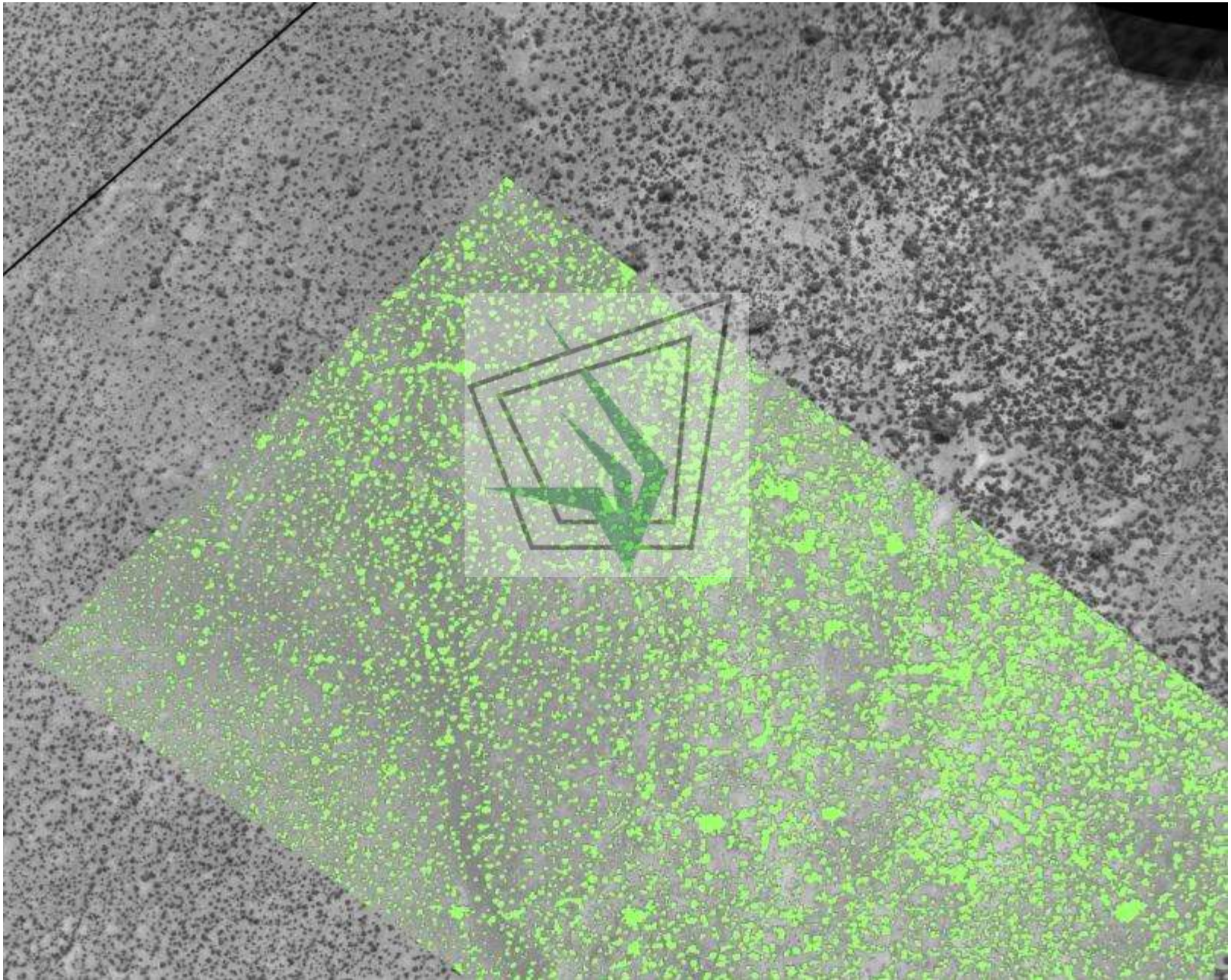

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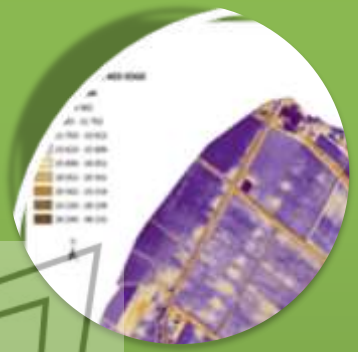
Algorithms (eg. NDVI)



Identify potential problems of farmland (diseases, nutrient deficiencies, weeds, environmental stresses)

In-field verification

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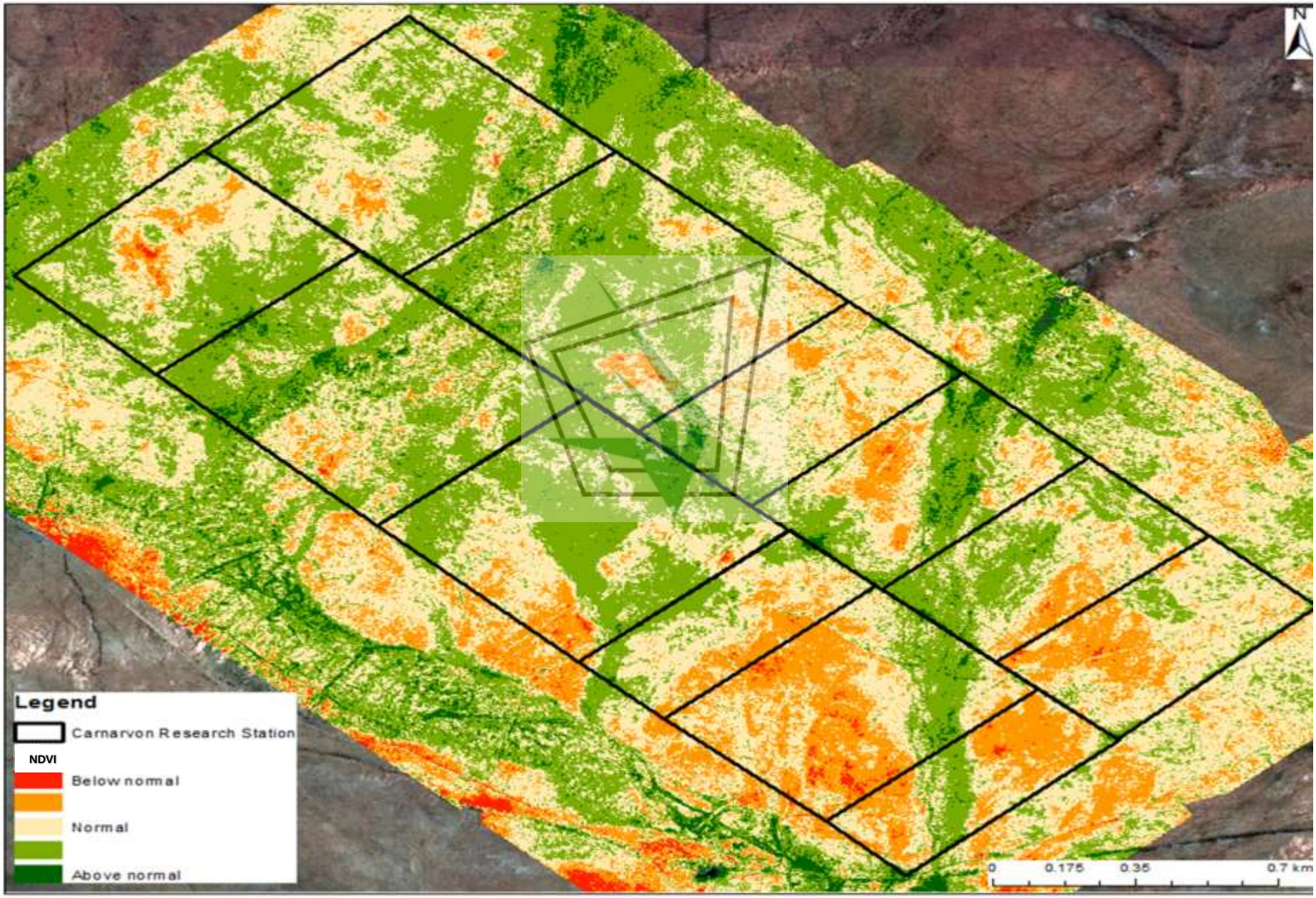
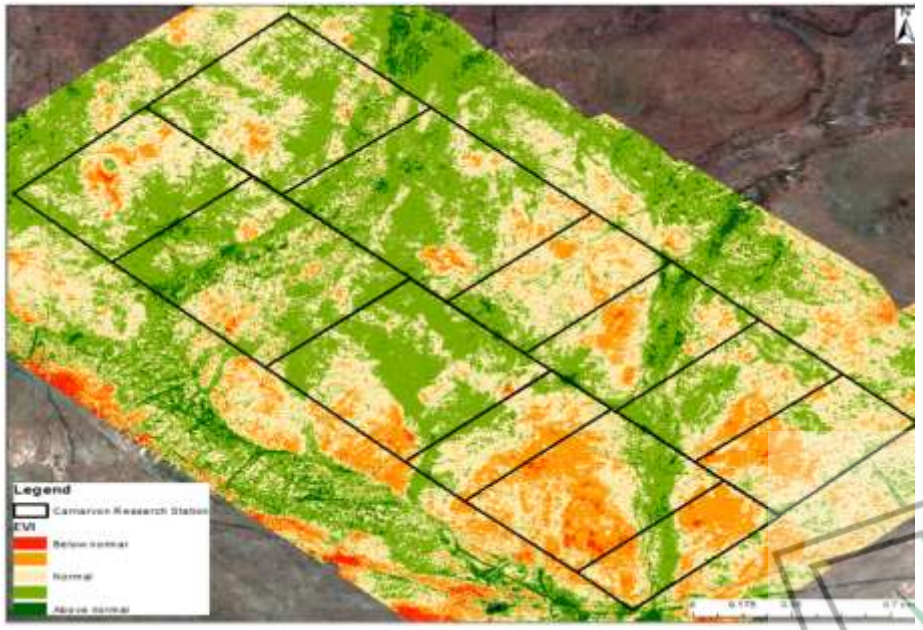
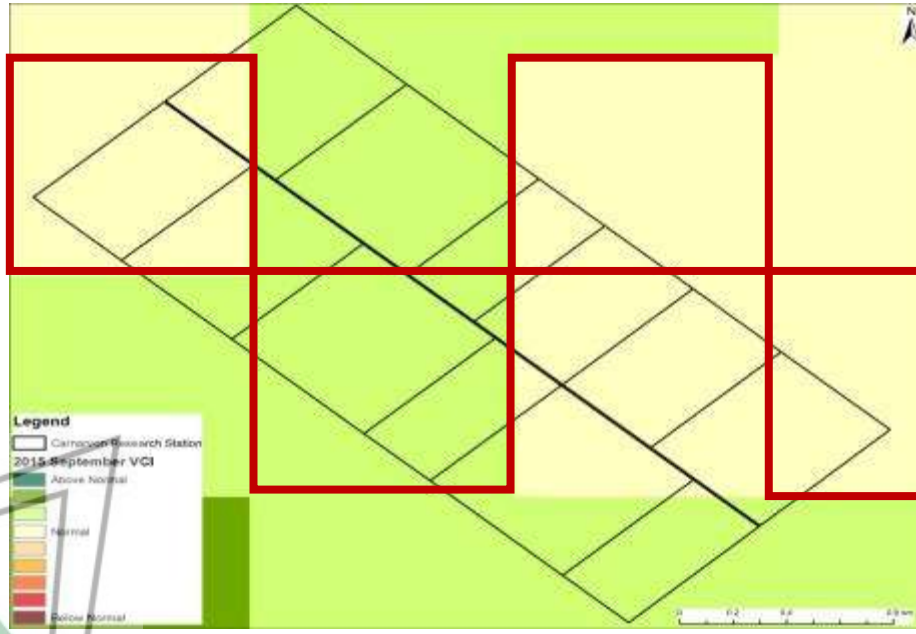
# NDVI


N
Legend
Carnarvon Research Station
NDVI
Below normal
Normal
Above normal
0
0.175
0.35
0.7 km

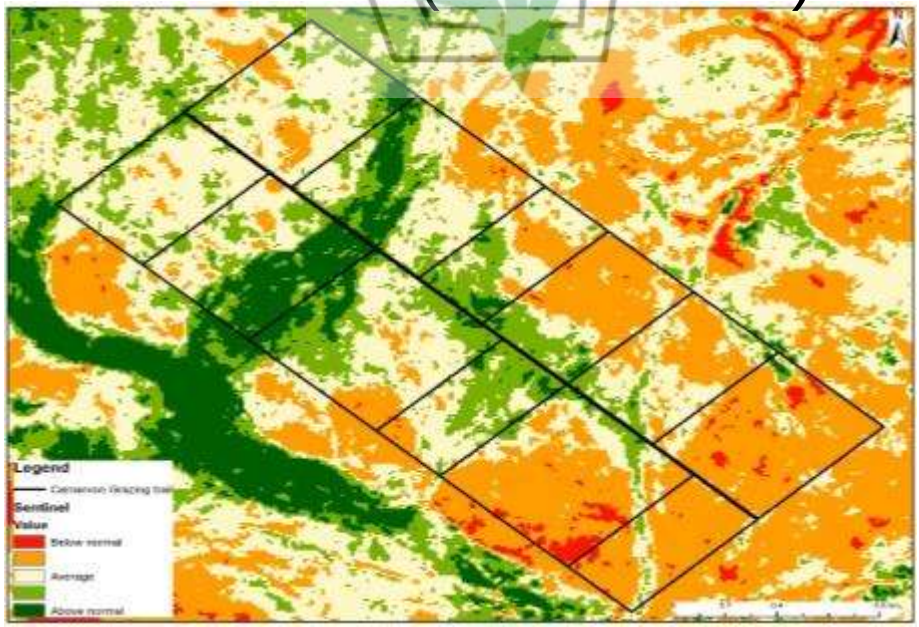
UAV (10 cm x 10 cm)




Satellite (1 km x 1 km)



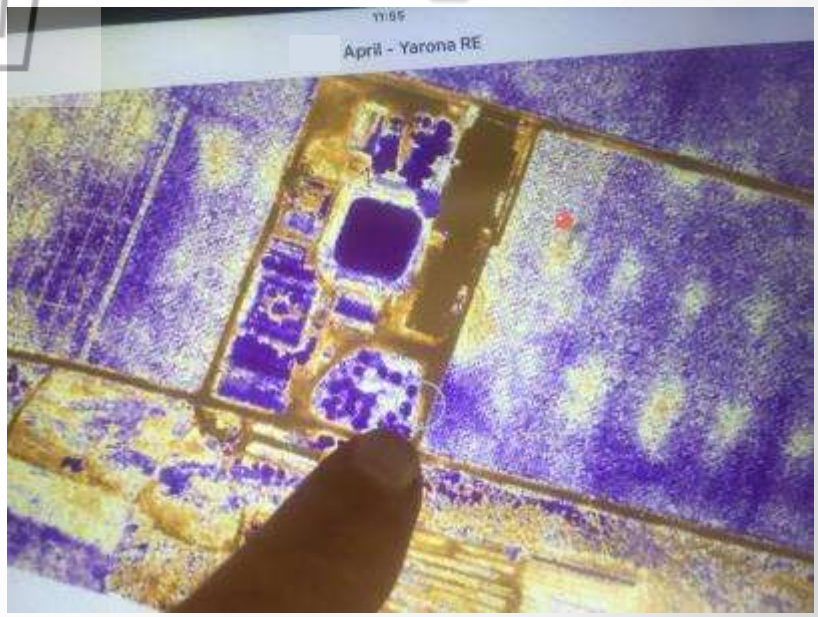

Satellite (10 m x 10 m)



# In-field verification

Avenza Maps

Correlate with soil and plant factors

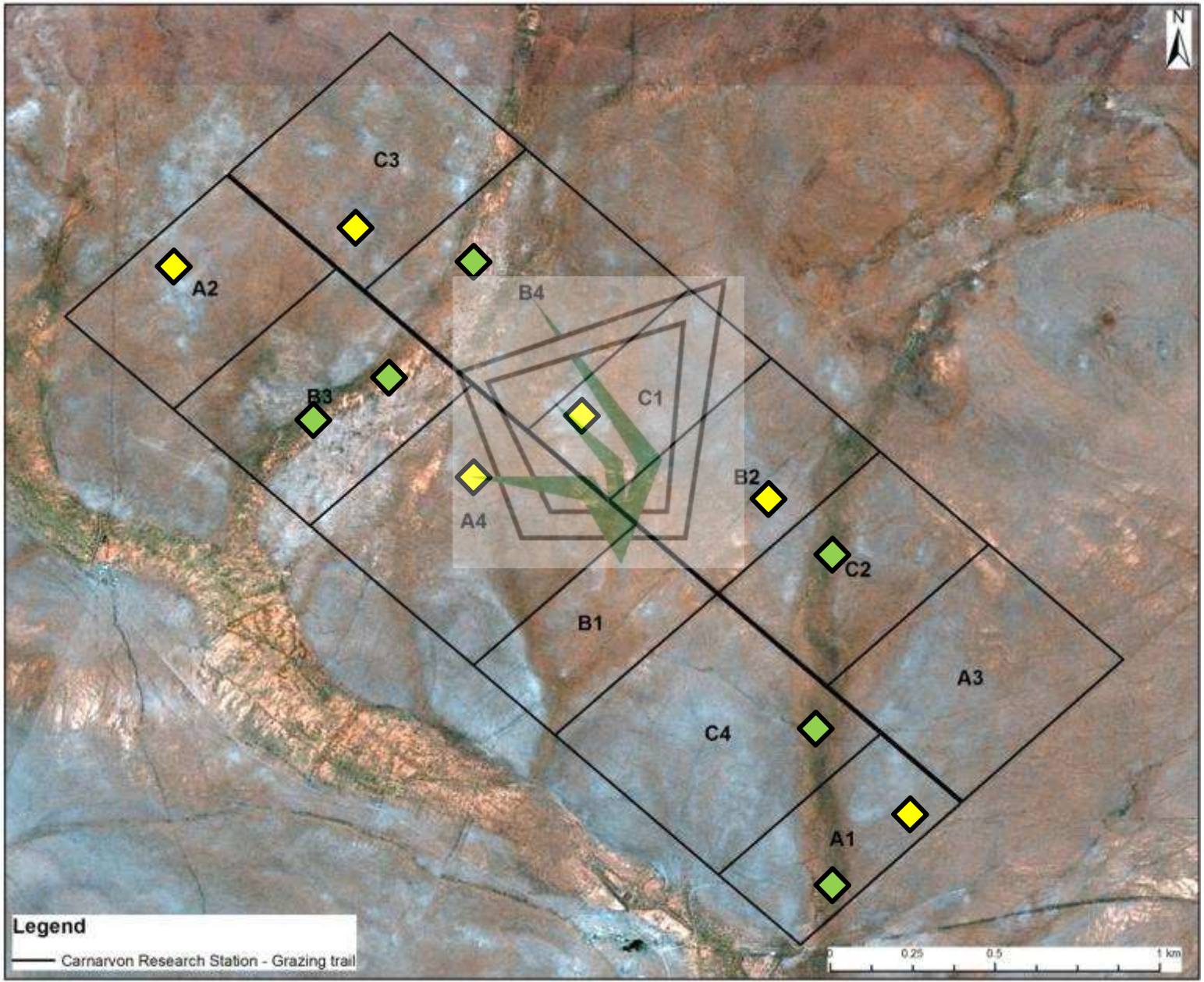
# Conclusions

- High resolution remote sensing is valuable ito.
  - NDVI (Vegetation condition)
    - As a simple transformation of spectral bands, NDVI is easily computed;
  - Vegetation cover/plant population
  - Yield/productivity
  - Vegetation classification

# Conclusions

- Spectroradiometer to determine spectral signature in order to ID plants from UAV data
- Small Plots – Towards larger area

# Conclusions



# Correctly interpret the imagery obtained from UAV's,

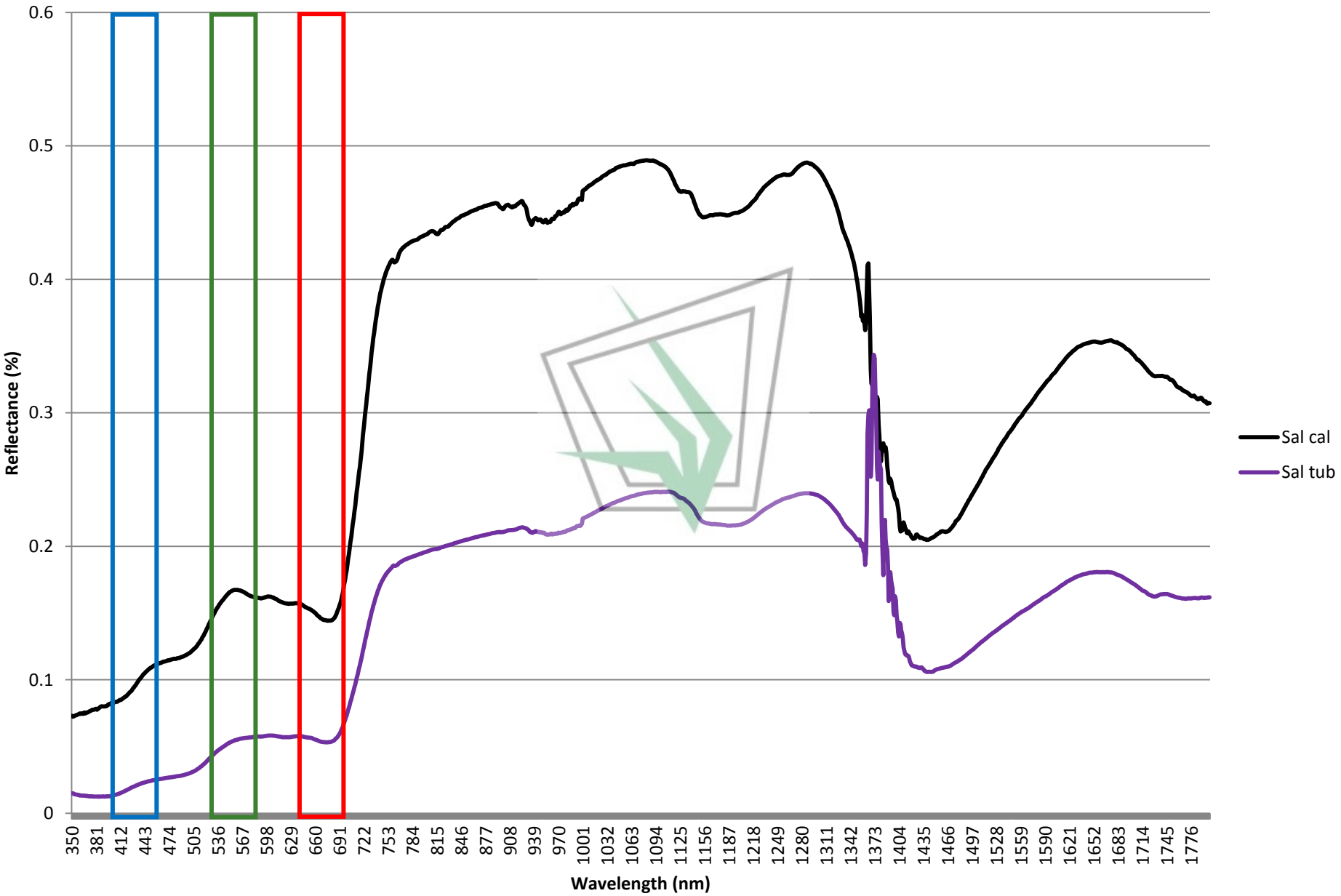
- Important to understand the capacity or capability of the particular sensor in use, as well as the reflection pattern which is derived from light that was absorbed and reflected from the EMS.

**Hyperspectral**
(200+ bands)

**vs.**

**RGB**
(3-4 bands)


# RGB


0.6
0.5
0.4
0.3
0.2
0.1
0
Reflectance (%)
350
381
412
443
474
505
536
567
598
629
660
691
722
753
784
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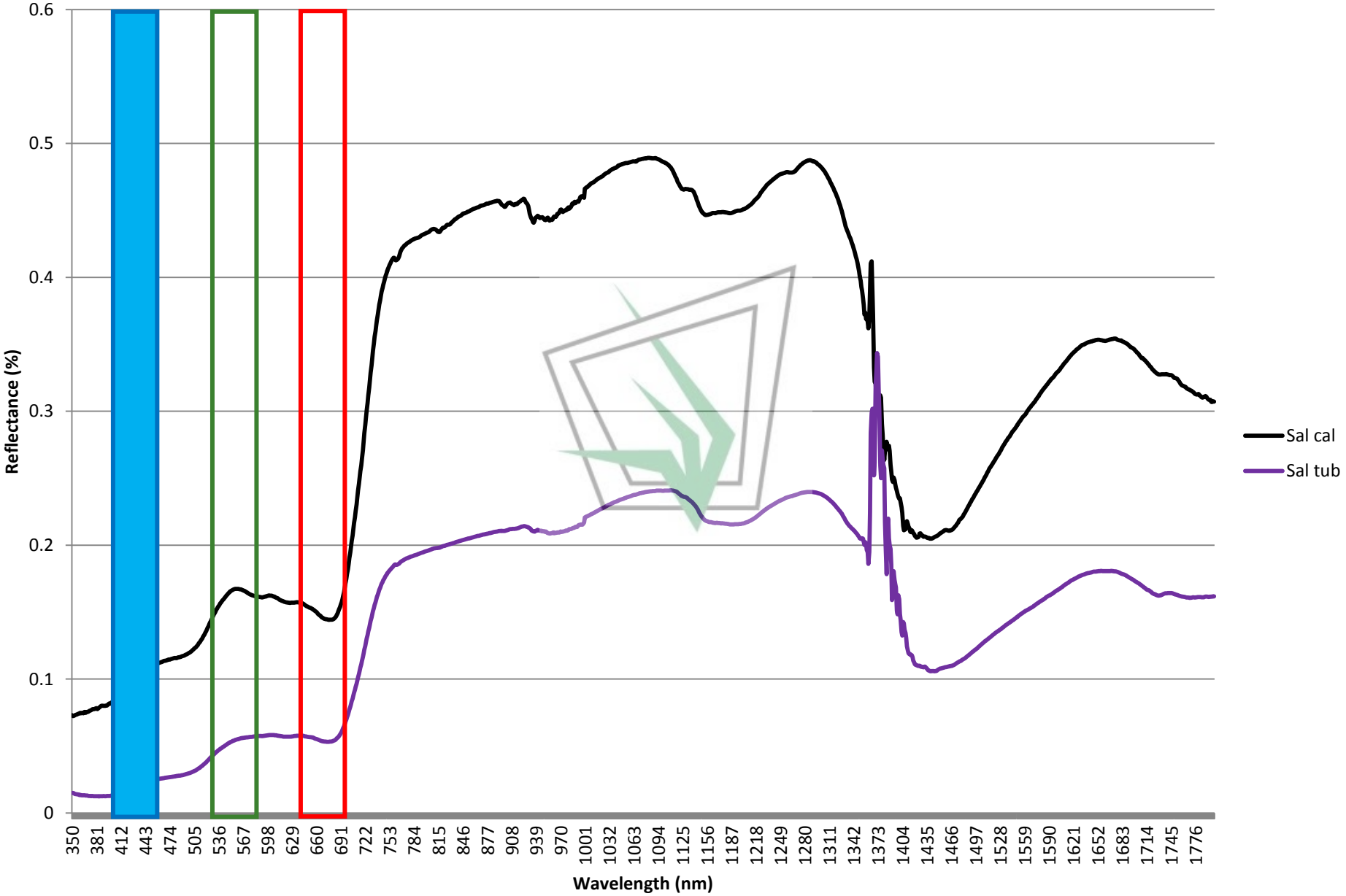
1652
1683
1714
1745
1776
Wavelength (nm)
Sal cal
Sal tub

# RGB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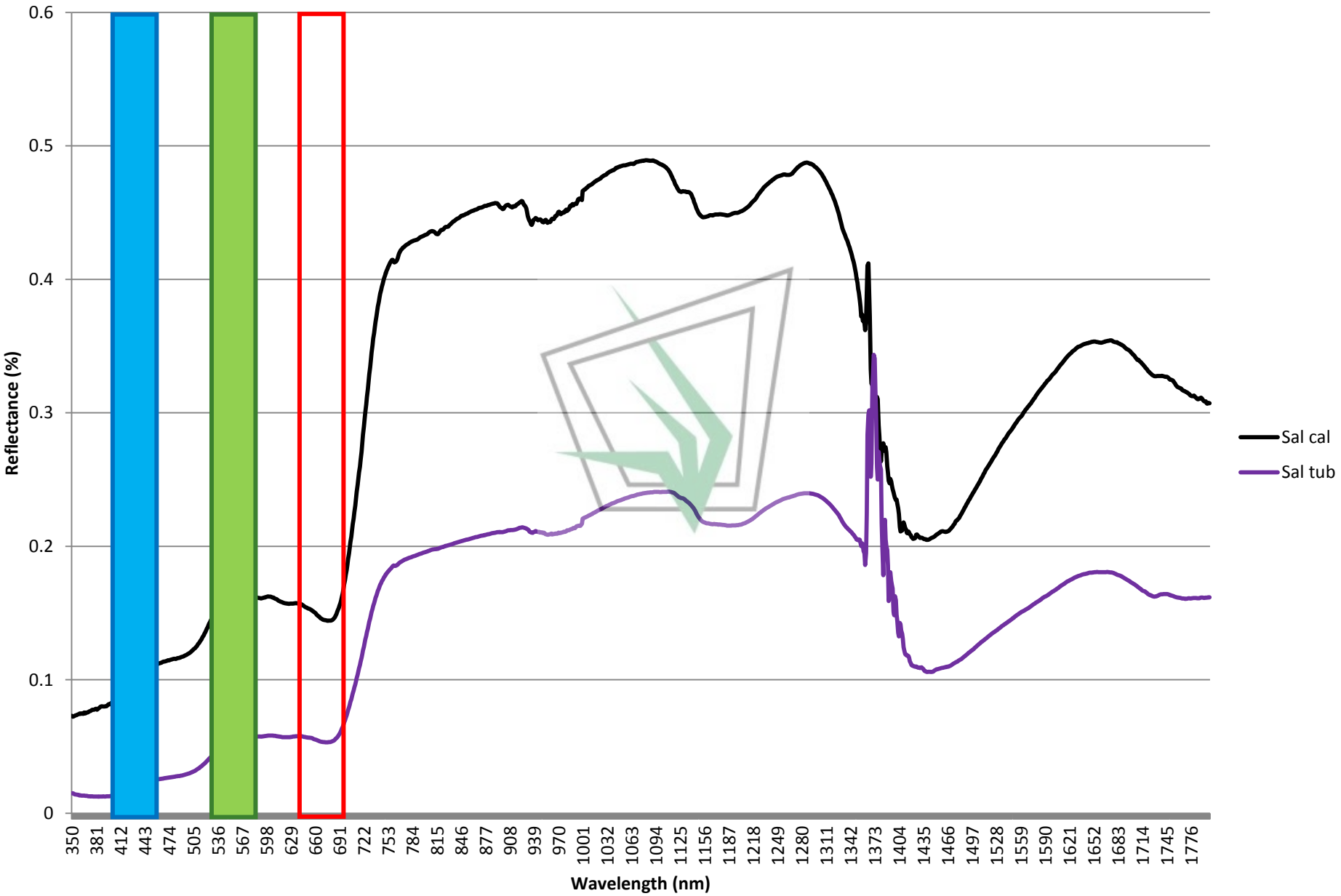
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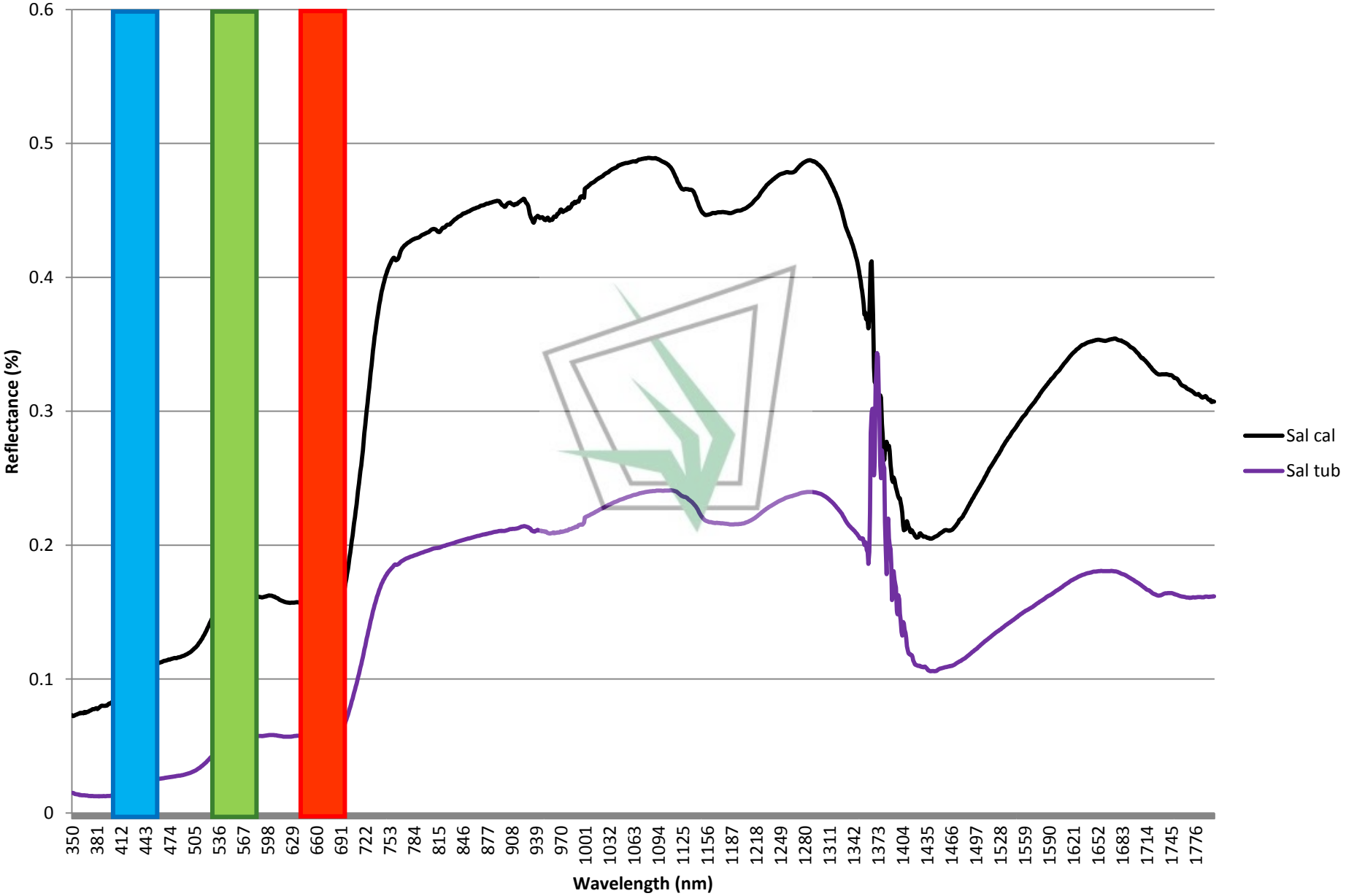
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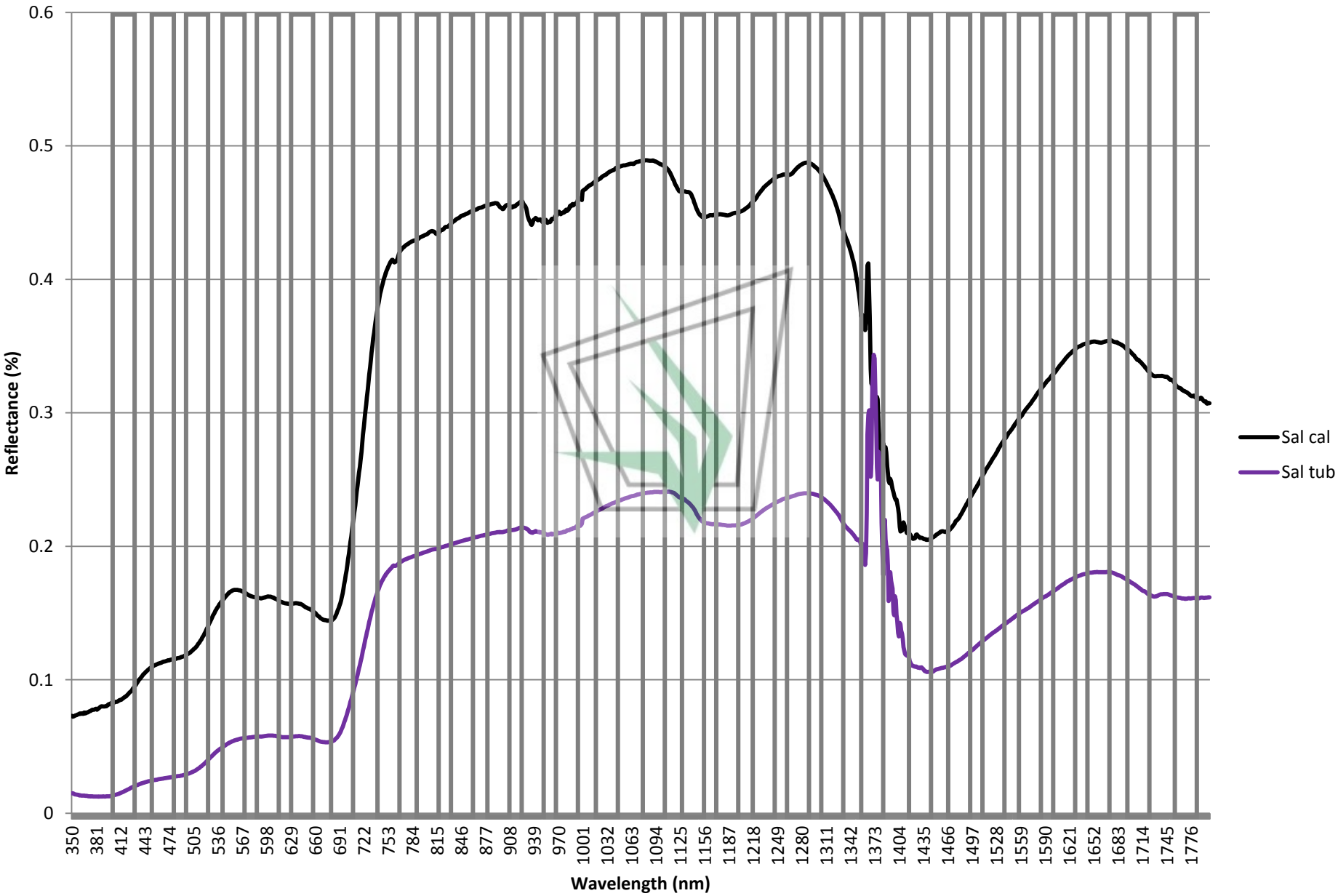
1621
1652
1683
1714
1745
1776
Wavelength (nm)
Sal cal
Sal tub

# Hyperspectral



KEEP CALM
AND
SAMPLE ON

BUT ALWAYS REMEMBER...

WE'RE WATCHING
YOU

# Thank you