Τηλεπισκόπηση από πλατφόρμες χαμηλού ύψους έως δορυφόρους για εφαρμογές γεωργίας ακριβείας

From proximal to remote sensing for precision farming applications

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Volcani Center – Agricultural Research Organization, ARO
ISRAEL

The ARO is the leading Agro research & development organization in Israel, operating as **the research arm of the Ministry of Agriculture**

ARO aims to improving existing agricultural production systems and introducing new products, processes & equipment, thereby ensuring the basis of Israel's future agriculture.

The ARO is responsible for about 70% of the agriculture research and development in Israel.

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Plant Protection

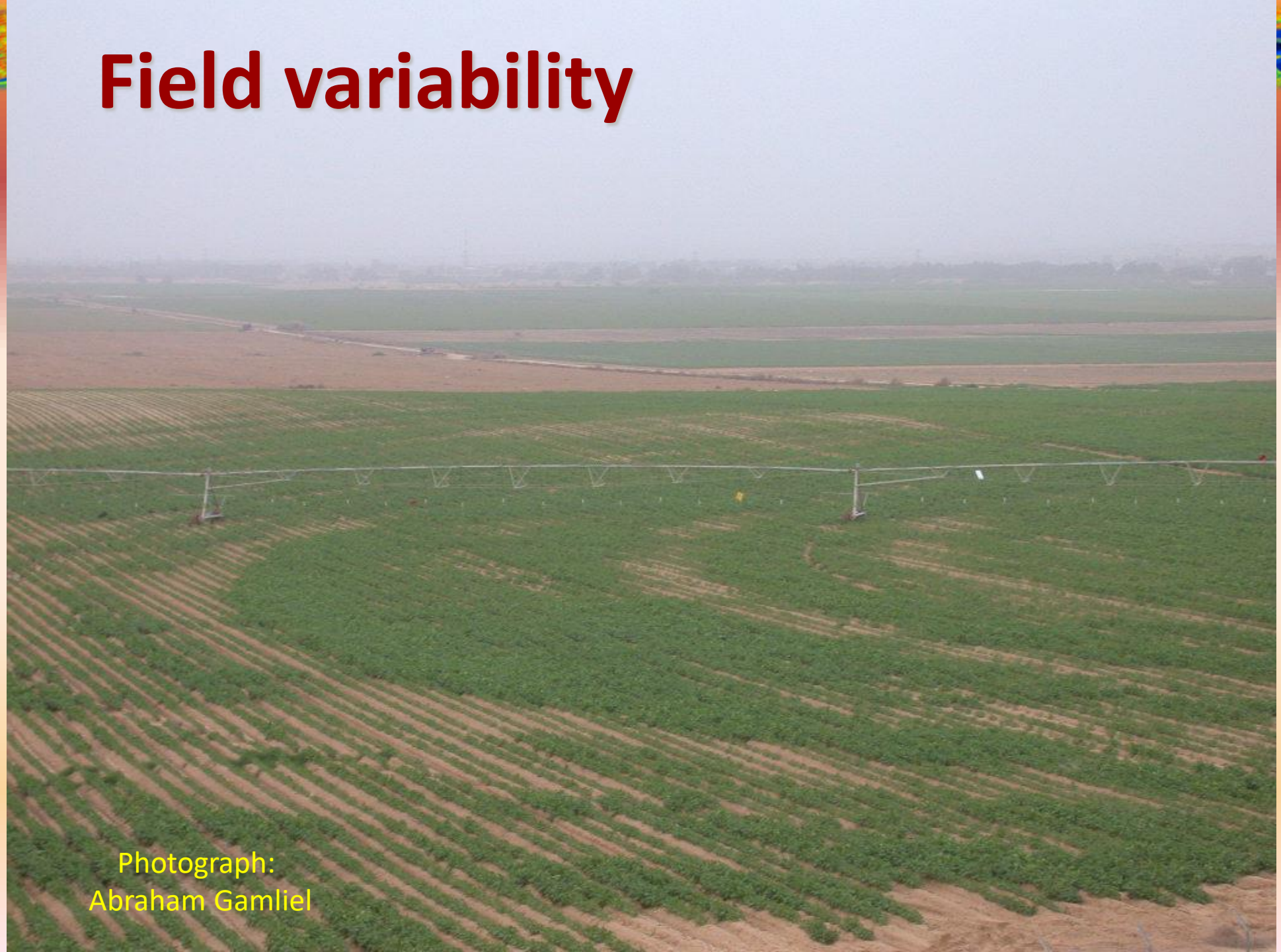

Plant Science


Engineering


Neve Yaar

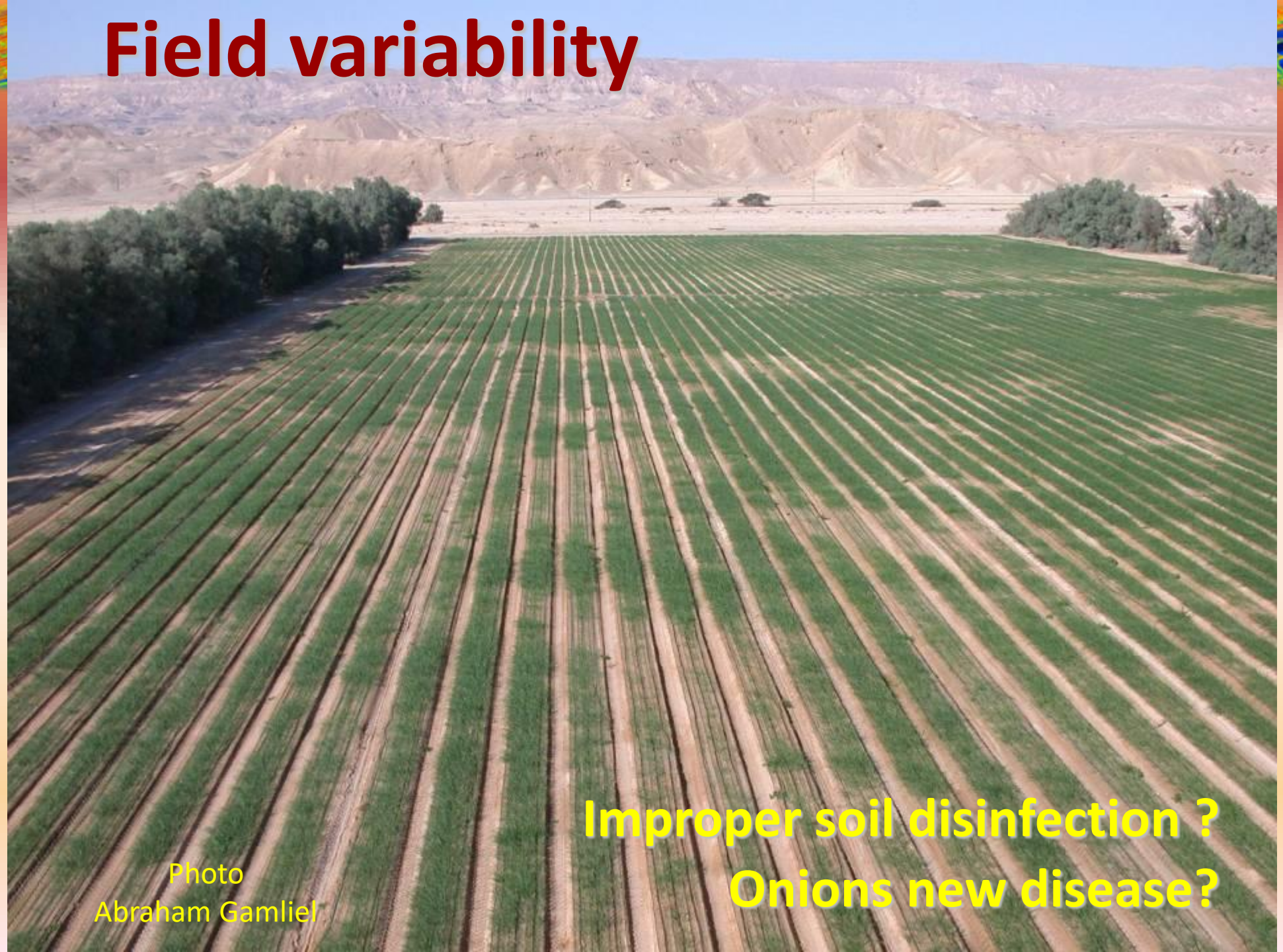

Gilat

Field variability



Photograph:
Abraham Gamliel

Field variability

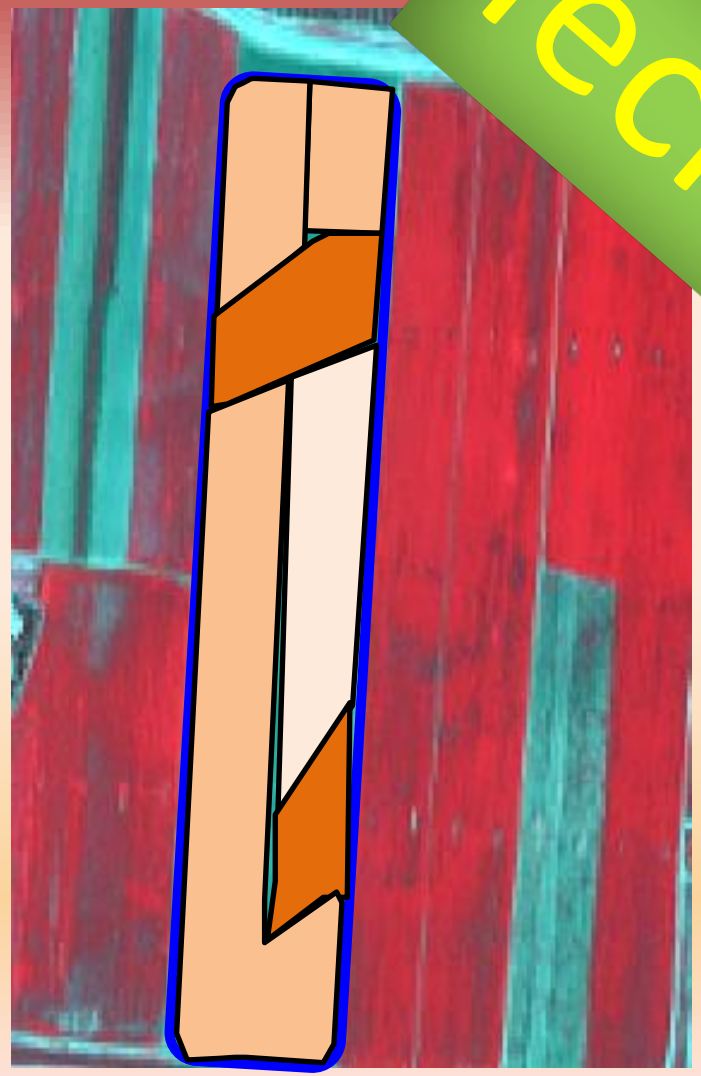


Improper soil disinfection ?
Onions new disease?

Photo
Abraham Gamliel

Variability

Precision [A]griculture (PA)



Technology…

Site-specific management
- the 3 *r*s:

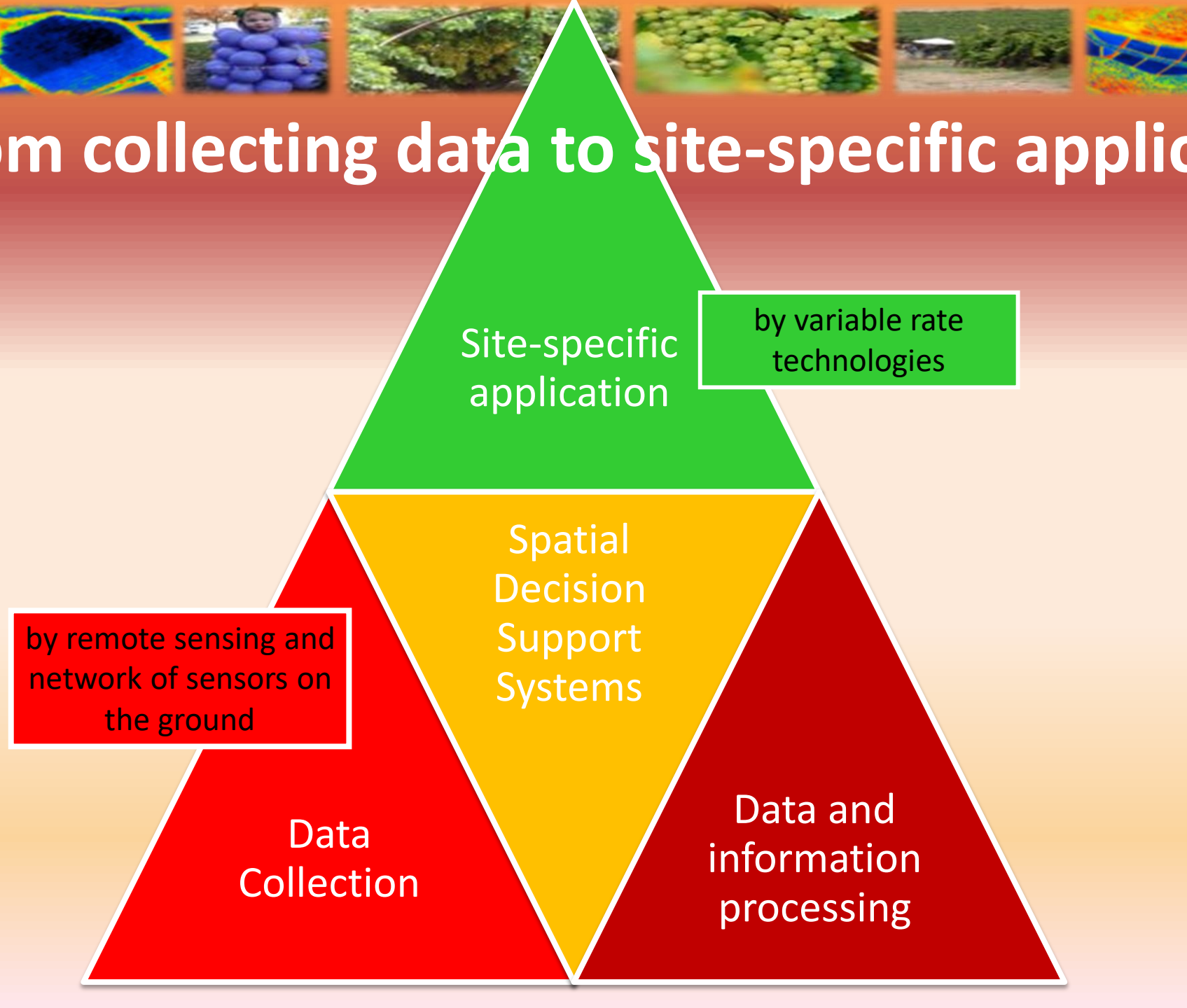
…oing

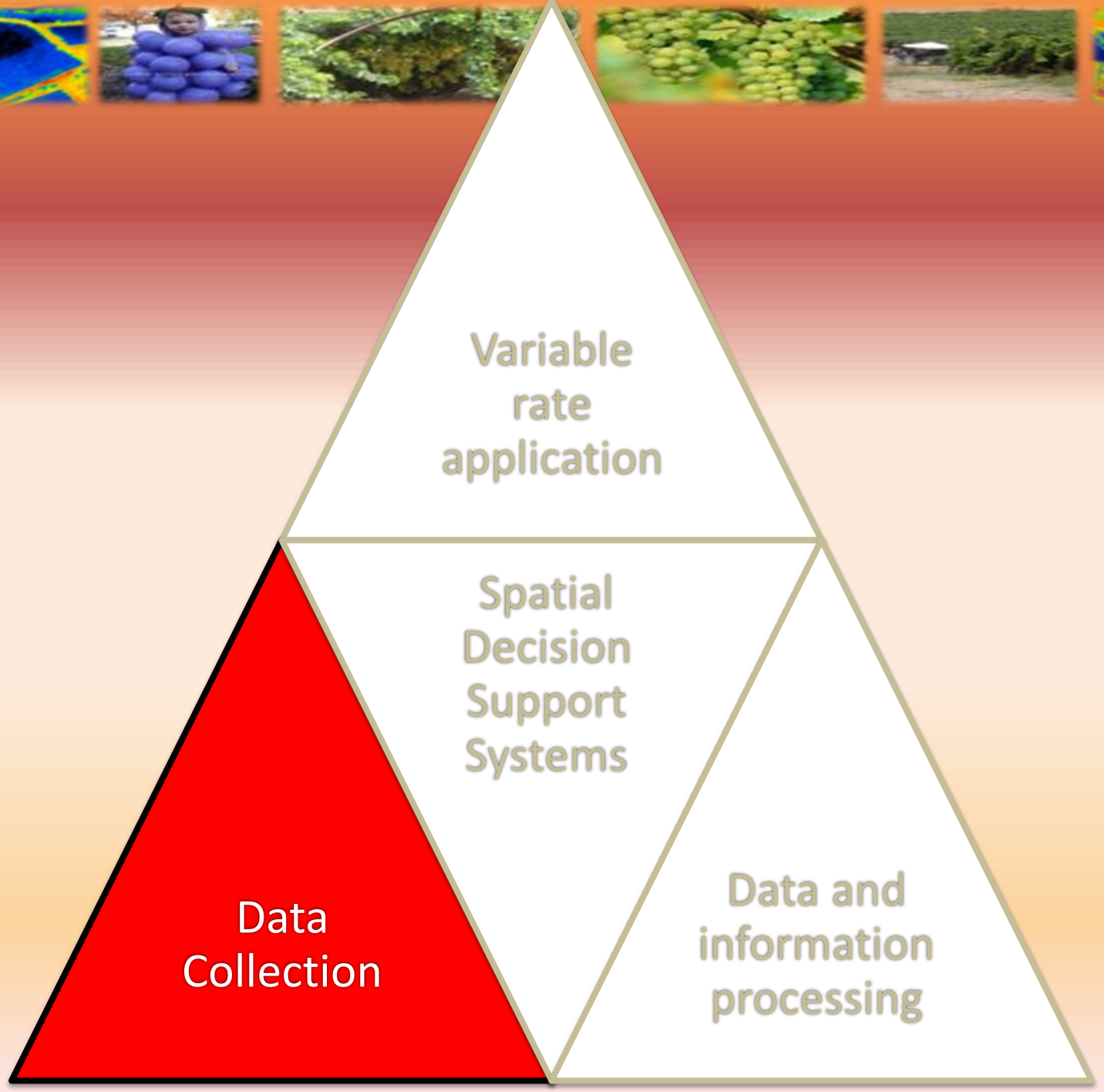
…e ***right*** thing

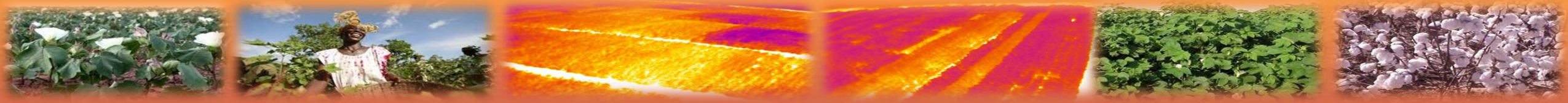
…***ht*** place

at t… ***ight*** time.

From collecting data to site-specific application




Variable rate application
Spatial Decision Support Systems
Data and information processing
Data Collection



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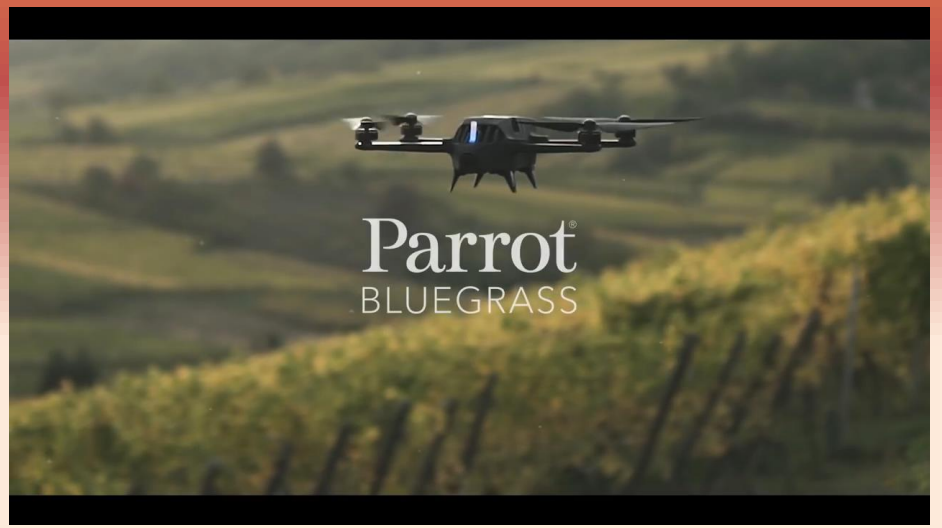

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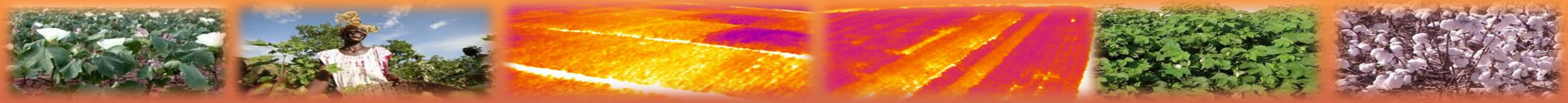
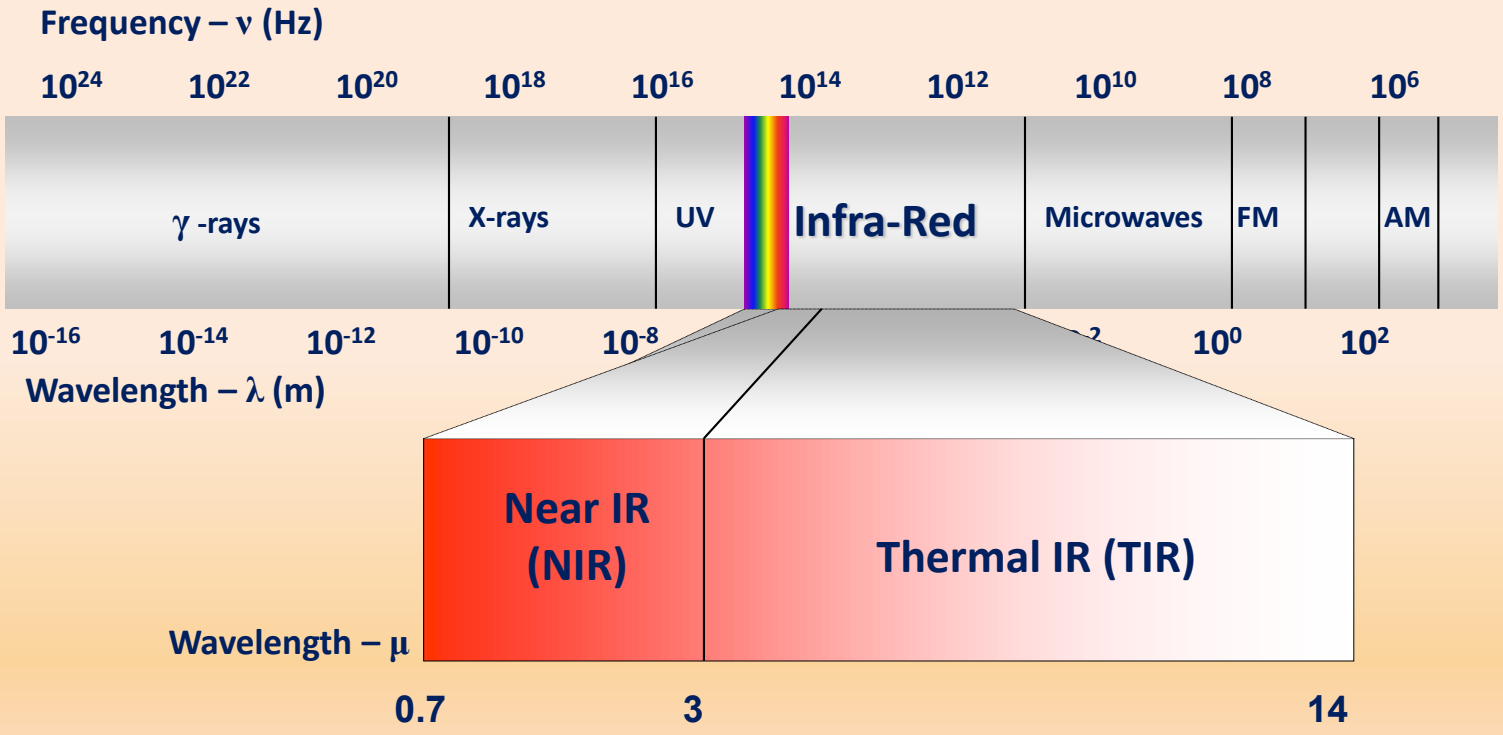
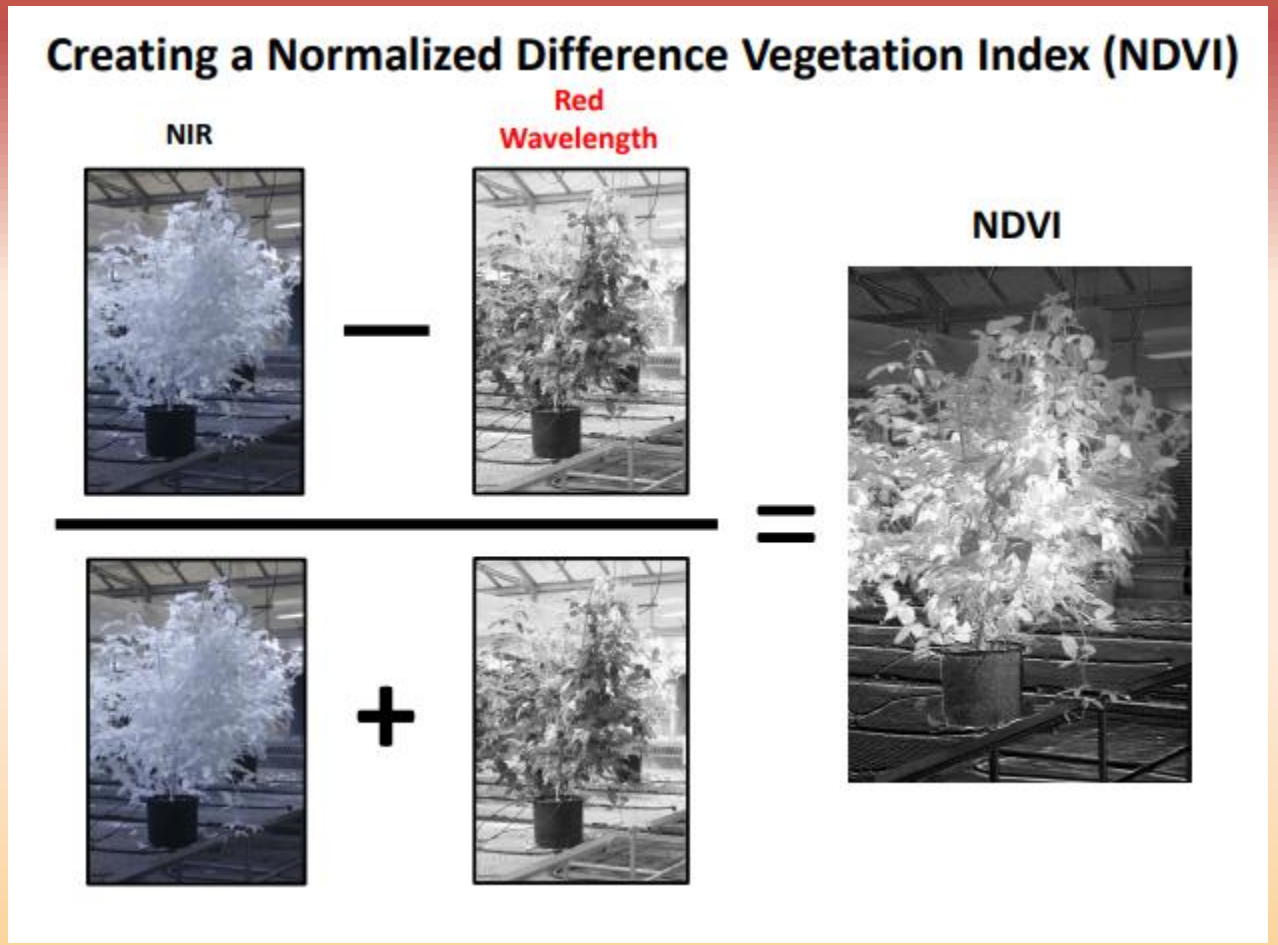
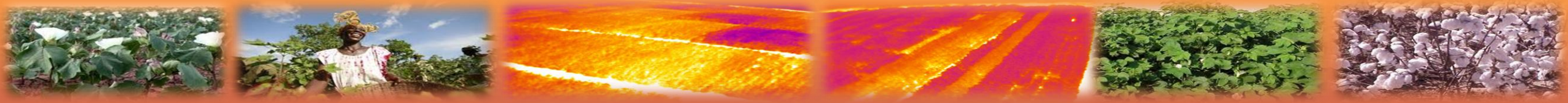


The electromagnetic spectrum

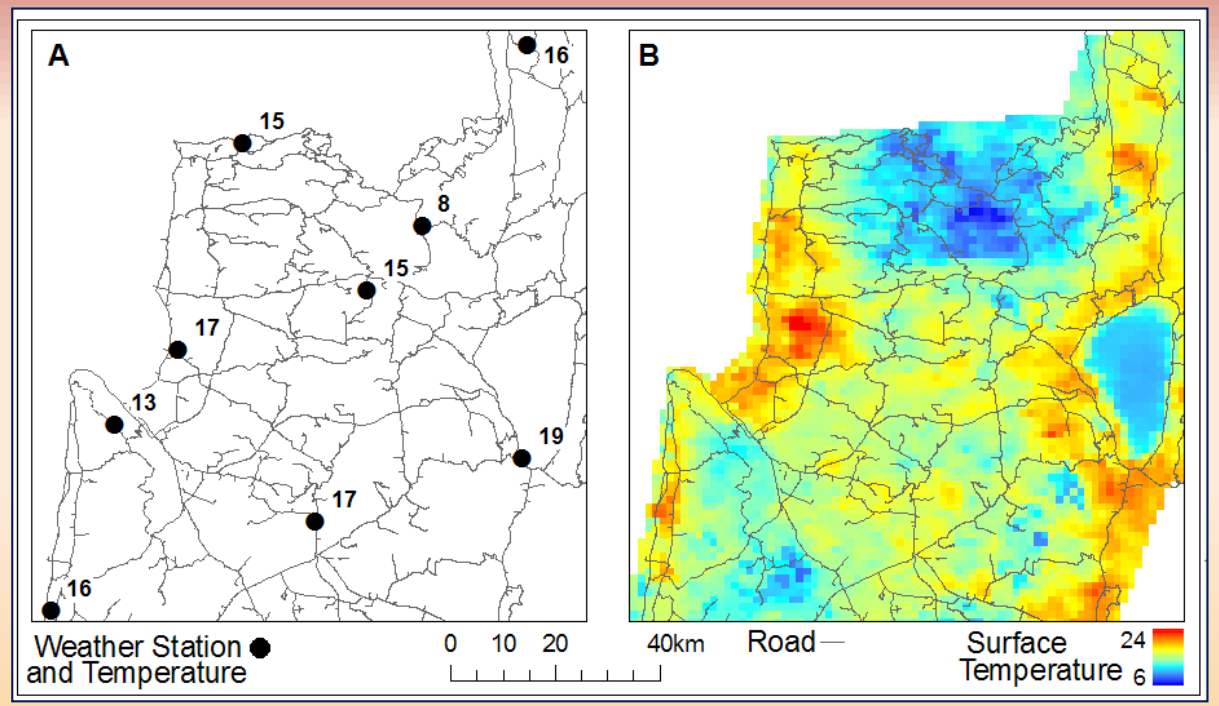


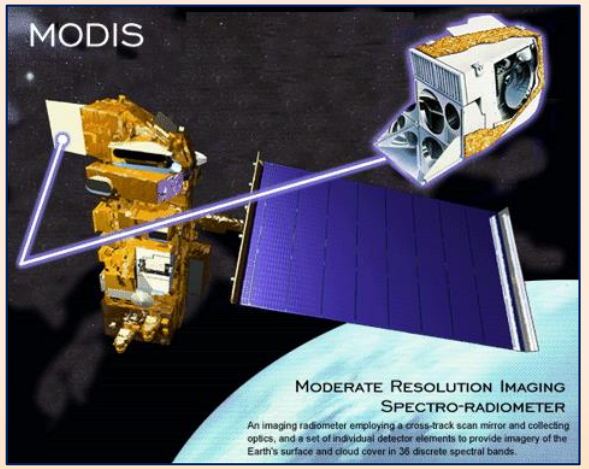


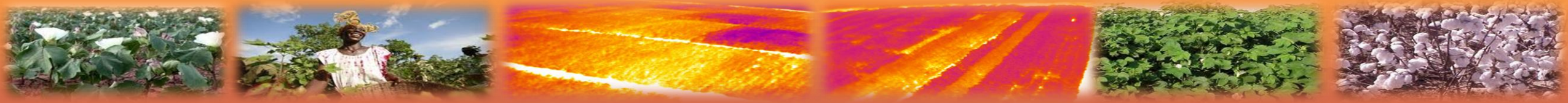
https://umanitoba.ca/faculties/afs/agronomists_conf/media/8_-_2-30_-_Price_Dec_11_2014_RoboFlight.pdf



MODIS -Daily surface temperature







Planet Labs

- https://www.youtube.com/watch?v=UHkEbemburs

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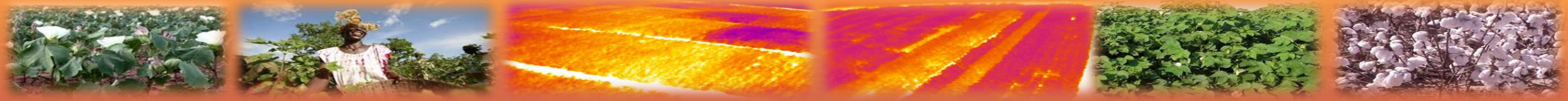
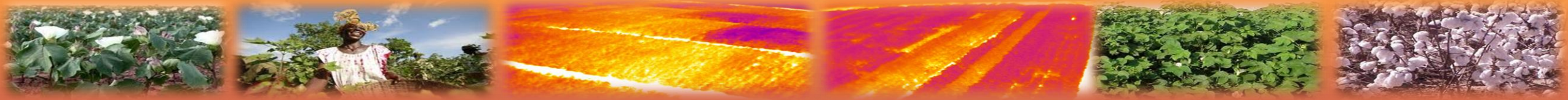


Current technology

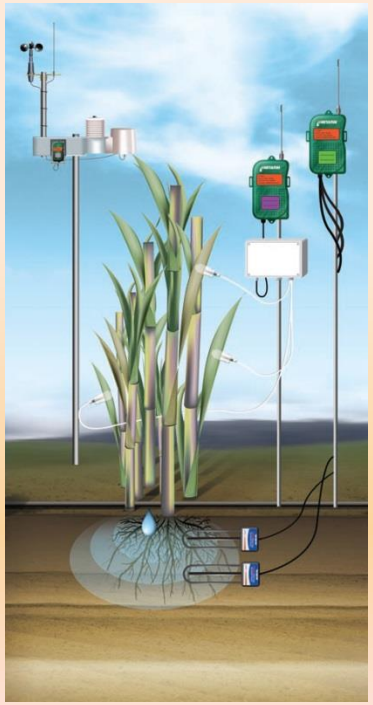
SNIPER

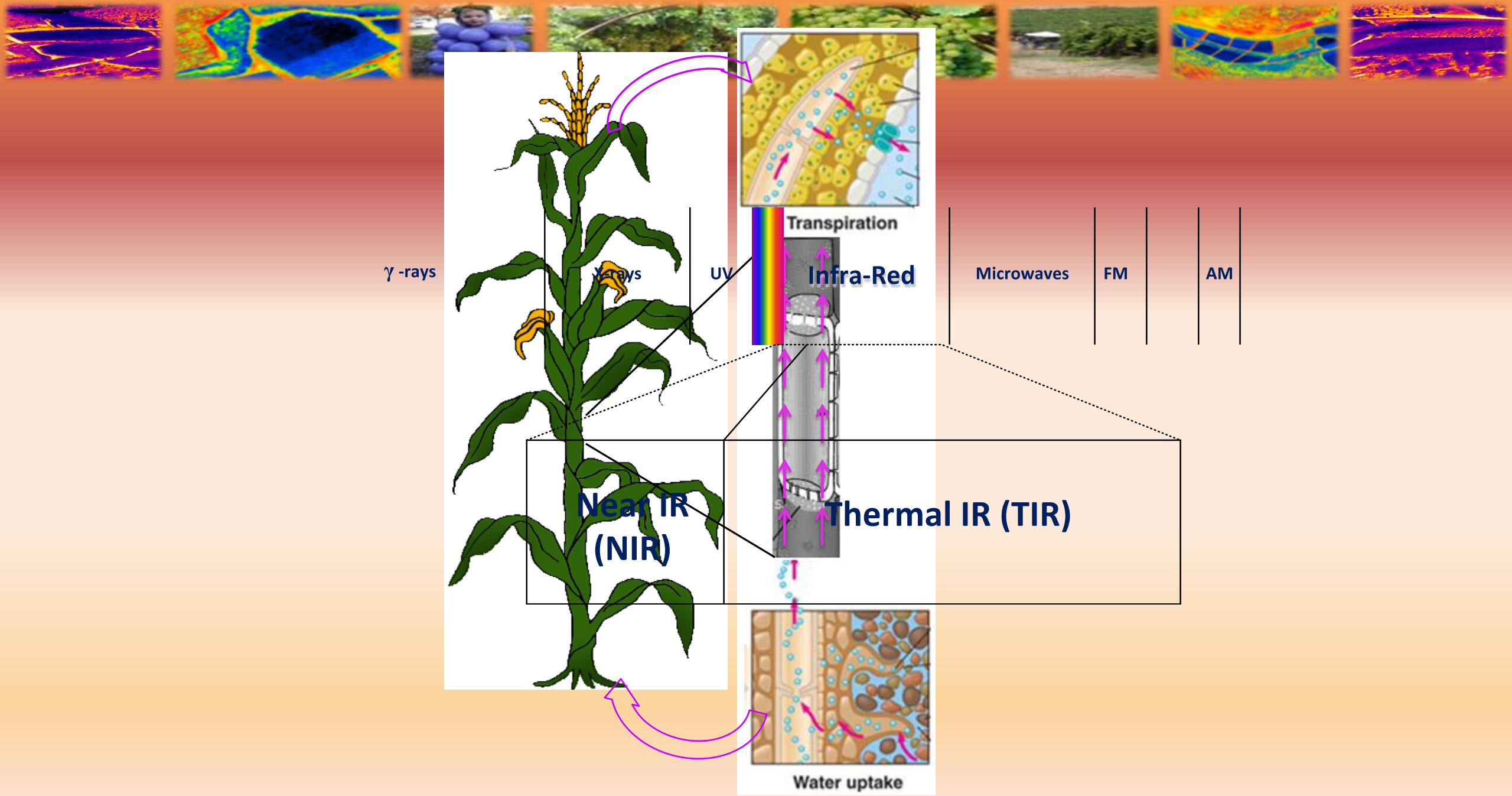

File
Preset
Map
Maintenance
Help
Alarms
Visionair
UAV
COM FAIL
NOT RECORDING

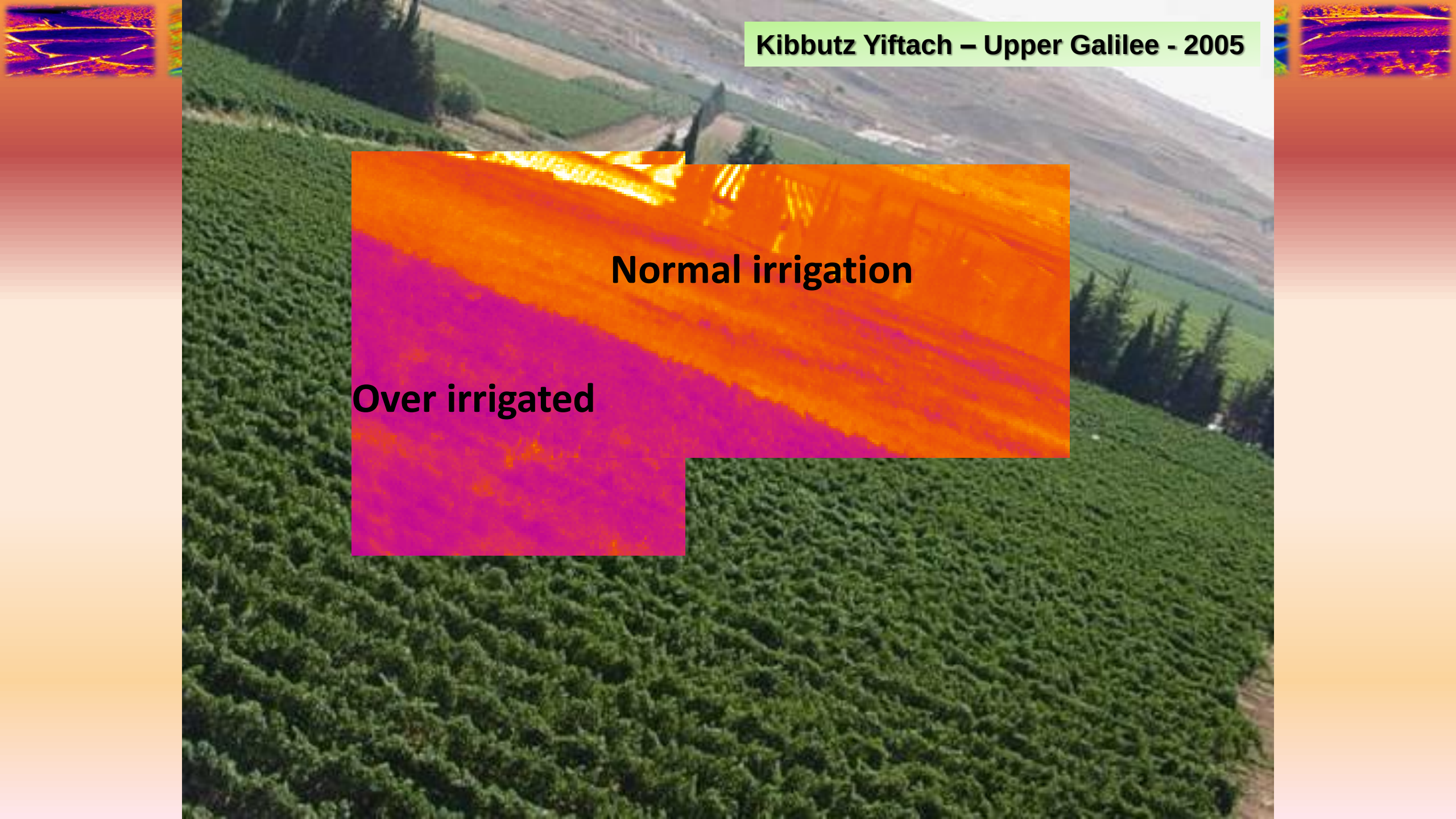


Irrigation management

- Pan A evaporation
- Model based ETp
- Soil water potential
- Leaf water potential
- Dendrometers and alike




γ -rays
X-rays
UV
Infra-Red
Microwaves
FM
AM
Transpiration
Near IR
(NIR)
Thermal IR (TIR)
Water uptake

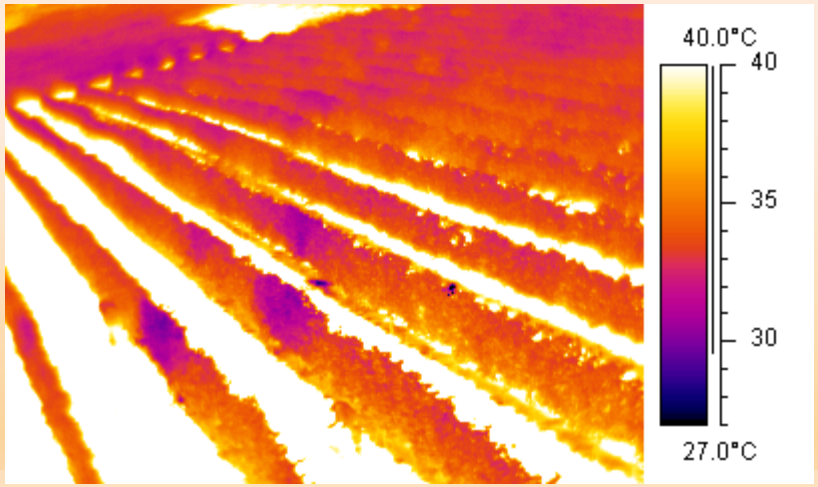

Kibbutz Yiftach – Upper Galilee - 2005
Normal irrigation
Over irrigated

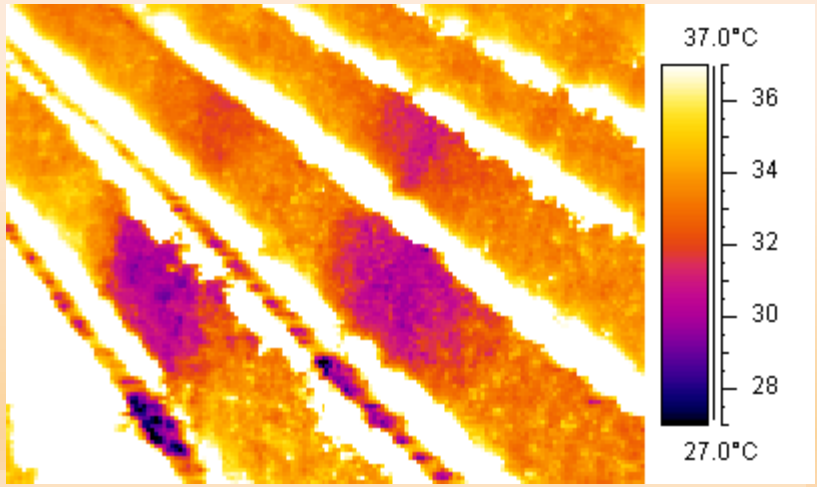
Detection of irrigation malfunctions: grapevines

Leach in single drippers…

Vineyard, Upper Galilee

Detection of irrigation malfunctions: grapevines

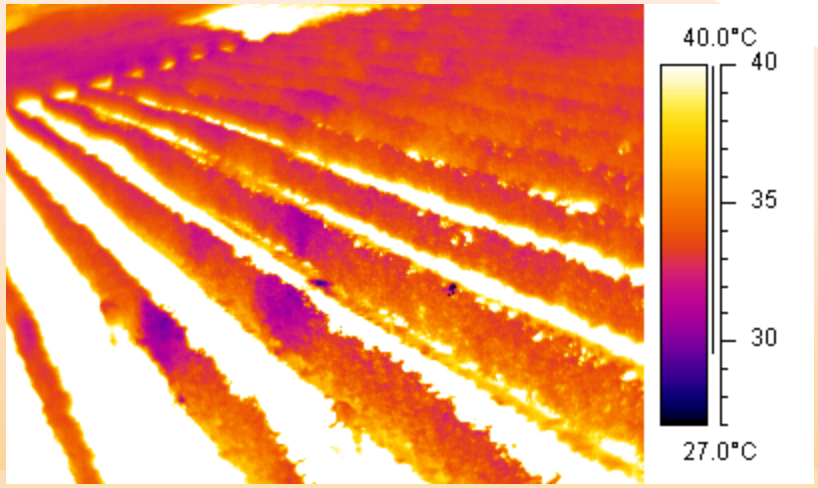




Leach in single drippers…

Vineyard, Upper Galilee

Thermal images can detect change in water status before it is seen by bare eyes

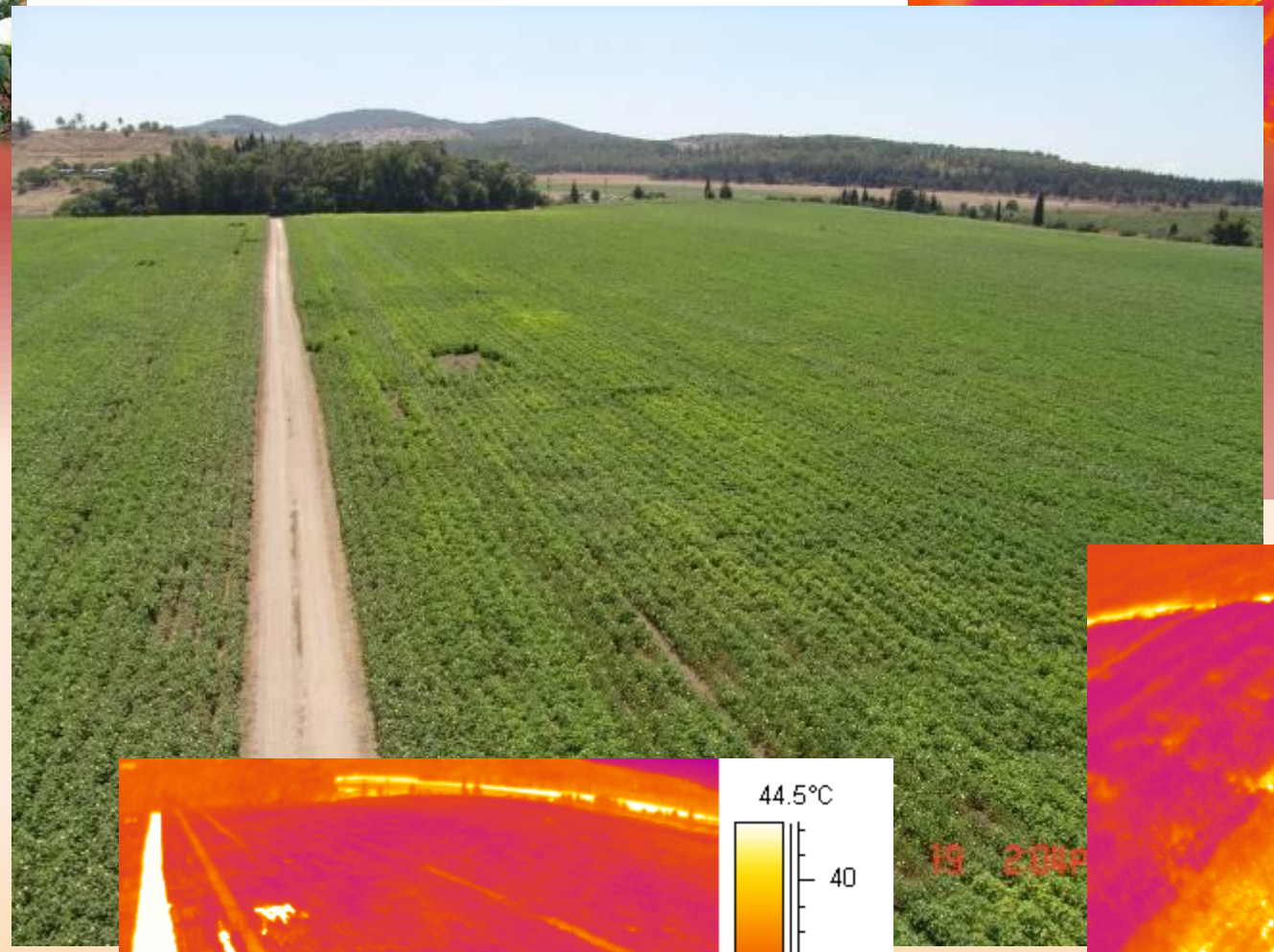


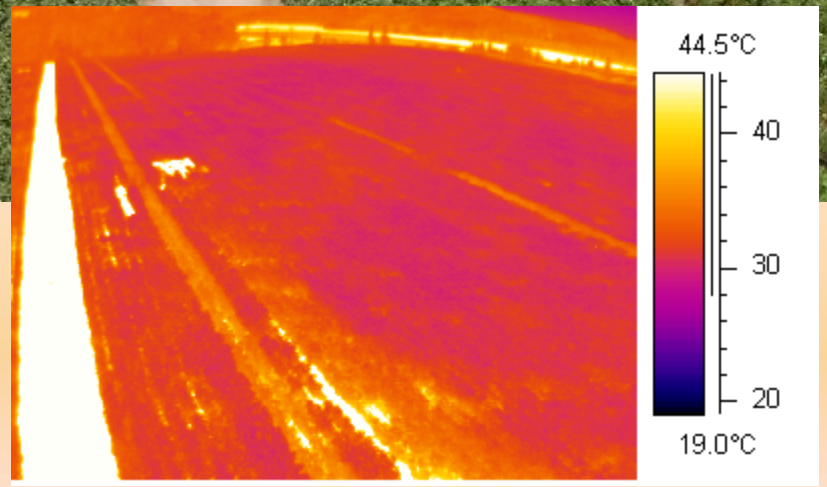
Leach in single drippers…

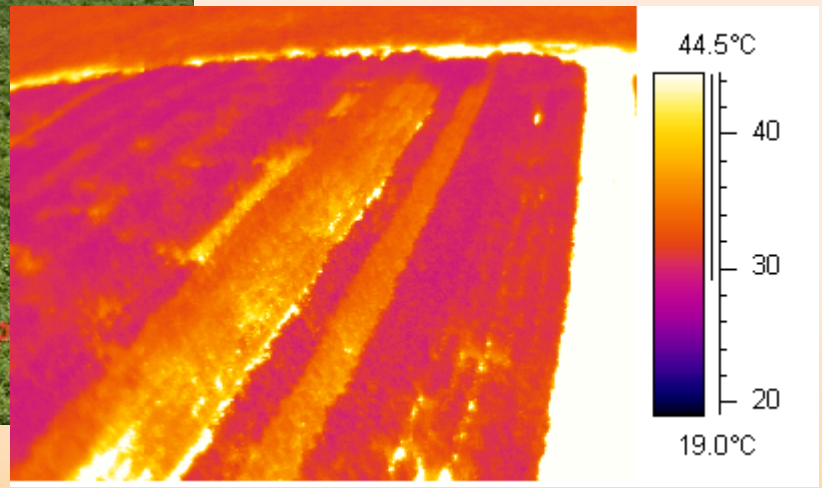
Vineyard, Upper Galilee



Detection of irrigation malfunctions: cotton

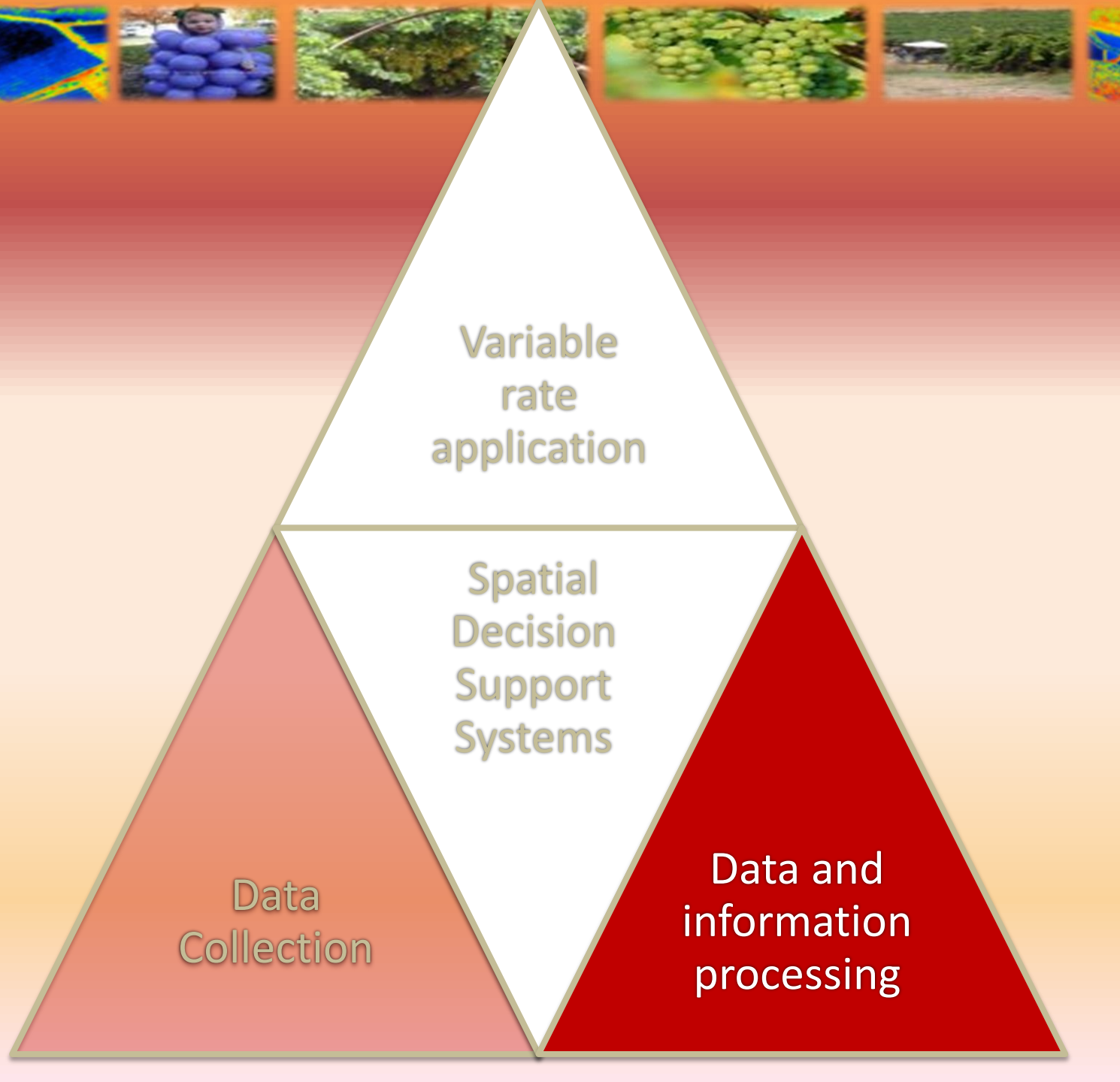






Clogging in drippers…

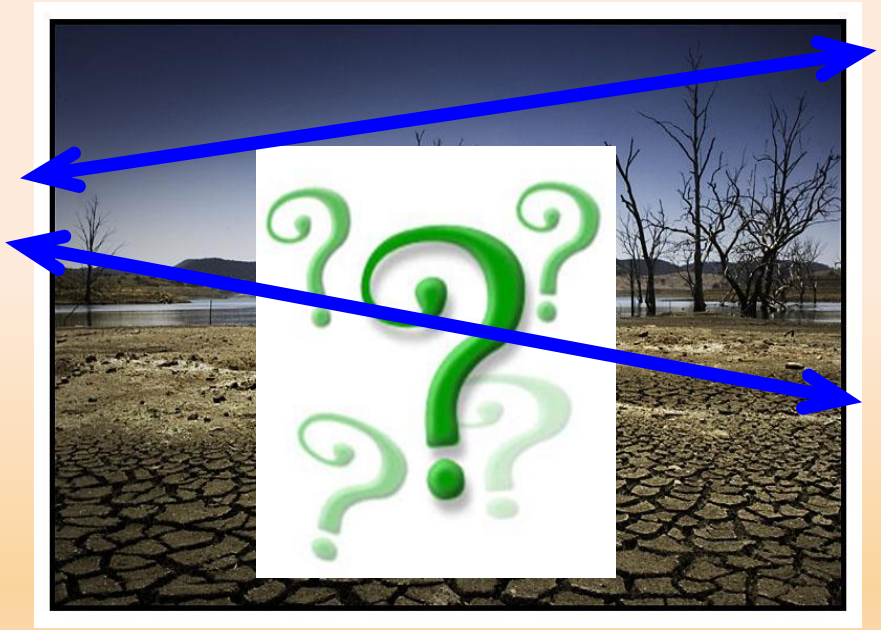
Cotton, Northern Israel, Megido


Variable rate application
Spatial Decision Support Systems
Data Collection
Data and information processing

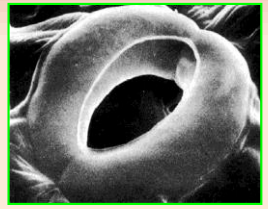
Irrigation Scheduling

Water Stress

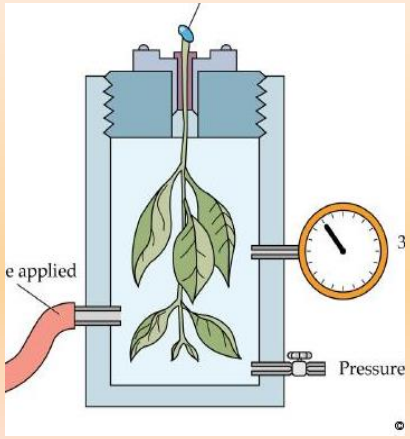
Canopy Temperature



Stomatal Conductance

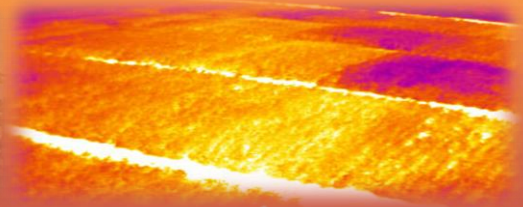
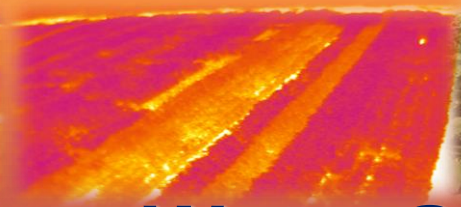


Leaf Water Potential



Pressure Chamber



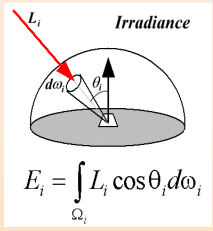



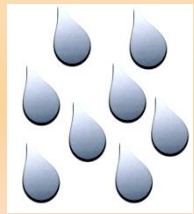
Canopy Temperature ↔ Water Stress

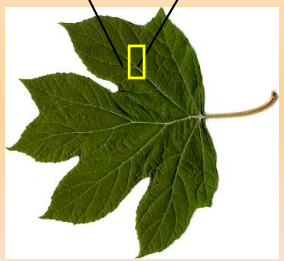
Canopy temperature as is ≠ crop water status

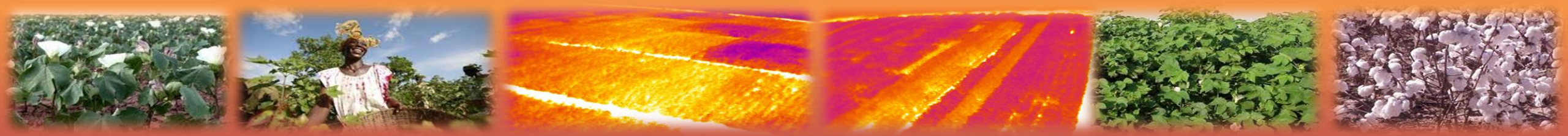
Leaf temperature **is** a function of:

- Air temperature
- Net Radiation
- Wind speed
- Vapor Pressure Deficit (VPD)
- Leaf Boundary Layer









Crop Water stress Index – CWSI

A Quantitative way to measure crop water stress via canopy temperature

$$CWSI = \frac{(T_{canopy} - T_{min})}{(T_{max} - T_{min})}$$

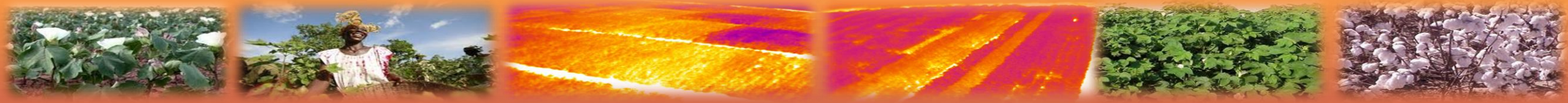
were:

- T_{canopy} = measured canopy temperature
- T_{min} = Fully transpiring leaves temperature
- T_{max} = Fully stressed leaves temperature

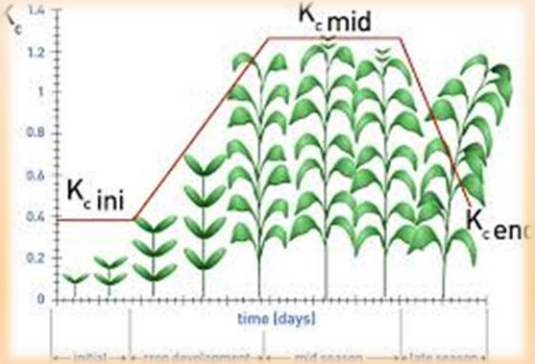
Lower Baseline

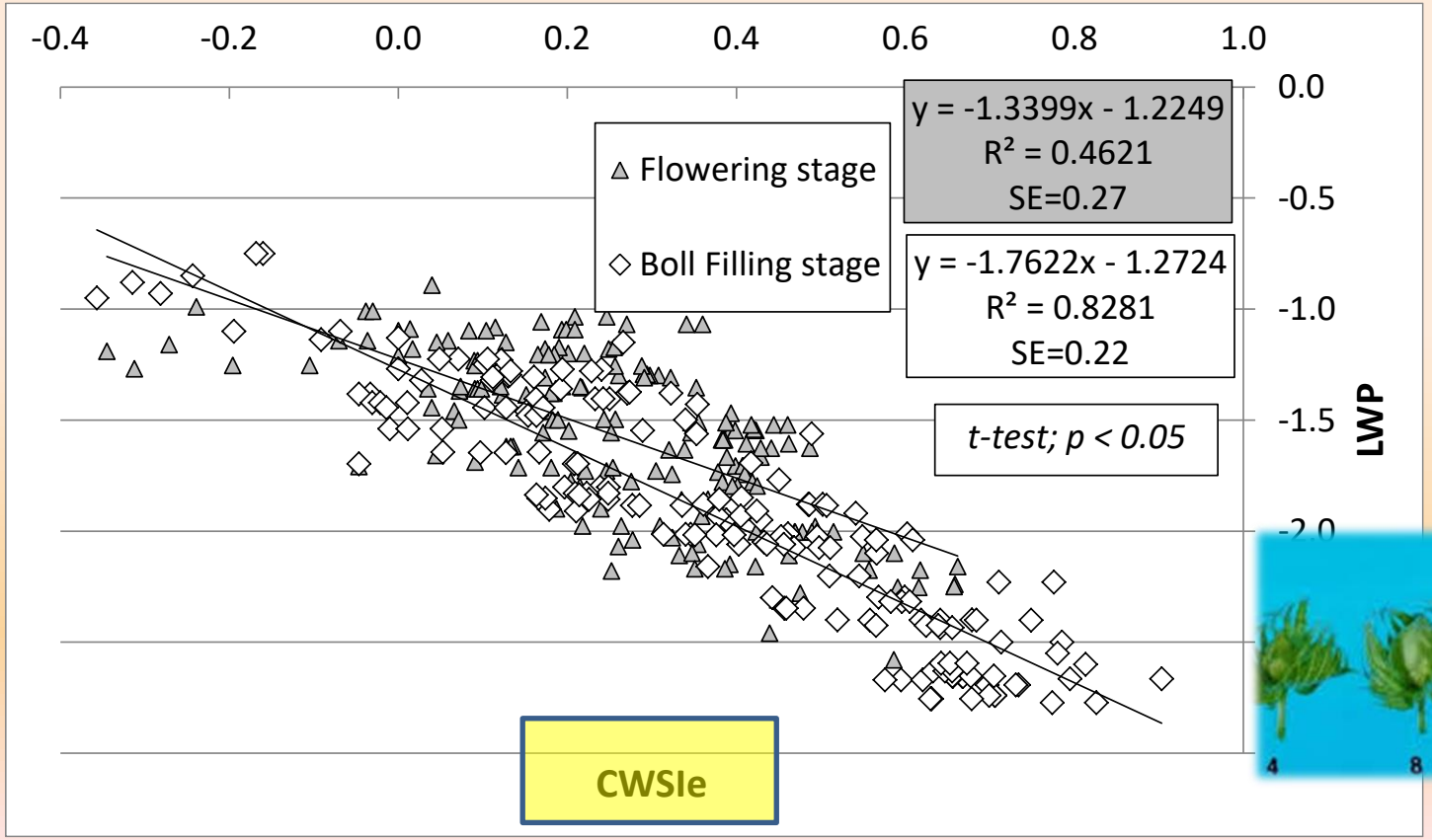
Upper Baseline

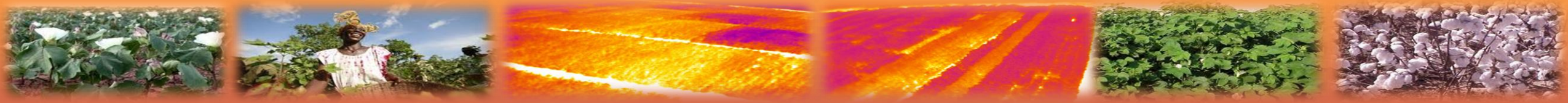
(Idso *et al*., 1981)



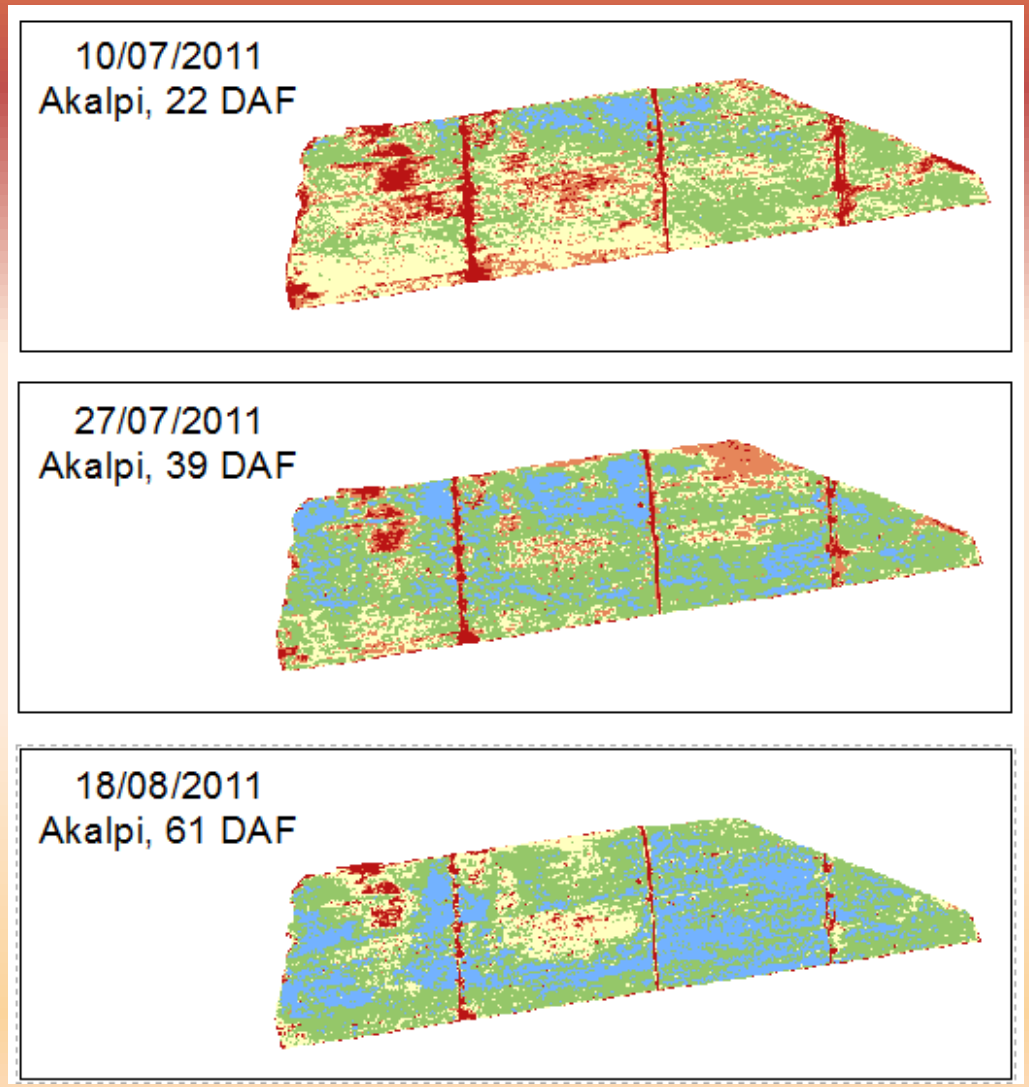
Model for cotton irrigation management using Thermal Remote Sensing

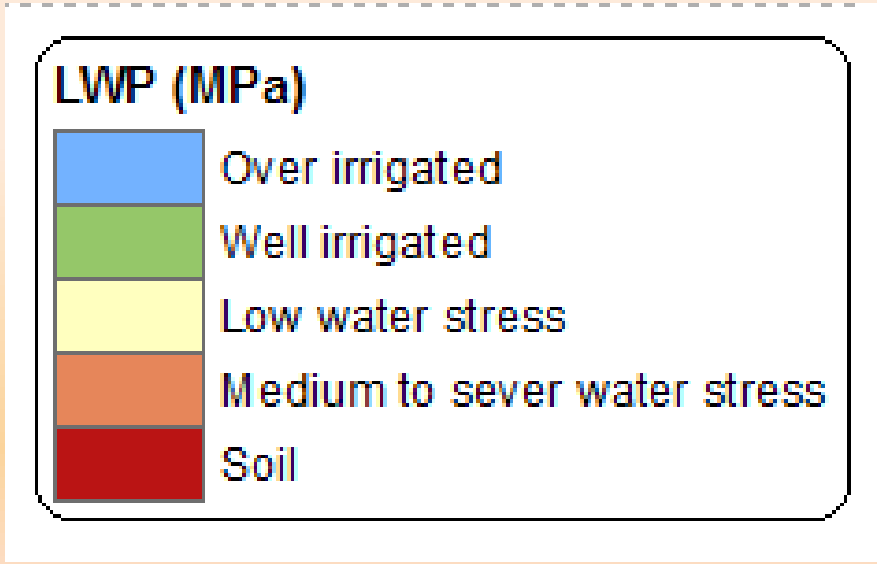






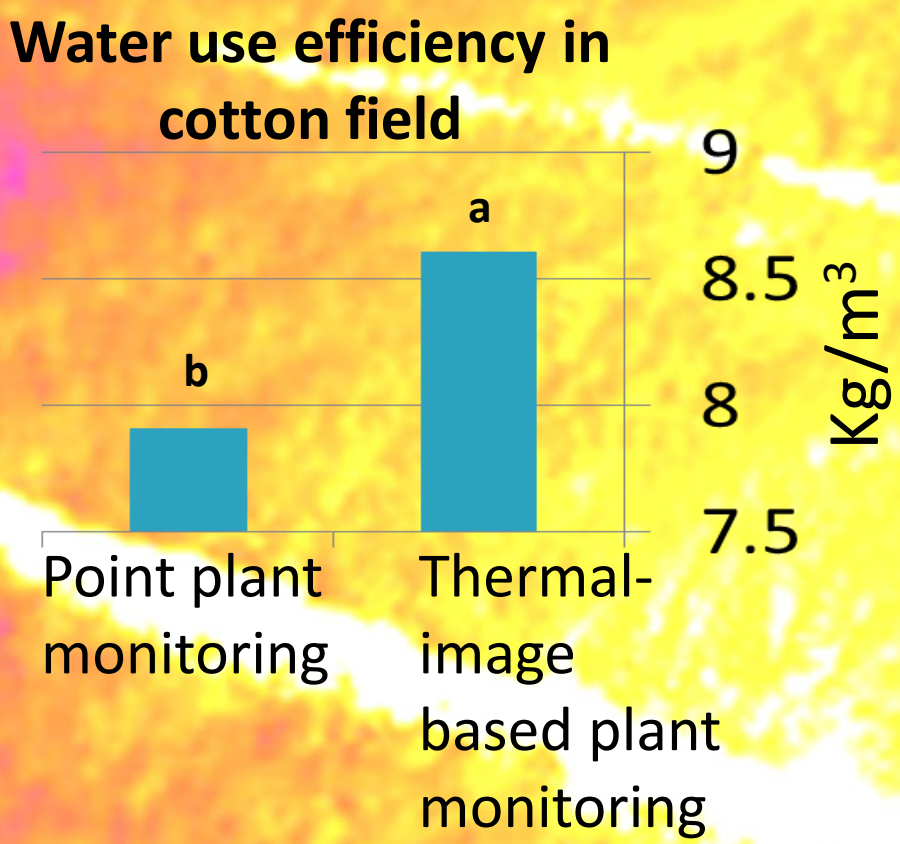
Semi automated mapping of leaf water potential enables irrigation management of commercial fields





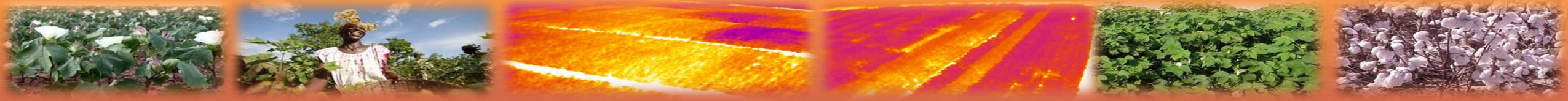
Cohen, Y., et al. 2017. *Precision Agriculture* 18(5):801-822.

Irrigation management using remote thermal sensing

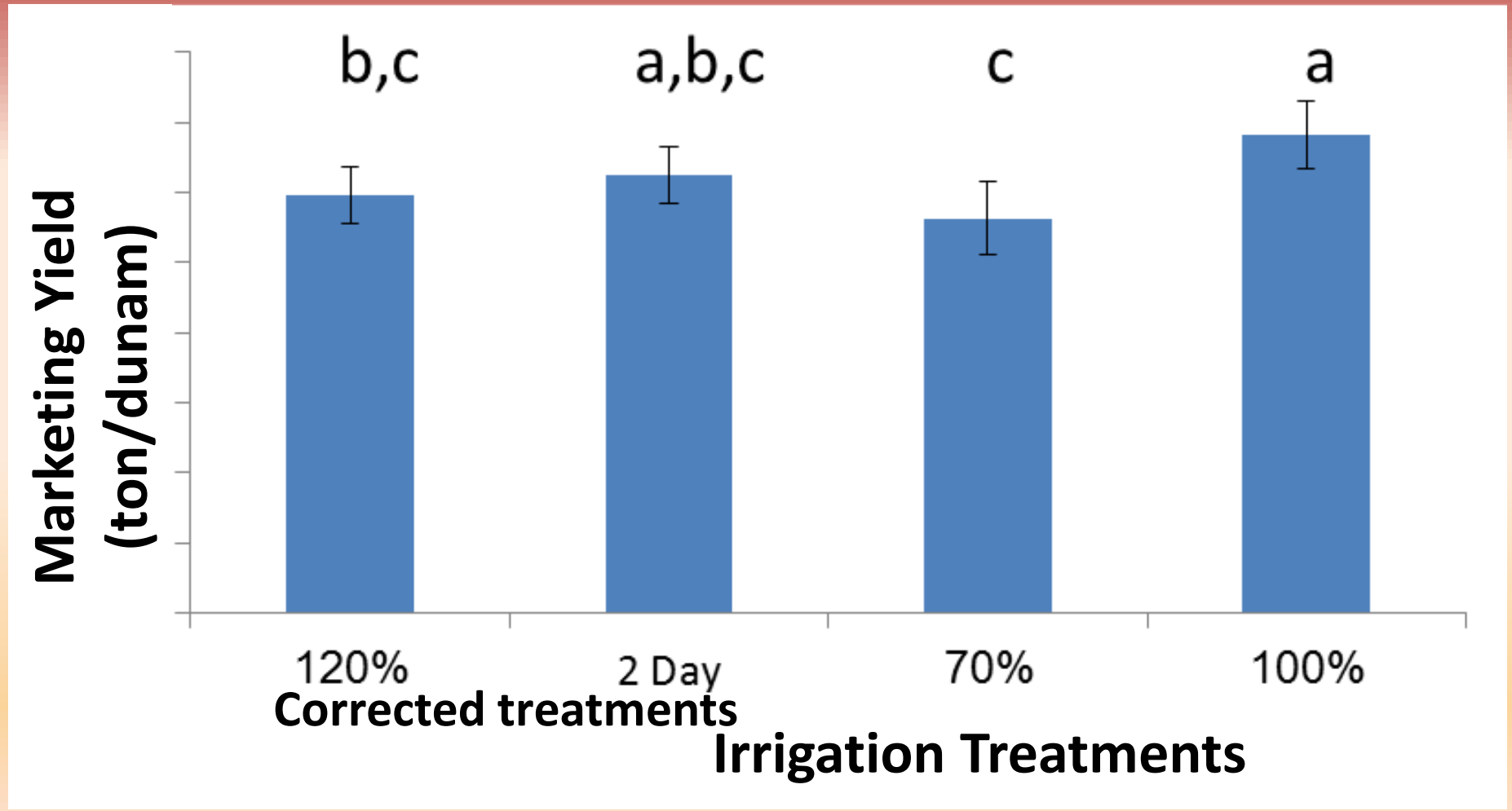


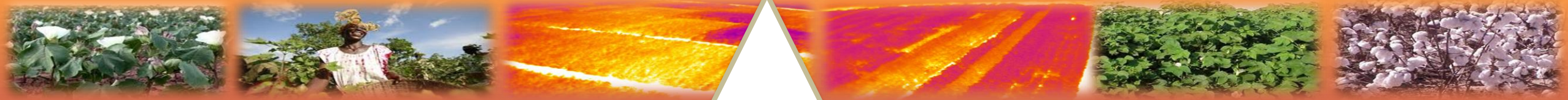
Thermal imaging can increase water use efficiency

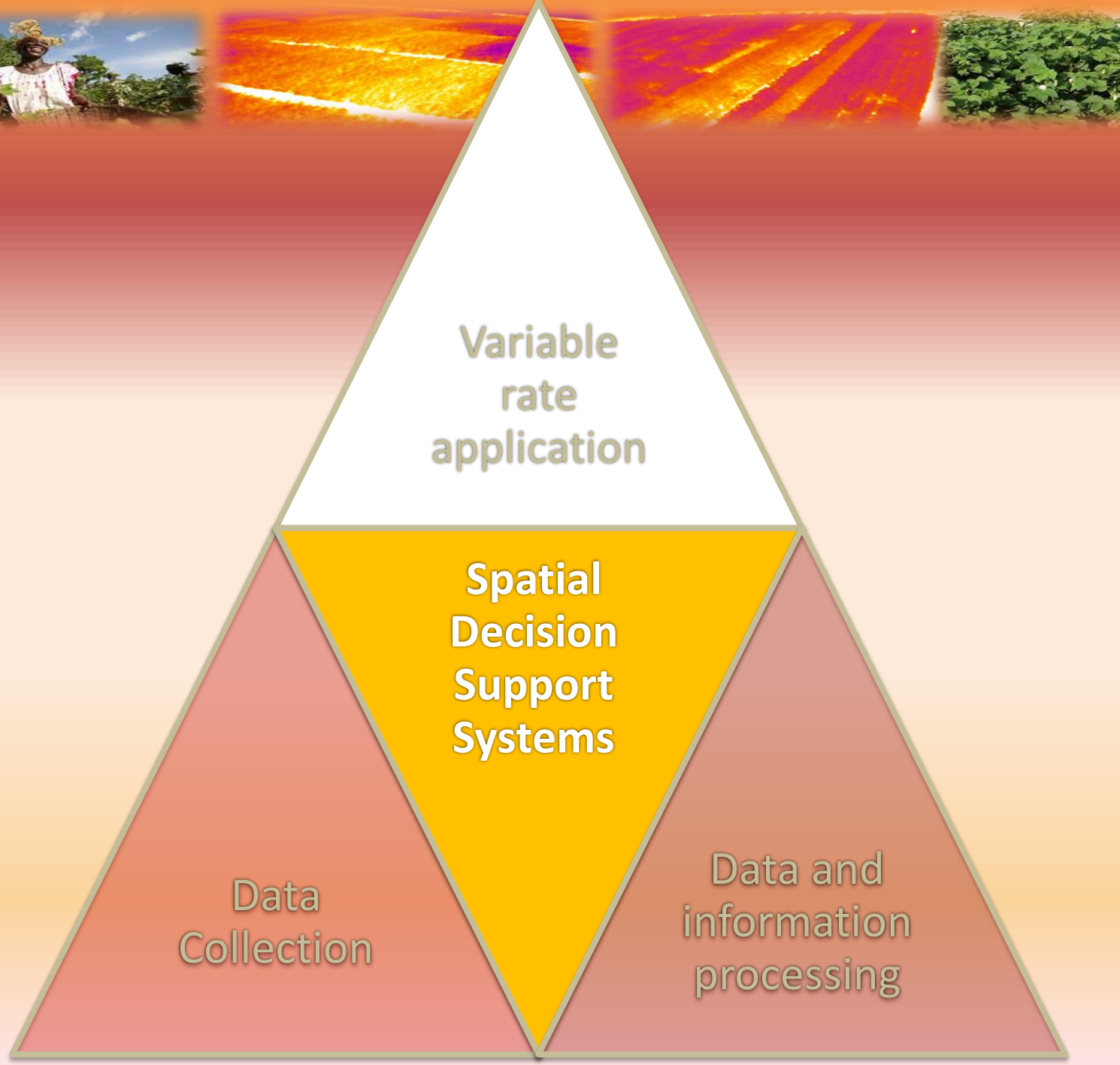
(Rosenberg et al., 2014, 2015)

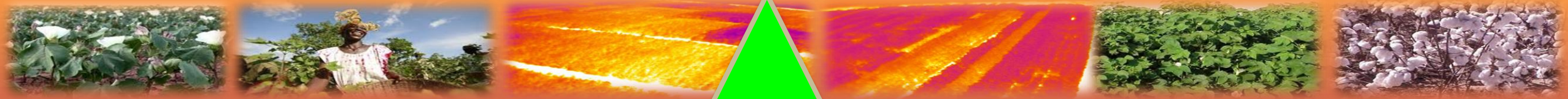


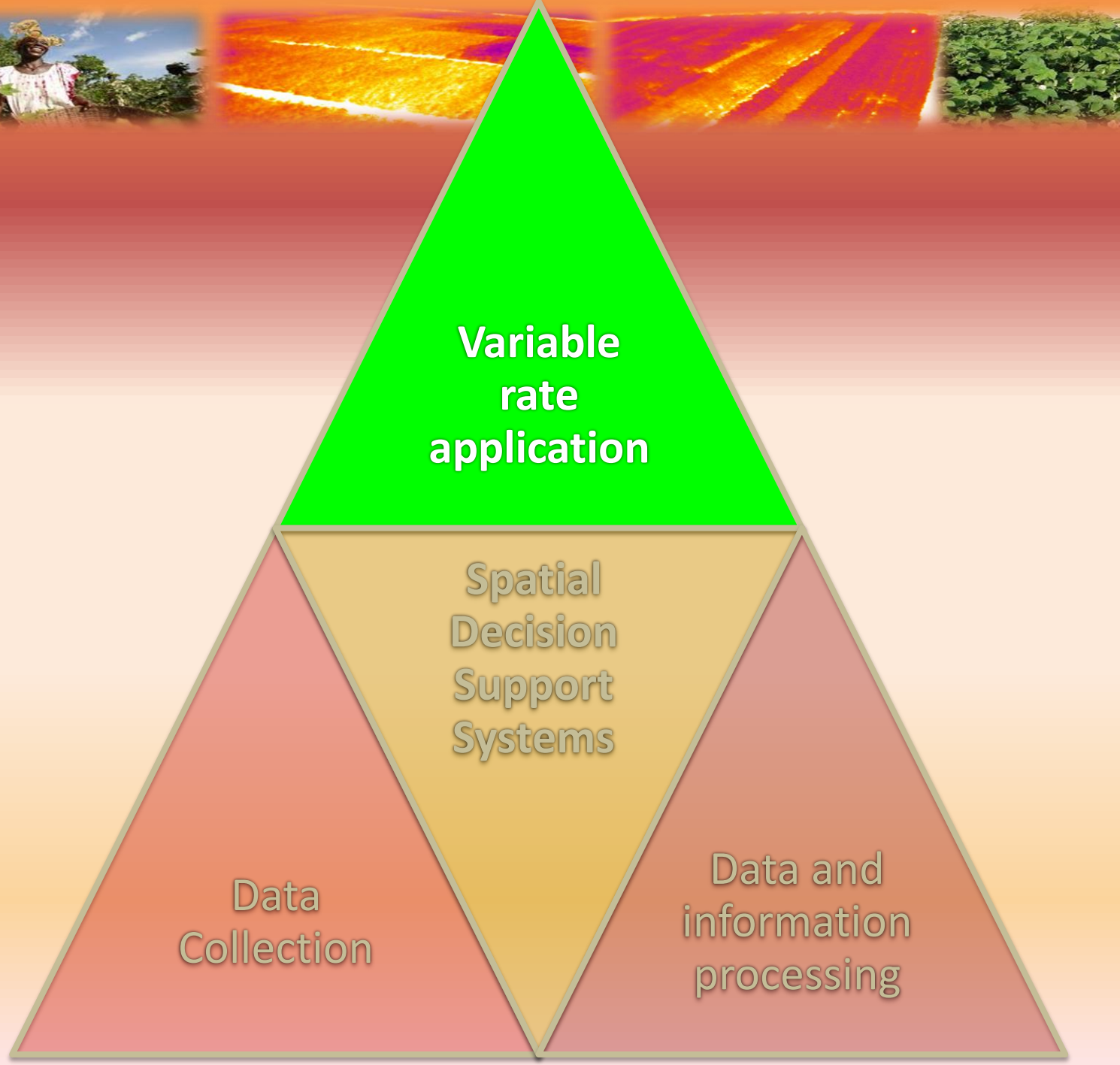
Yield - Potatoes






Variable rate application
Spatial Decision Support Systems
Data Collection
Data and information processing

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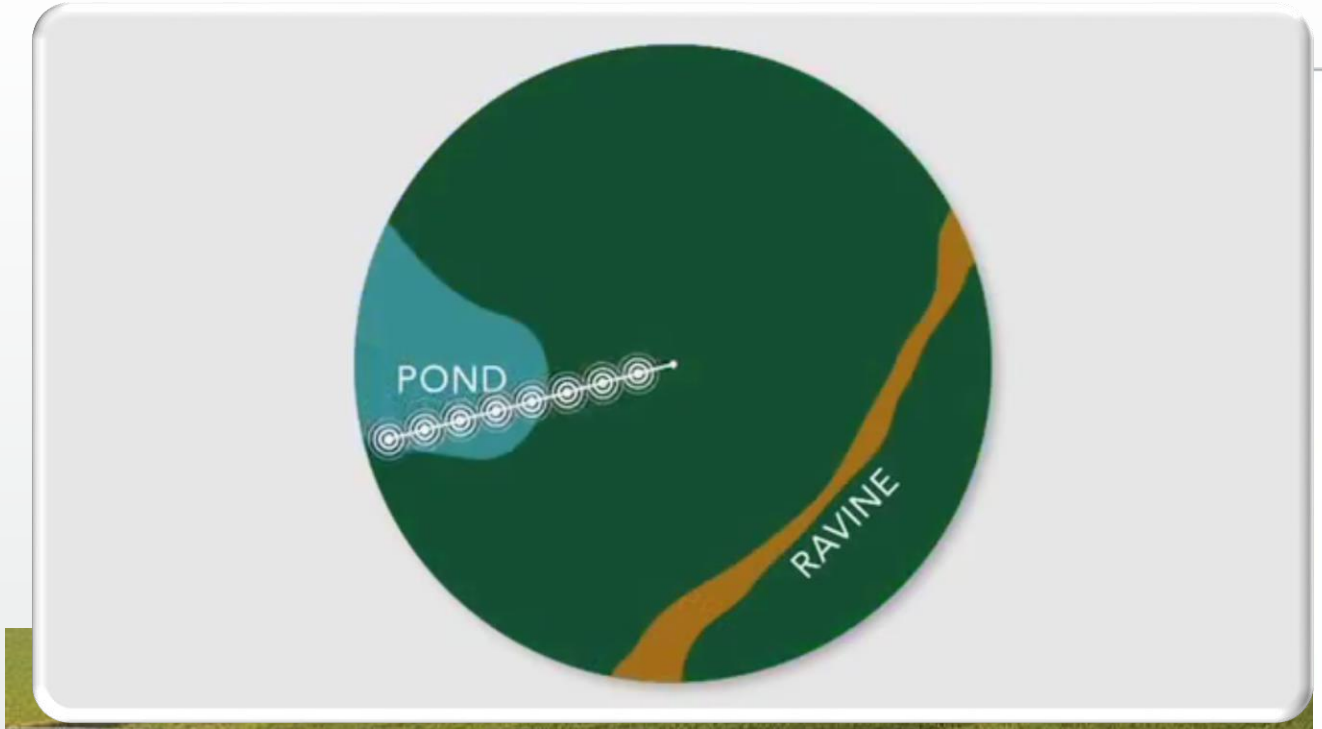
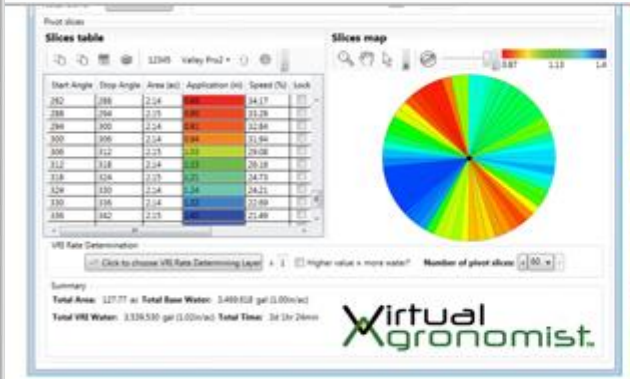
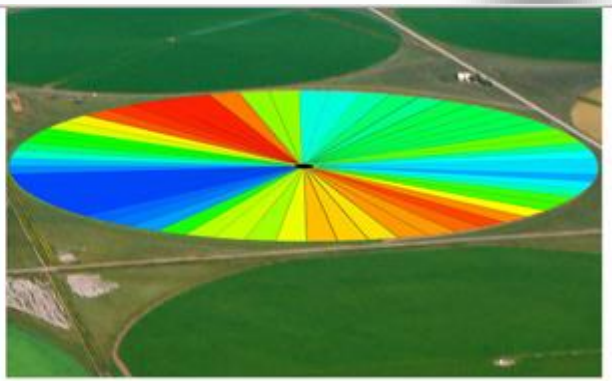
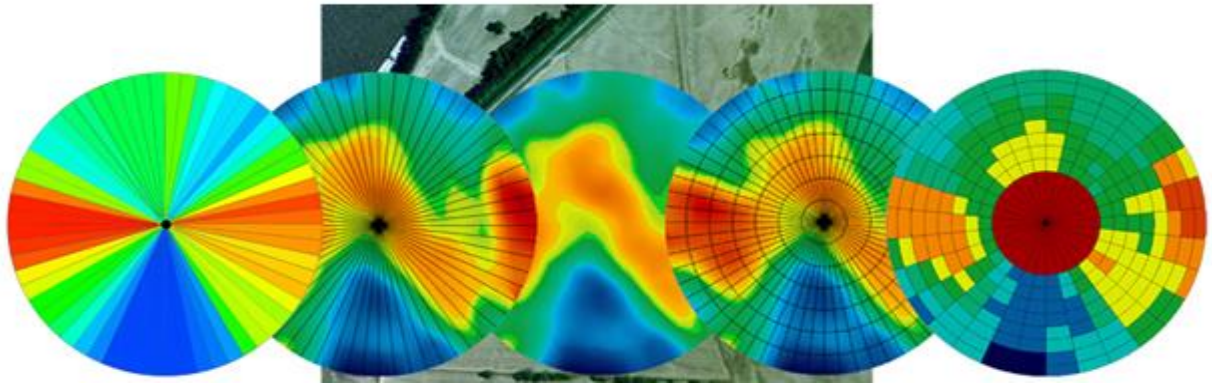
Variable rate irrigation

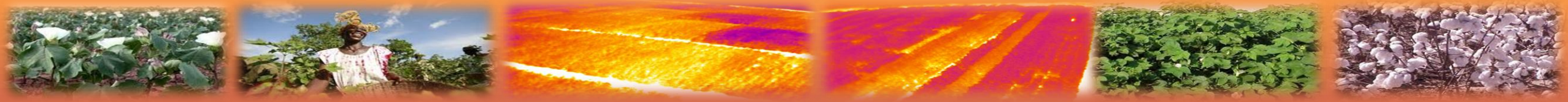






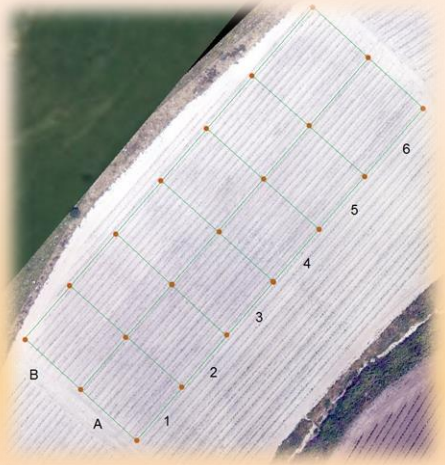


http://cropmetrics.com/features/variable-rate-irrigation/

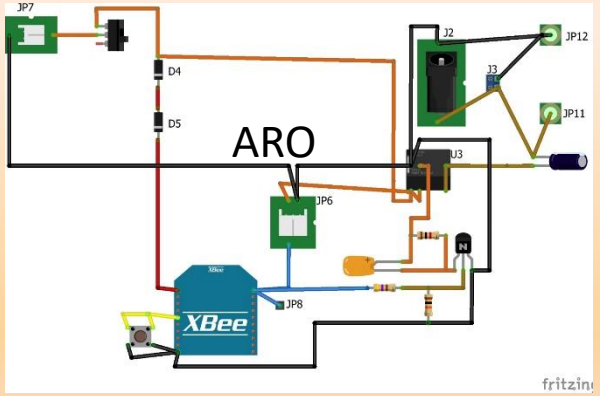


VRI in drip and micro irrigation

- Prototypes constructed by Netafim and ARO
- Dripper with VRI capabilities under development in ARO



NETAFIM™



Thermal imaging for the detection of biotic stress in orchards

The red palm weevil
Rhynchophorus ferrugineus (Olivier)

The red palm weevil, *Rhynchophorus ferrugineus*, is a species of snout beetle

Larva

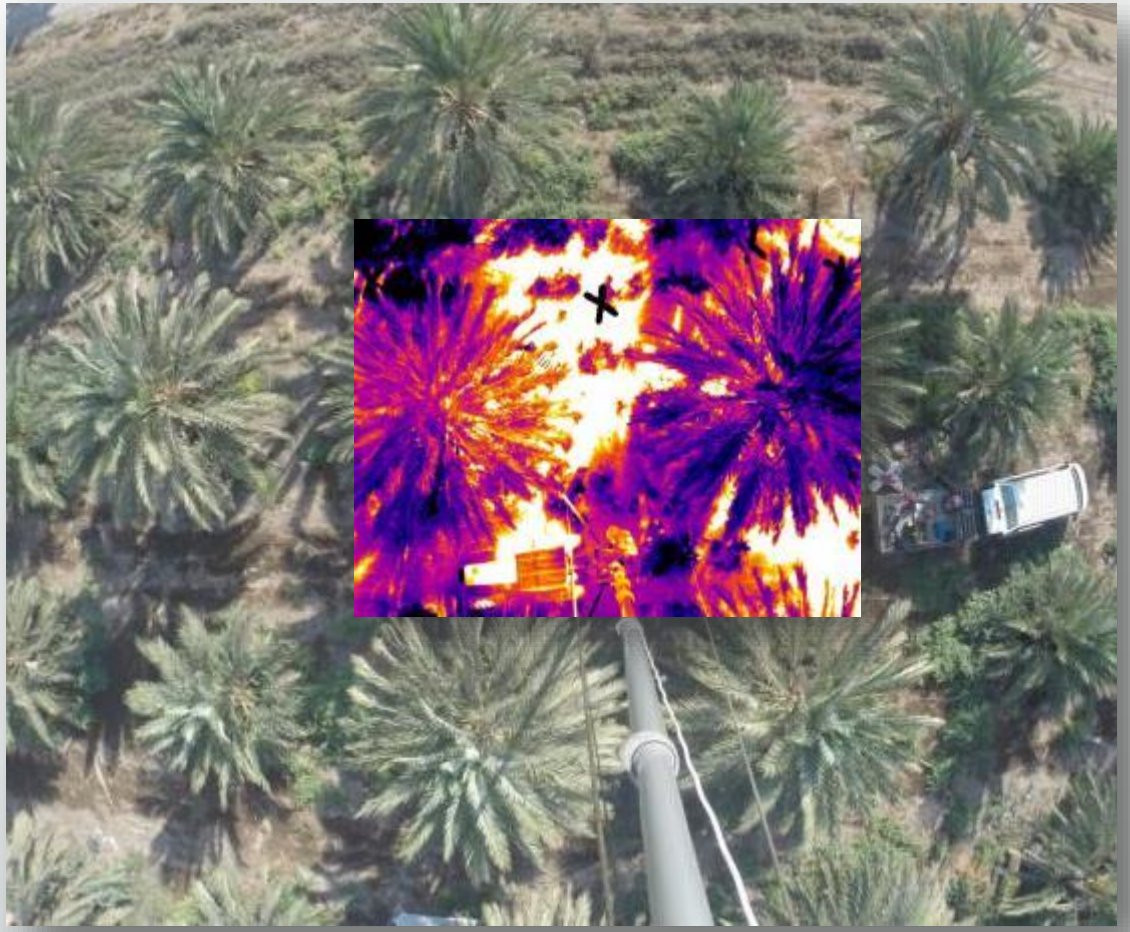
Pupal Case

Pupa

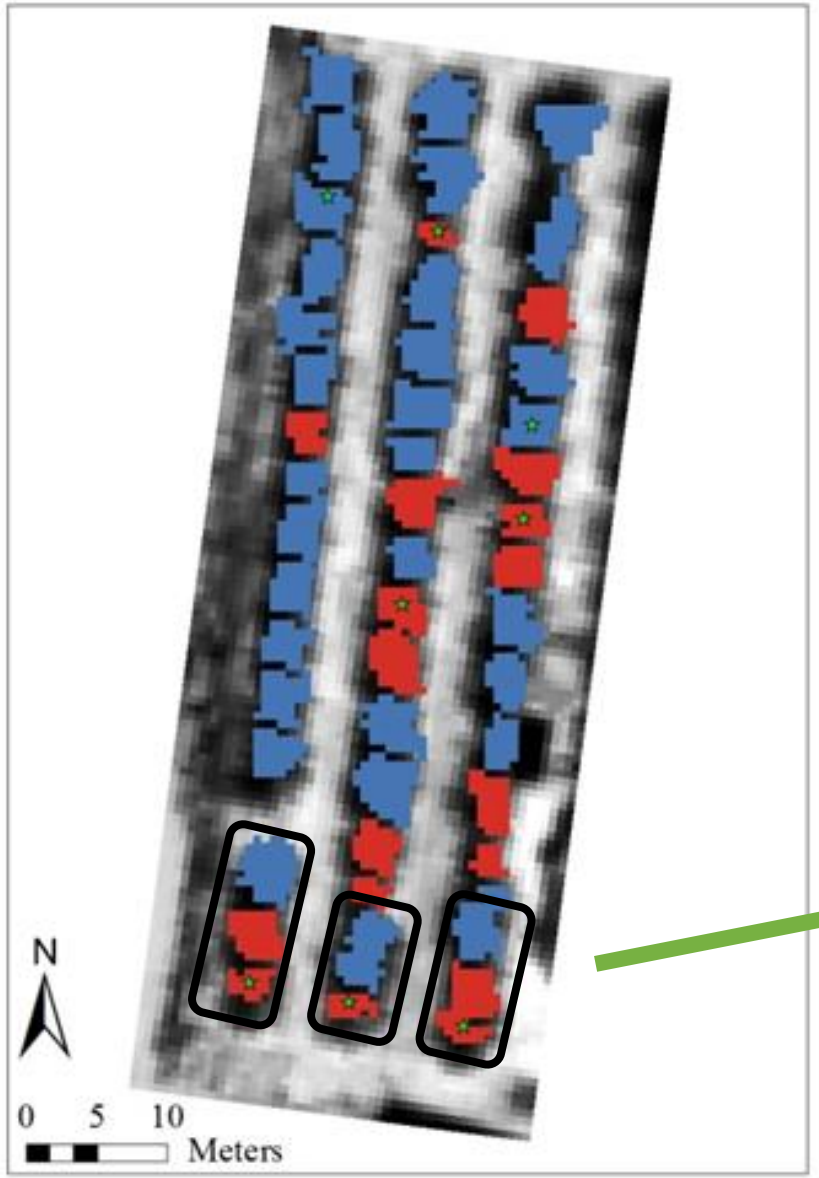
Adults

https://en.wikipedia.org/wiki/Rhynchophorus_ferrugineus

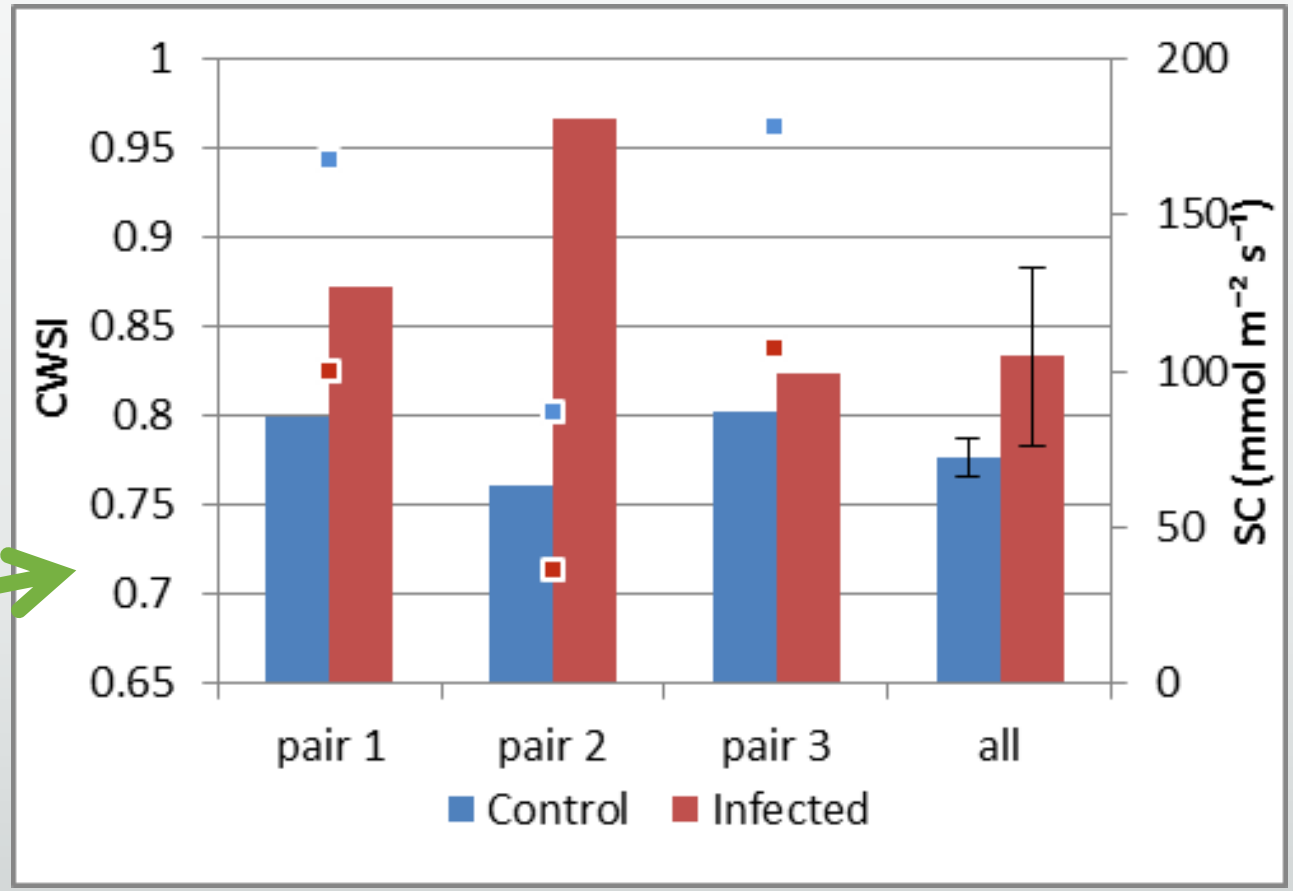
Diurnal dynamic of canopy temperature - commercial orchard



Ma’ale Gamla. 'Hayani' date palm, Sep. 2013

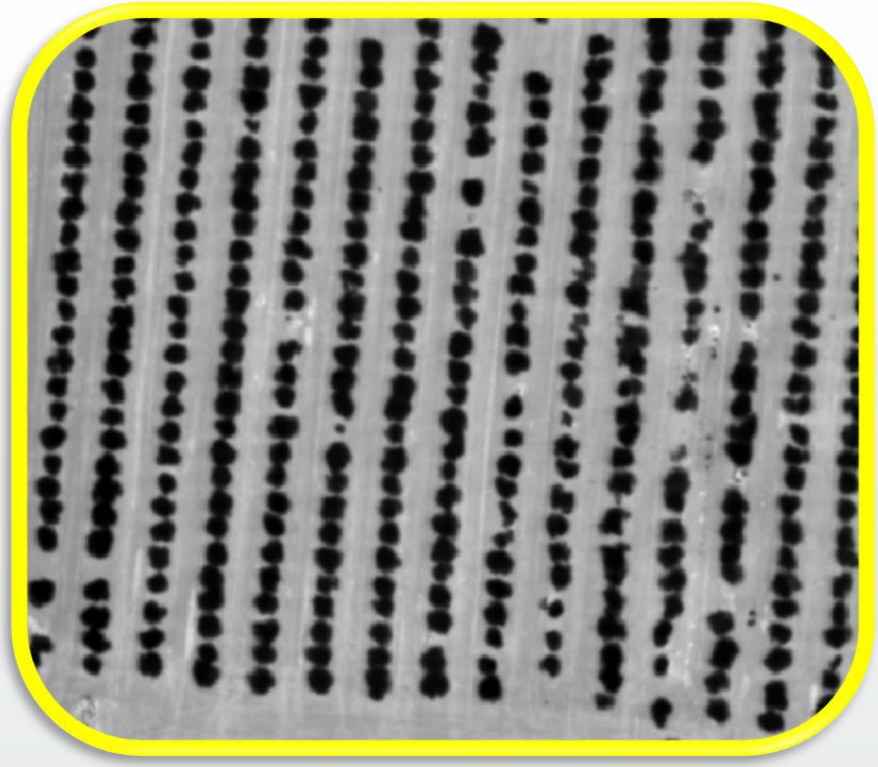


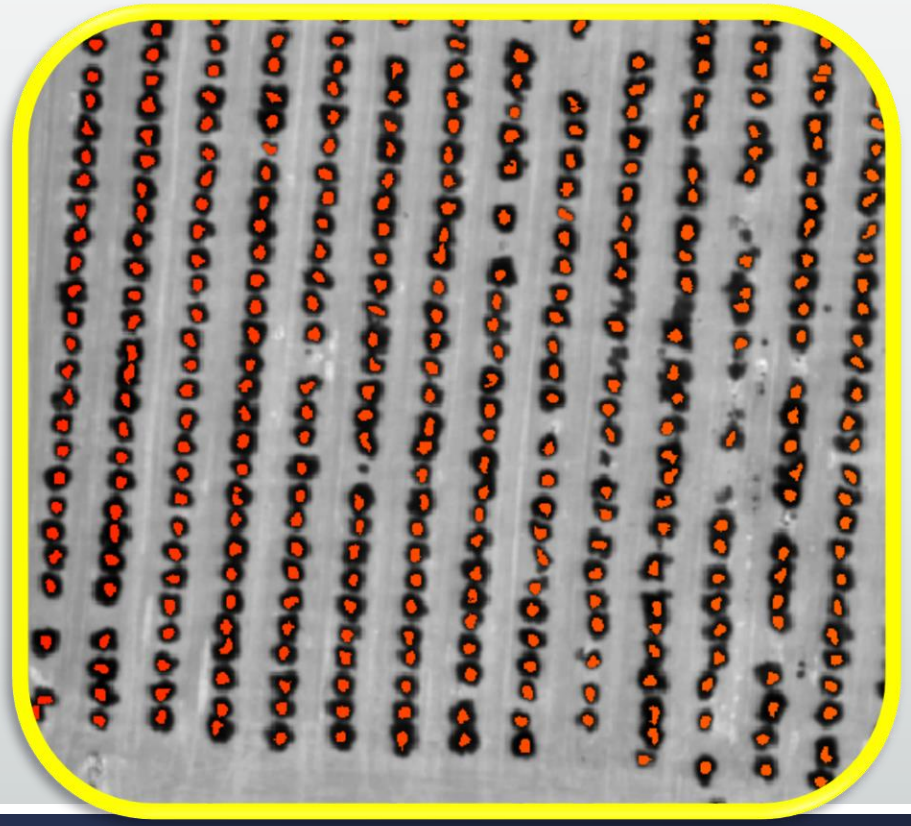
Detection Accuracy: 75%
Overestimation: 25%



Thermal imaging for the detection of Jojoba plants infected by *Fusarium oxysporum*

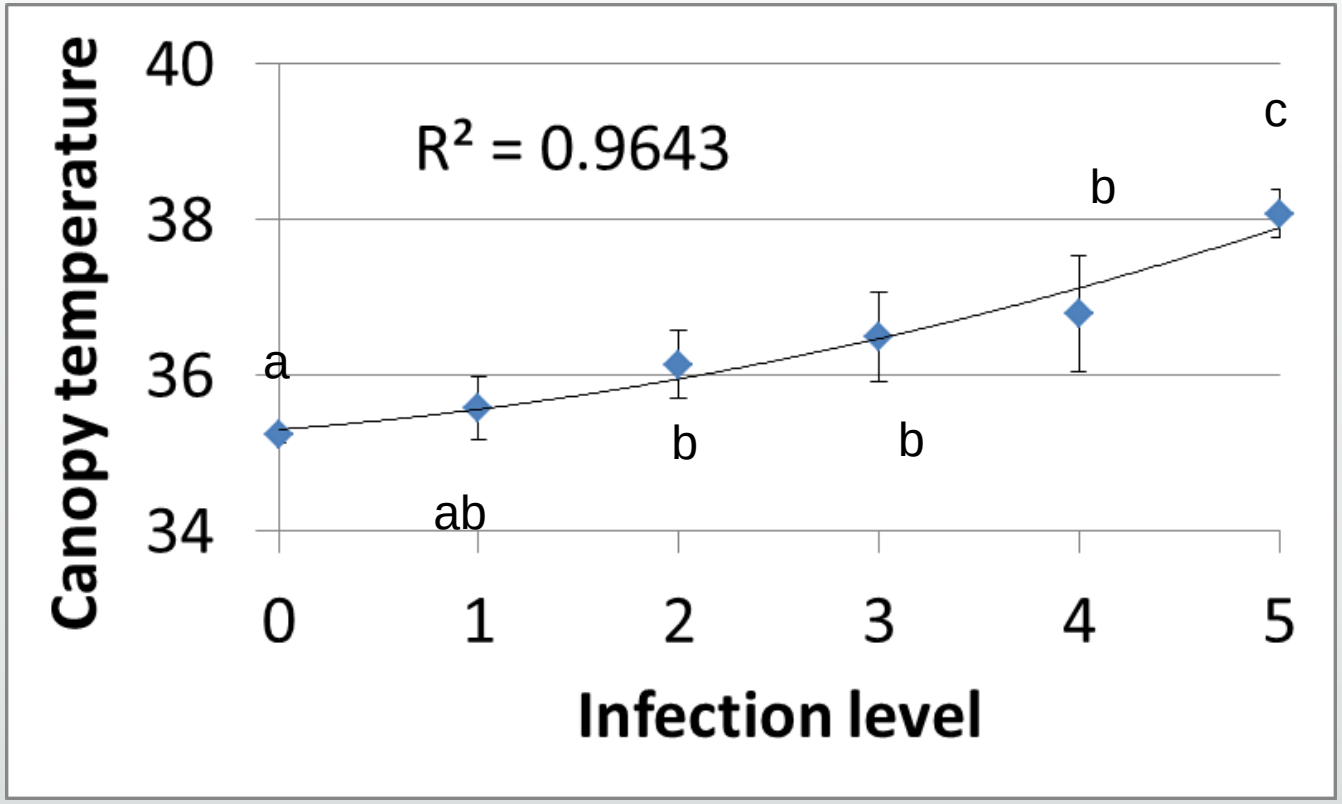
Canopy Segmentation





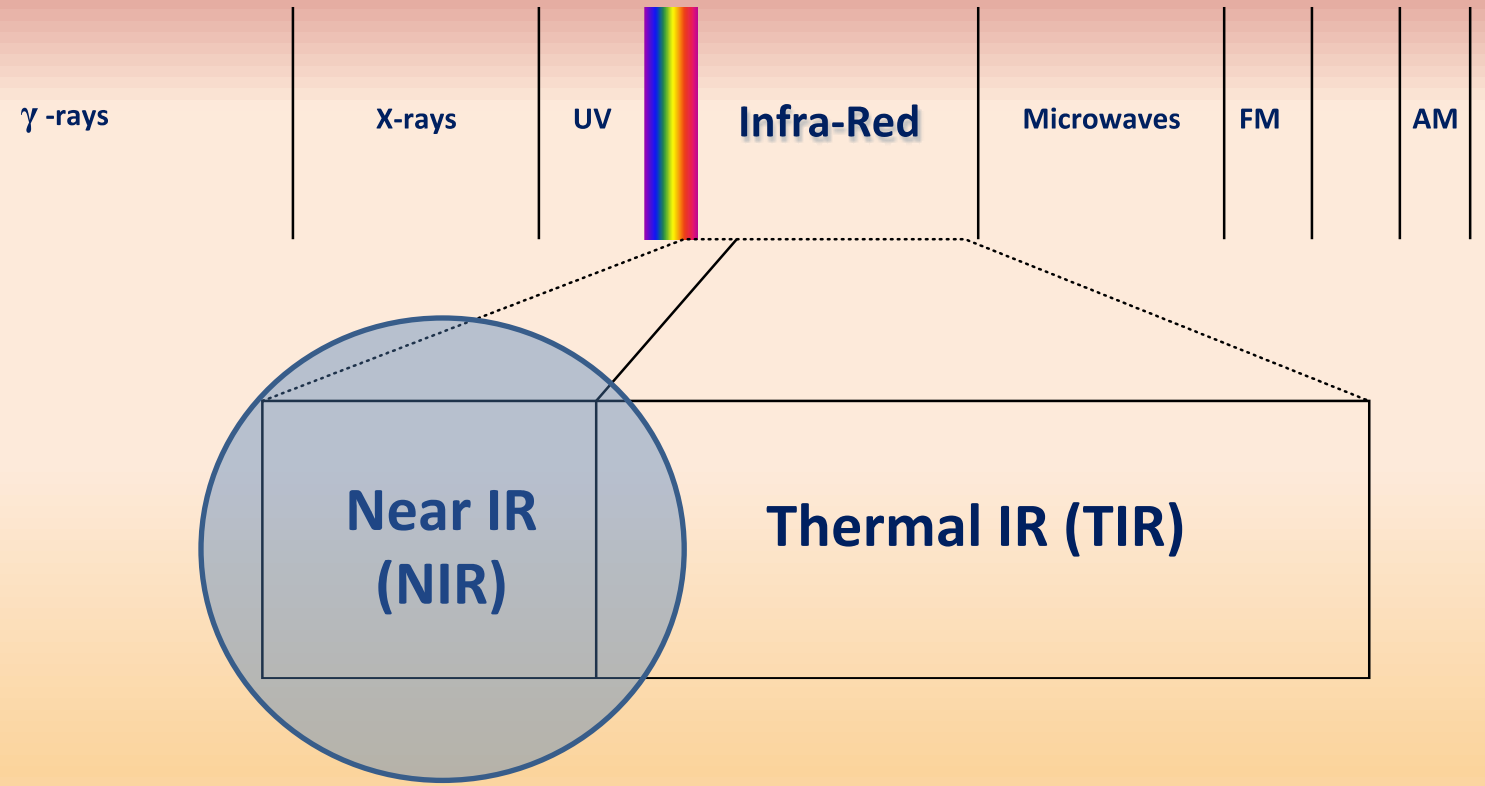
Results

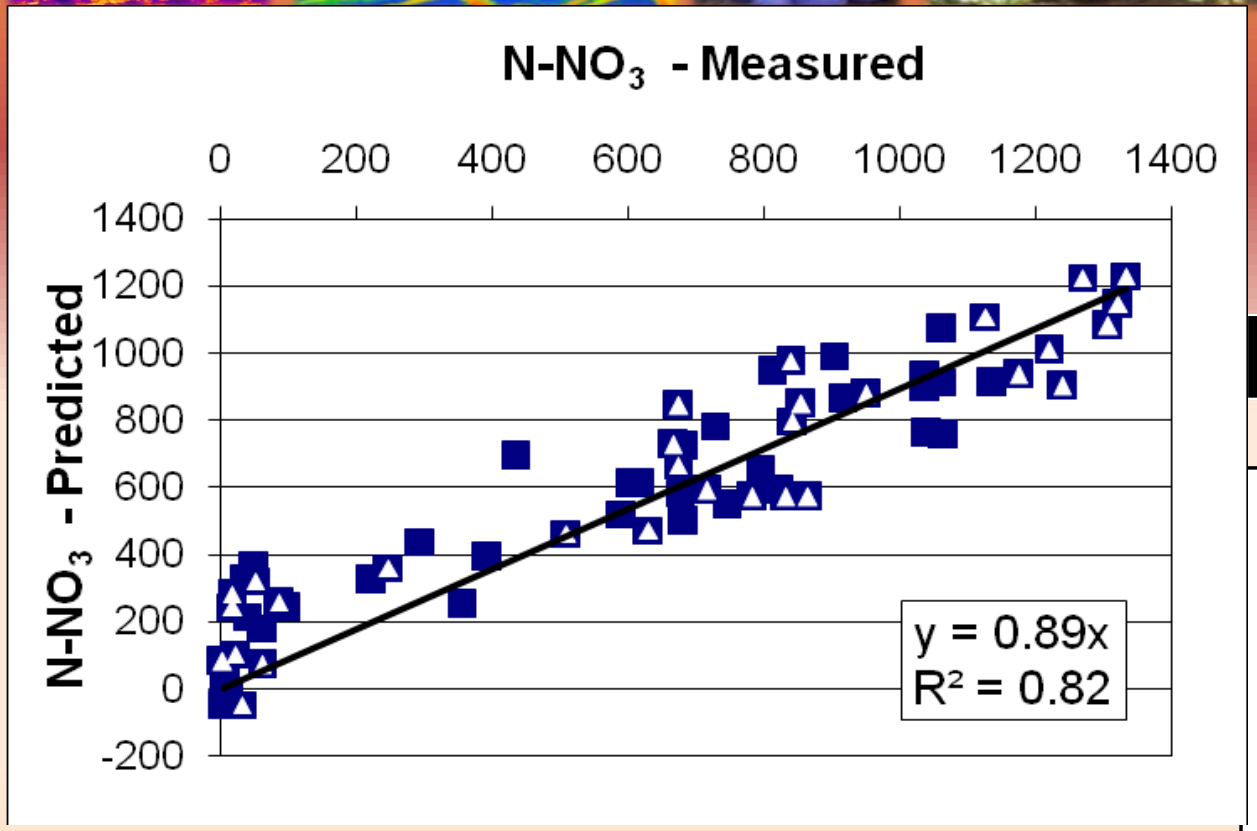
Canopy temperature increases with infection level



CROP NUTRIENT MANAGEMENT (FERTILIZATION) USING REMOTE SPECTRAL SENSING

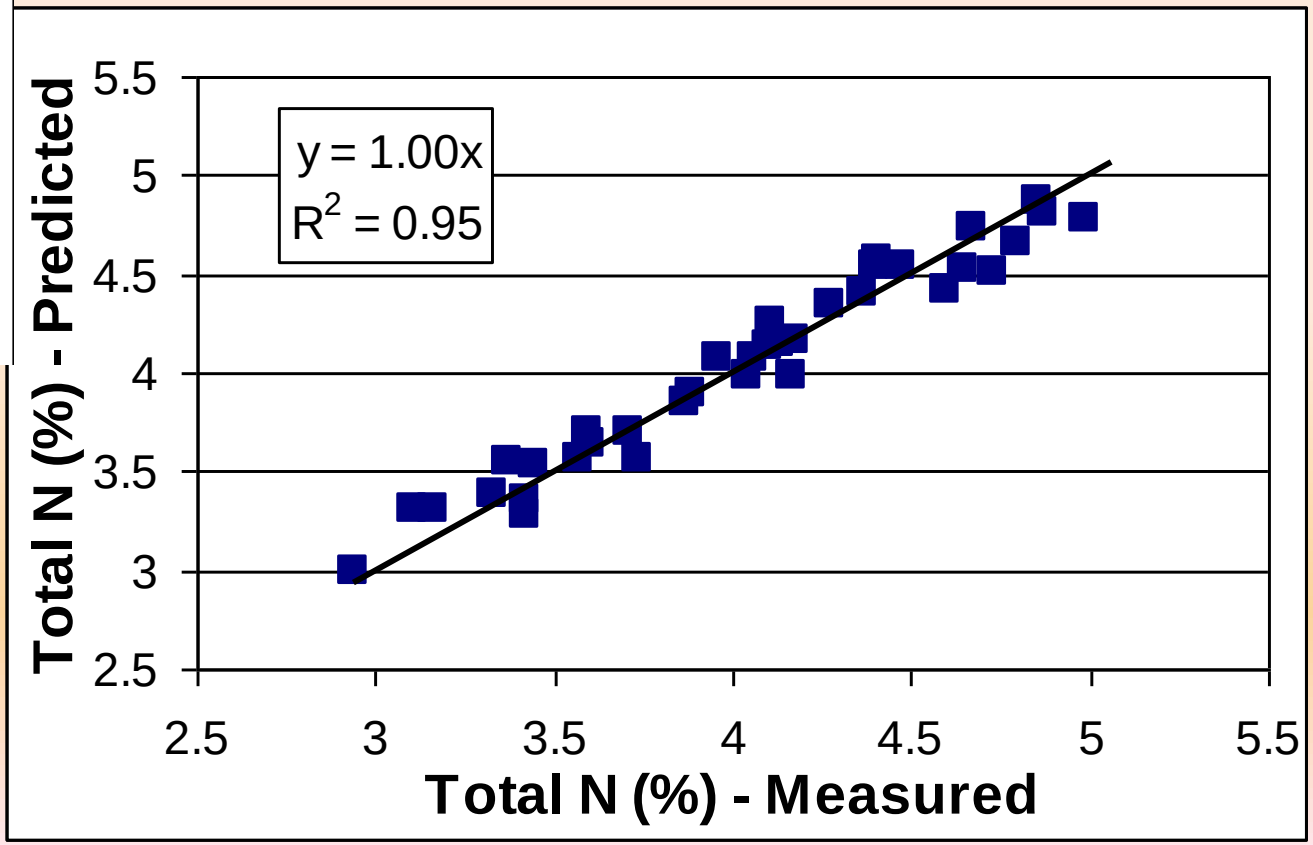
Nitrogen in potatoes


γ -rays
X-rays
UV
Infra-Red
Microwaves
FM
AM
Near IR (NIR)
Thermal IR (TIR)



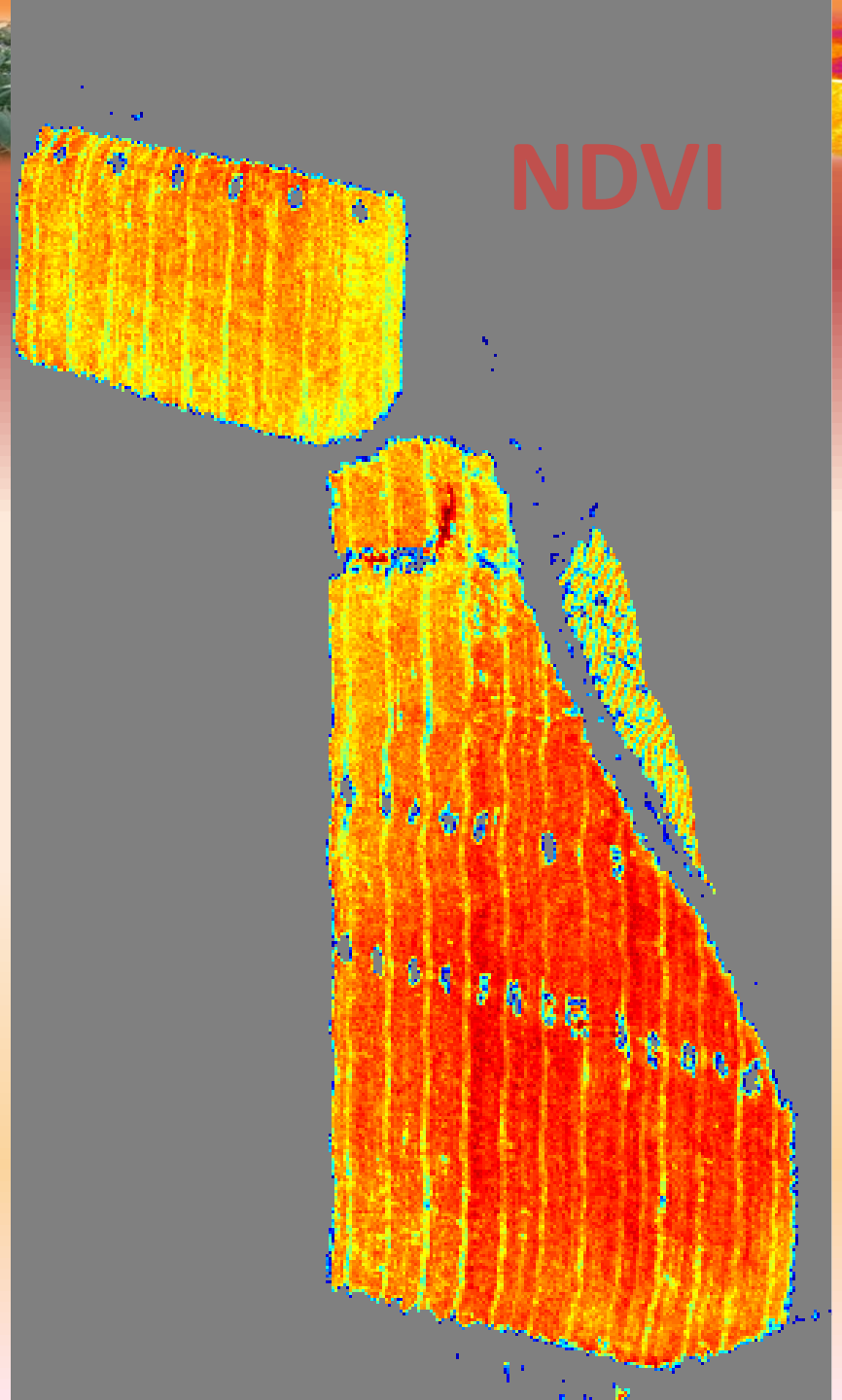
Average petiol nitrate content estimated from PLSR- 2007

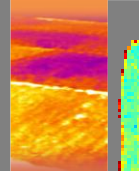
RMSECV= 182 ppm

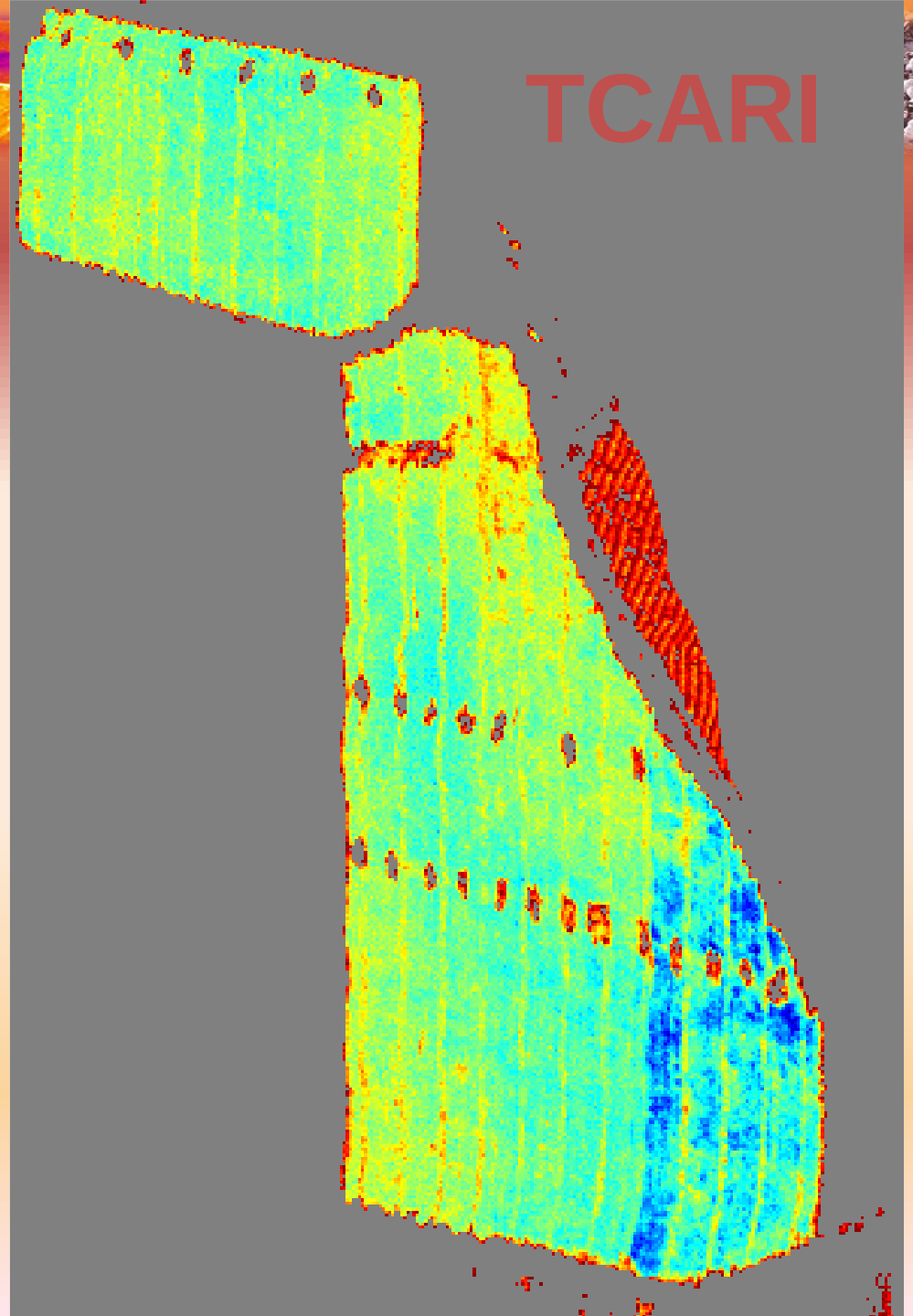


Average leaf nitrogen content estimated from PLSR- 2007

RMSECV= 0.11%


NDVI




TCARI

רשות החדשנות
Israel Innovation Authority

אוניברסיטת בן-גוריון בנגב
Ben-Gurion University of the Negev

Early detection of corn and sunflower stress induced by chemical spraying

Shahar Gad

Victor Alchanatis, Yael Edan, Tidhar Sandovsky, Idan Harary, Tslil Nacson

Objective

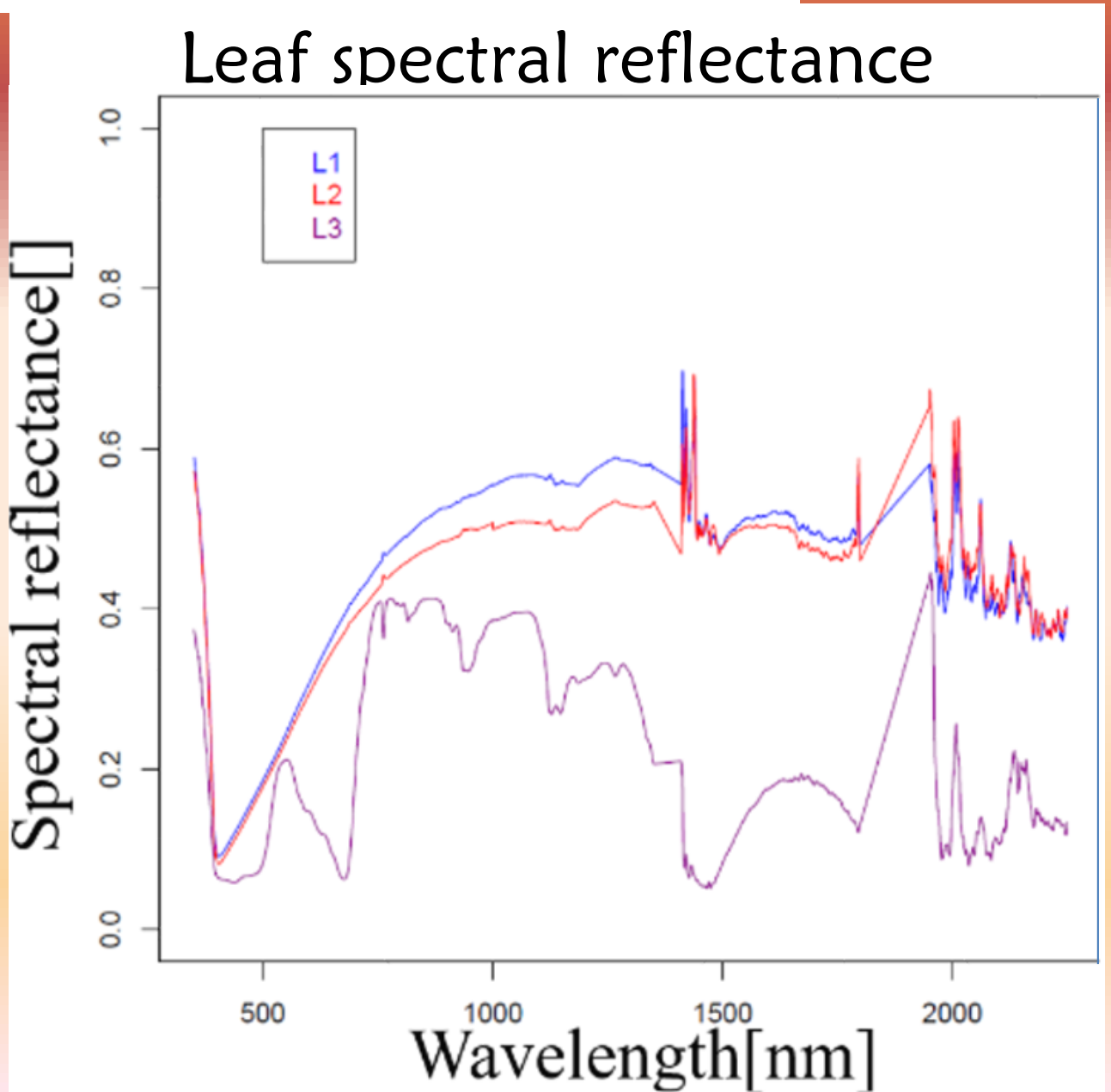
Detect abiotic stress using leaf spectral reflectance.

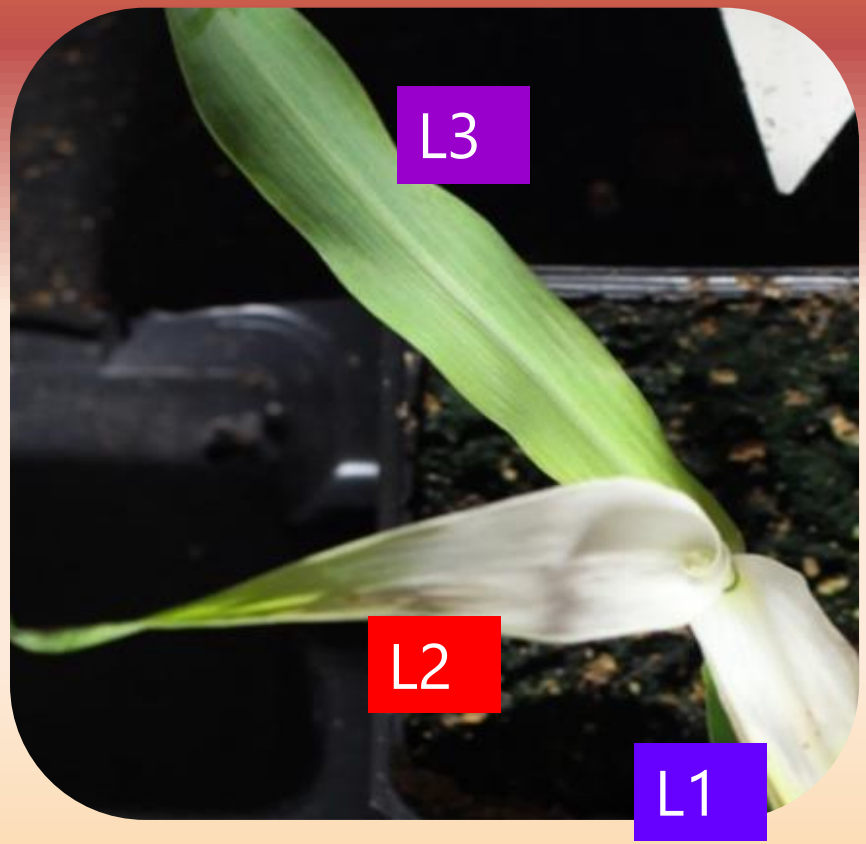
Detect inhibition of 3 mechanisms:

- lipid metabolism
- photosynthesis
- amino acid metabolism

mechanisms of action (MOA)

Data acquisition





Spectra were acquired from 2-3 leaves from each plant

PLS regression on average phenotypes

Results – All spectrum model

R-Squared

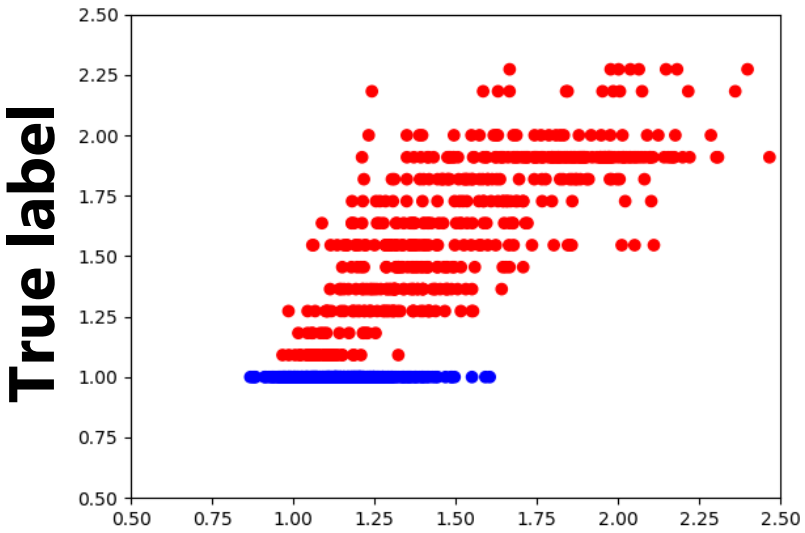
0.64

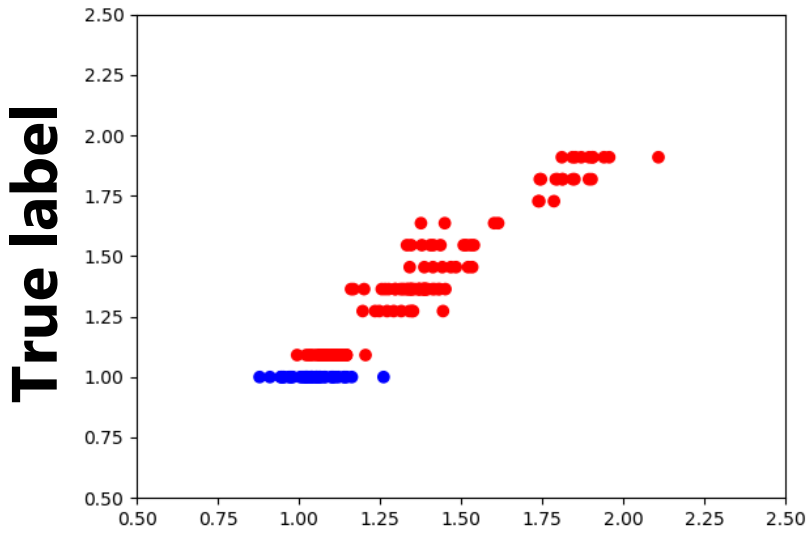
R-Squared

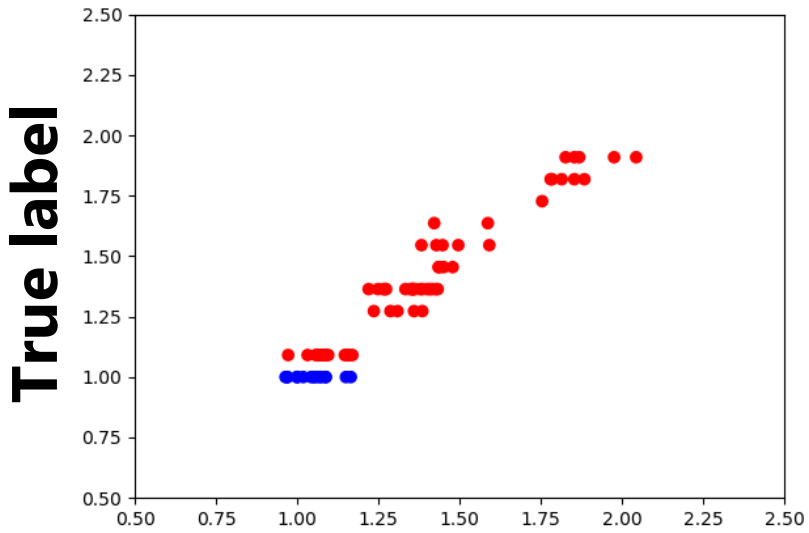
0.93

R-Squared

0.94







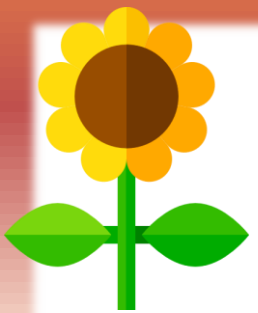
All corn

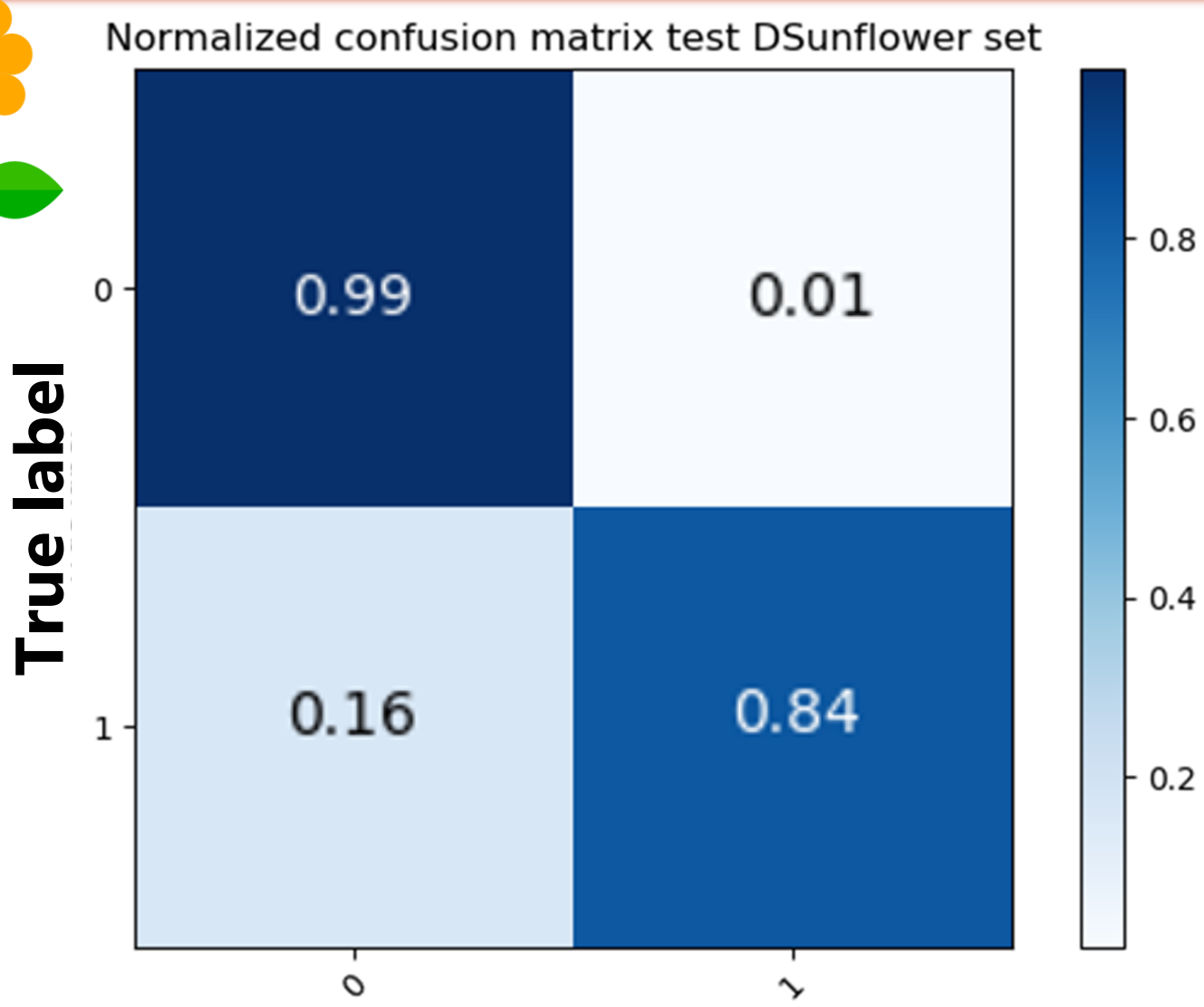
Amino acid metabolism corn

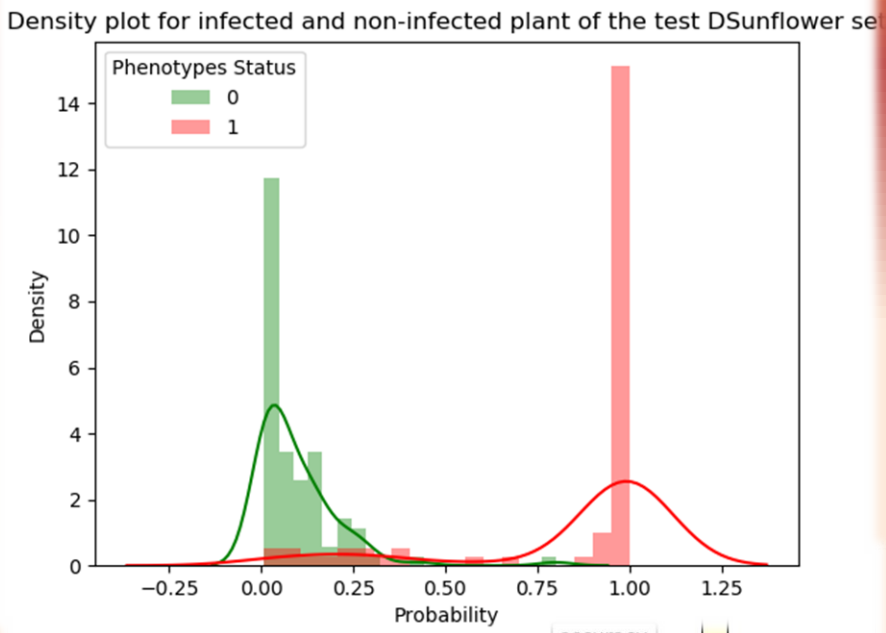
Amino acid metabolism corn L2

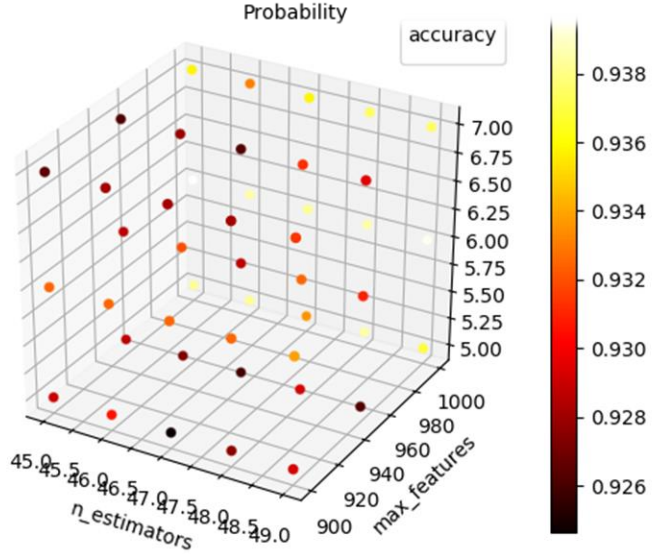
Random Forest

Machine Learning models





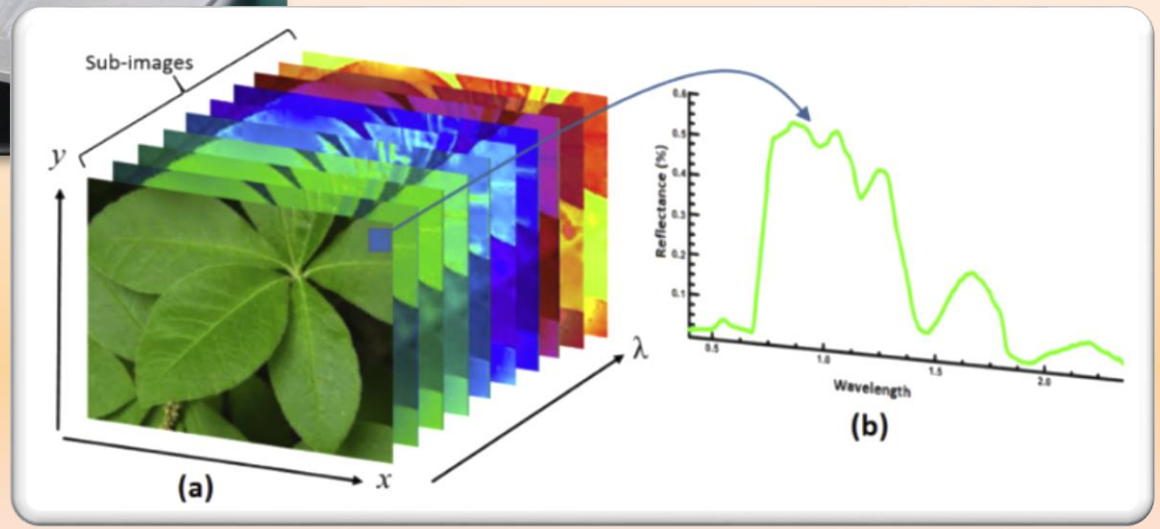


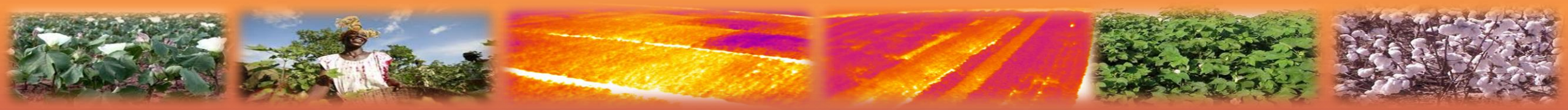


On-going work

Hyperspectral Image analysis

Υπερφασματική απεικόνιση





Other activities

- LIDAR sensing platform from UAV
- Super resolution algorithms for improving spatial resolution of remotely sensed data
- SAS – Software apps for scouting and ground truth data acquisition from farmers, and dissemination of research and extension services

Agricultural Research Organization

The Volcani Center