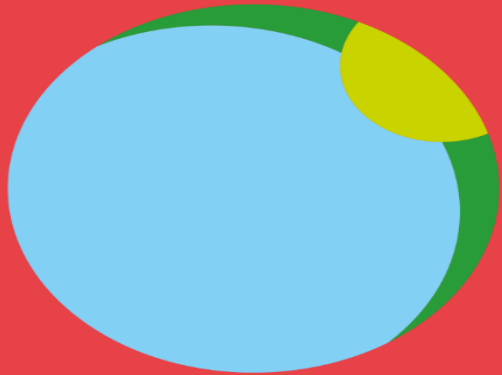


# Big Data in Strategies for Precision Farming

*Timiryazev Academy, Listvennichnaya Alleya*

*Kocks, C.G., Pot, A.J., & Dirksen, M.*



**AERES**  
UNIVERSITY OF  
APPLIED SCIENCES  
DRONTEN



Dr. ir. ir. ing. Corné G. Kocks  
Head of Department Research  
Professor on Precision Farming  
Director of Centres of Expertise Agriculture



Talent for growth

# Outline of the presentation

- Introduction of Corné and Aeres University of Applied Sciences
- How to feed the world?
- Big data analysis as basis for simple strategic use of the weather forecast in greenhouses
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- Smart farming 3.0?
- Big Data for real time nutrition of fields
- Be smart: think before acting

# Precision Agriculture is NOT Technology

**It is a Management Philosophy to Respond to Spatial and Temporal Variability on an Economical Base**



This presentation is not about Controlled tractor farming  
It is Smart Farming with Strategy by Big Data



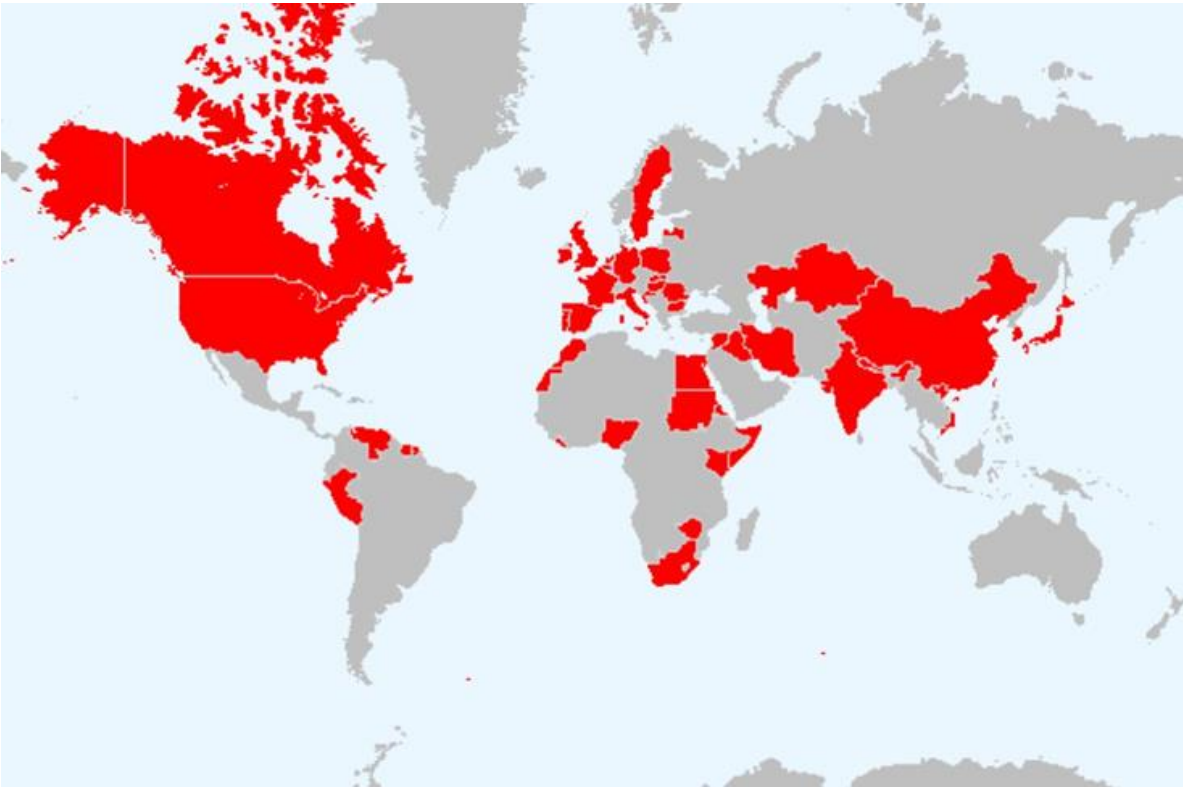
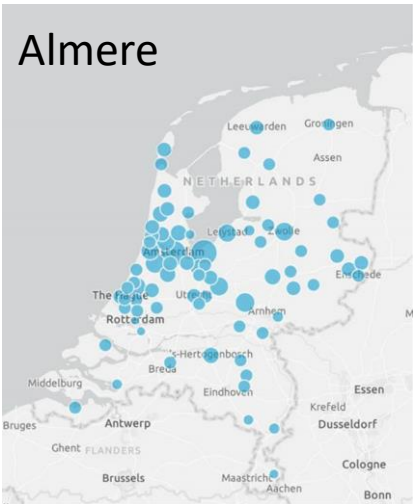
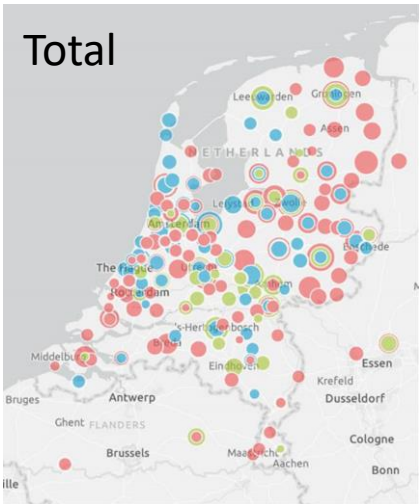


# Aeres University: Every faculty has its own substantive profile



- Almere: Nature, Food & Urban Green
- Dronten: Agrofood en Entrepreneurship
- Wageningen: Sustainable learning and development

# Students from Holland and abroad (43 nationalities)



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## INSPIRATION MEETINGS CLIMATE CHANGE PARIS







# THE URBAN QUESTION





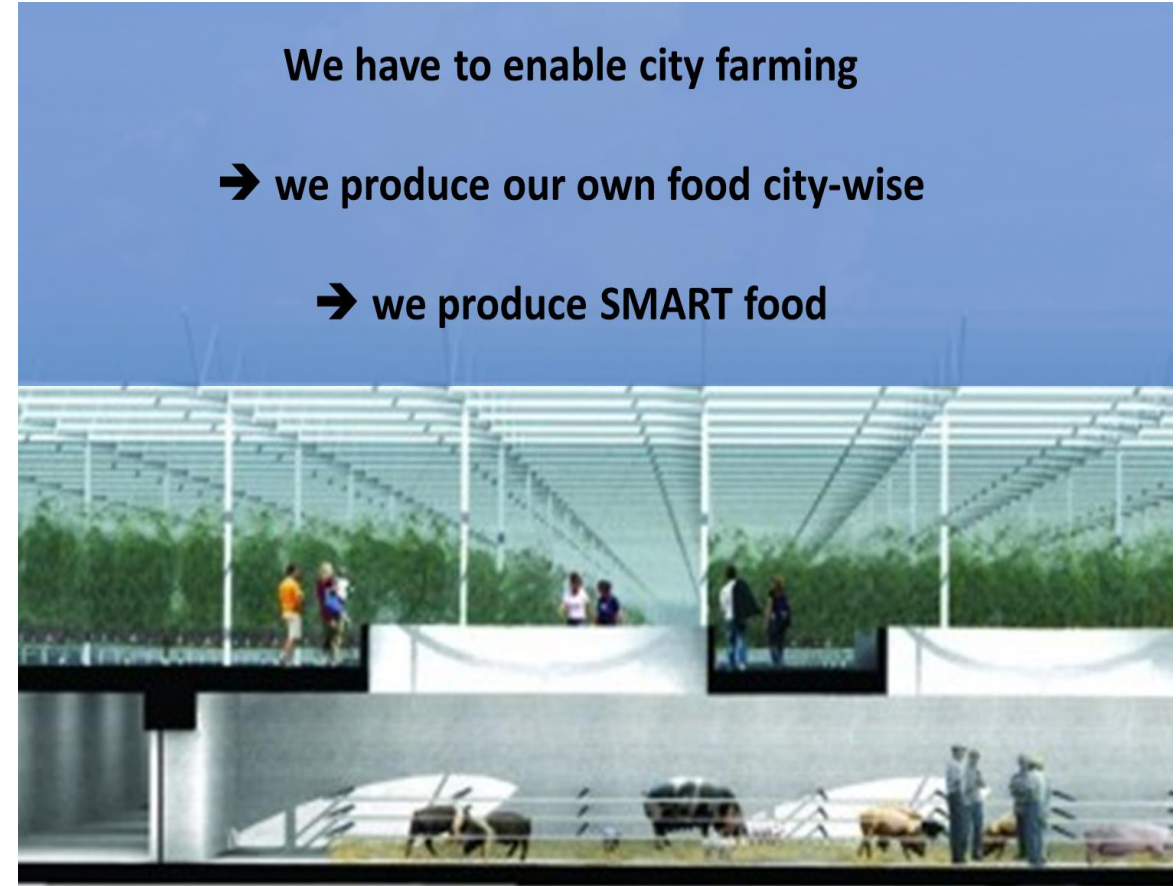


**The Quality of the Future depends  
on the Quality of Our Cities**





- We have to enable city farming
- we produce our own food city-wise
  - we produce SMART food





# Crop production transforms from horizontal to vertical





## Our high tech vertical crop production grows with led-light



# Big data on by

- Sensors on climate in vertical farm
- Hourly adaption of light intensity and light radiation
- Every minute information about crop growth
- Hourly data on crop protection, crop nutrition and water supply
- Information on consumers behaviour
- Information on supermarkets and logistics
- Information on shopping details
- Information on world growth of inputs for meal salads











# Outline of the presentation

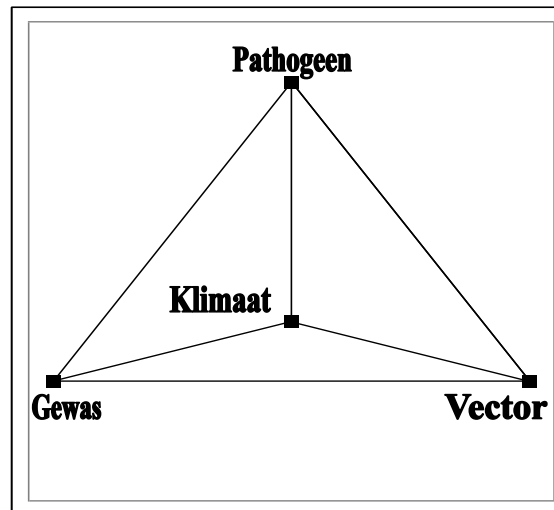
- Introduction of Corné and Aeres University of Applied Sciences
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# Fusarium in Paprika

# Methodology

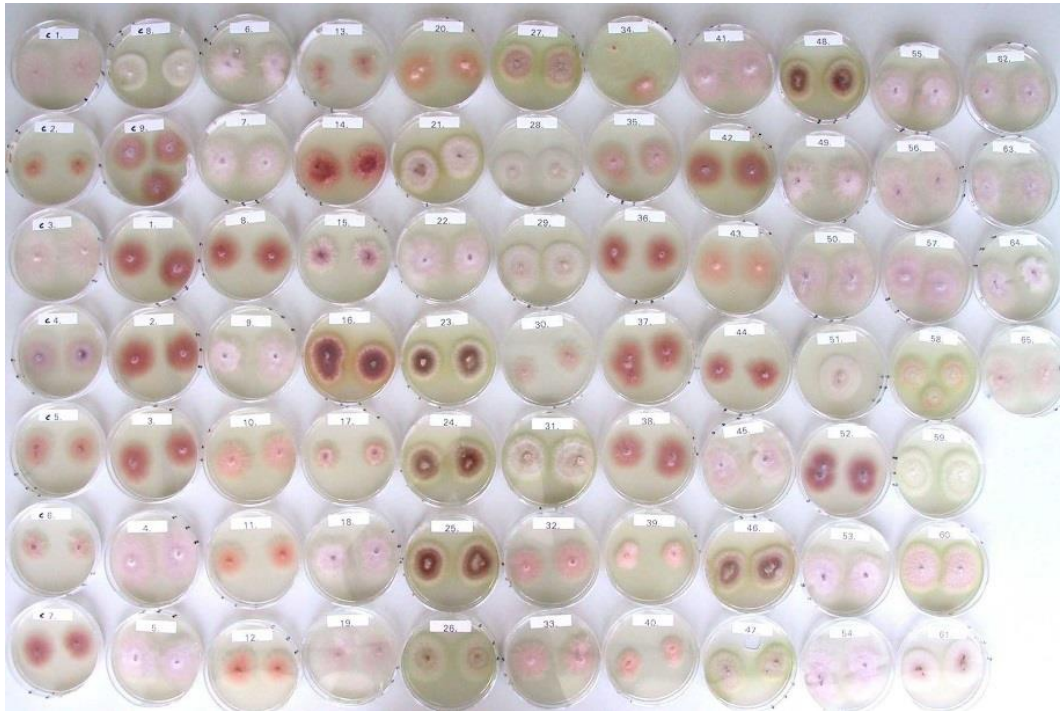
- 'Holistic' approach



- Negative selection of parameters
- Dataset: 147,461,293 values in 6 months

# Isolate detection *Fusarium*

Isolation of spores and determination (DNA and morfological)



- *F. solani*, *F. oxysporum* en *F. lactis*
- Paprika without symptoms → no detection of *Fusarium*

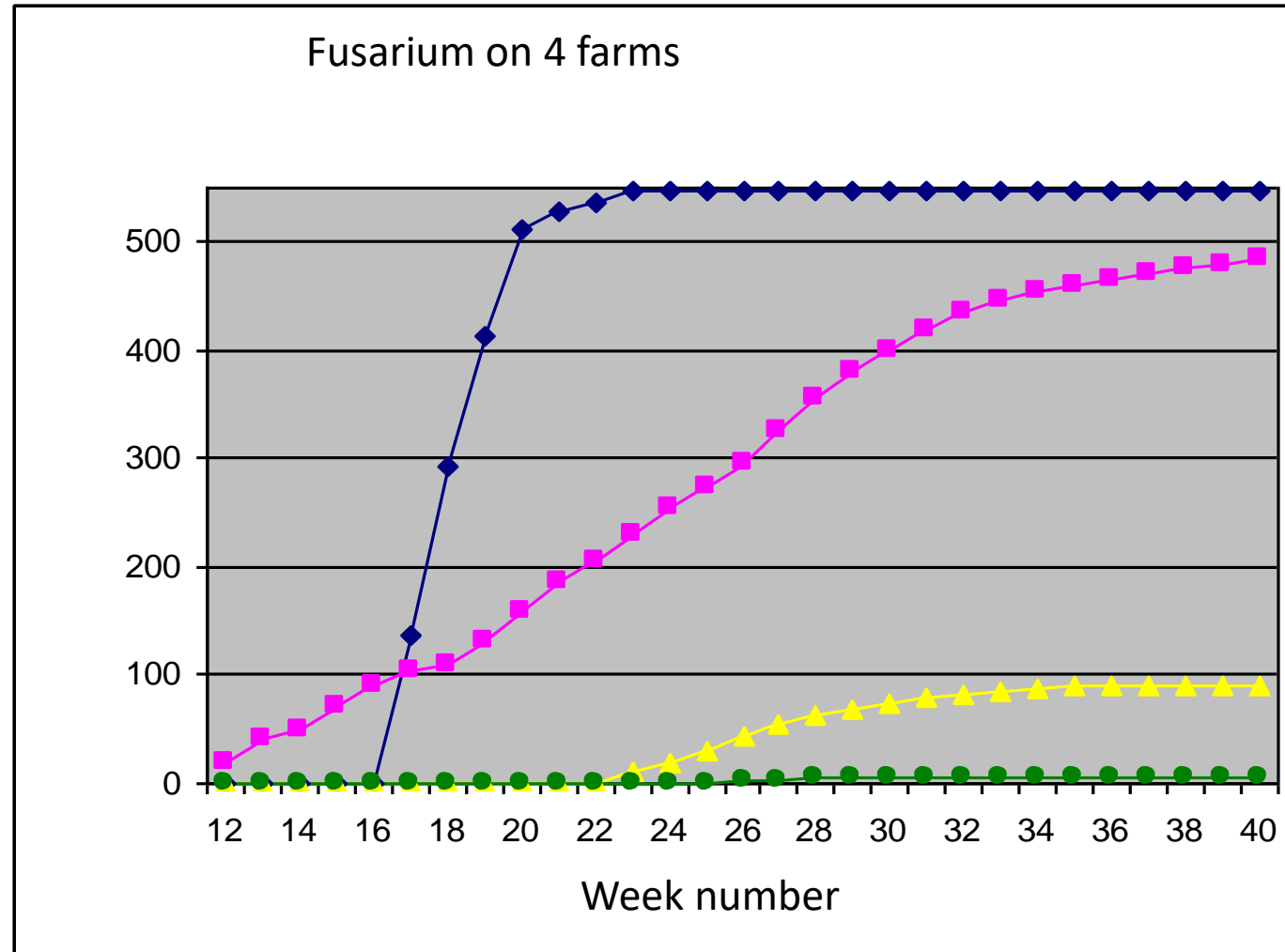


# Spreading mechanism of *Fusarium*



- Petridishes flower height were contaminated with *Fusarium*
- White fly was contaminated with *Fusarium*
- On Thrips no *Fusarium*
- Flowers contaminated with *Fusarium*
- Aborted fruits were contaminated with *Fusarium*

# Fusarium in greenhouses

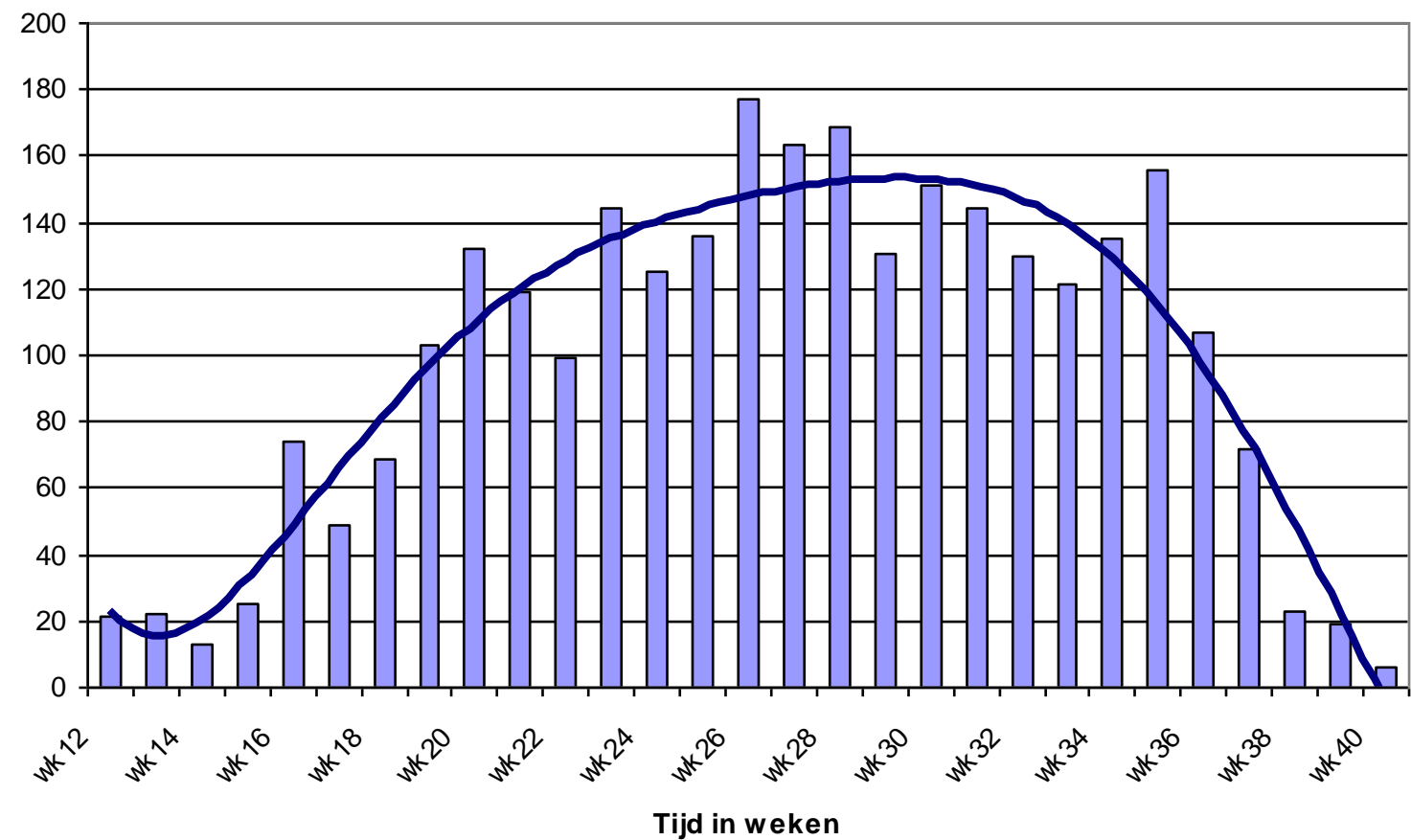


# Operational management in greenhouse

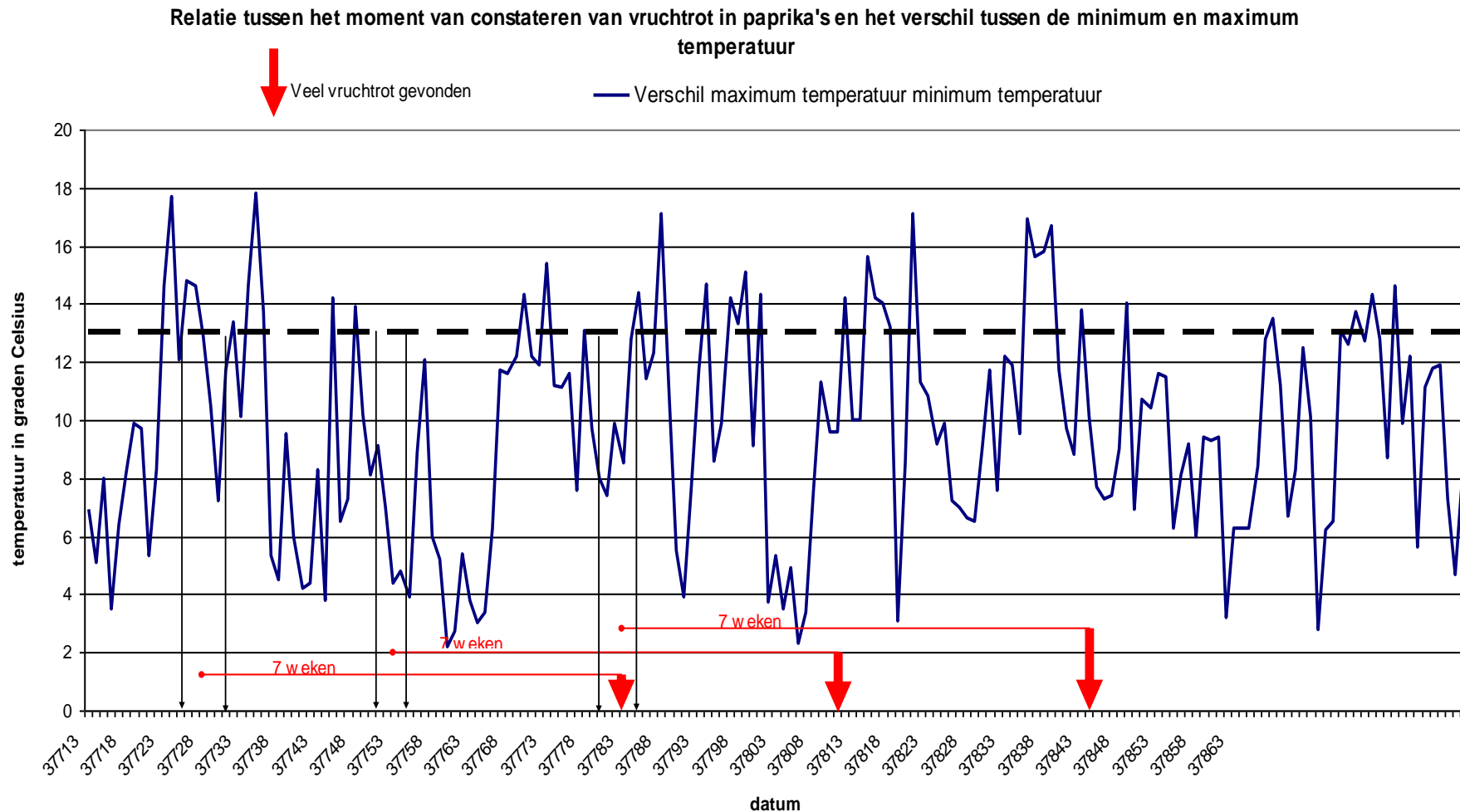
- Most measured parameters gave no correlation with Fusarium outbreak
- Temperature management in greenhouse showed a few correlations → further research → new data from weather stations (another dataset with 3.216,014 values)
- Back to the basics of phytopathology
  - Incubation time, infection period, infection time, plant vigour

# Amount of fusarium rot in paprika

Total fusarium week 12 till 41



# Climate and Fusarium



# Description of infection period

- Daily average temperature is high when compared with previous days
- Maximum temperature is high when compared with previous days
- Difference between minimum en maximum temperature is large
- No rainfall during infection period
- In infection period relative much radiation by sun

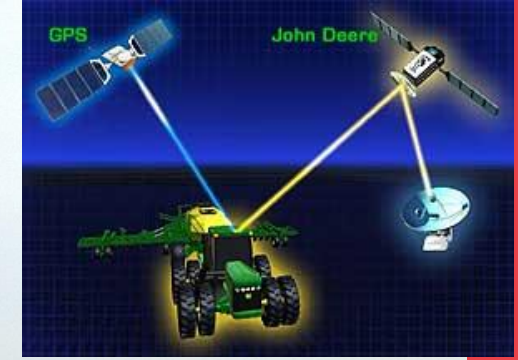
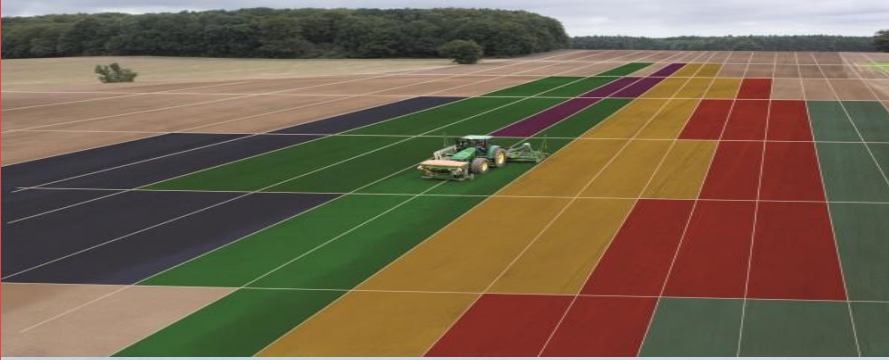
## Advice!!

- Check the weather forecast for the coming night
- Infection is low when crop is not sweating



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# Impressive benefits of controlled tractor farming including automatic planter shut-off



- 17% reduction sowing seeds
- Guidance systems and automatic shut-off make work easier
- Farmers are looking forward to the next level of precision farming

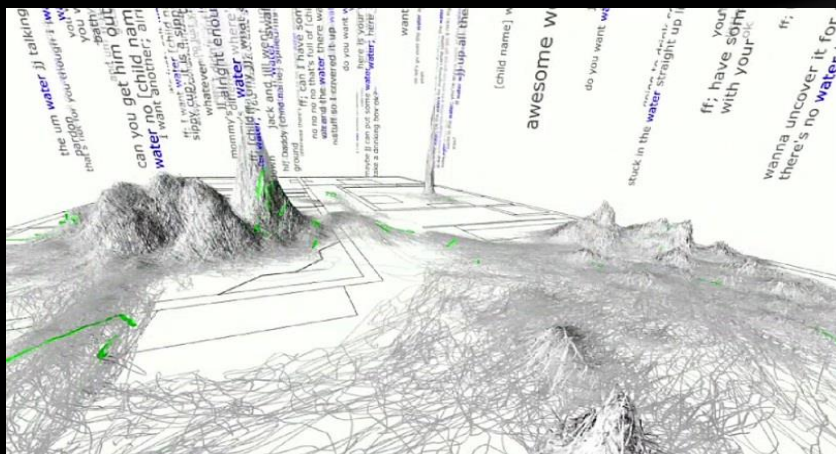
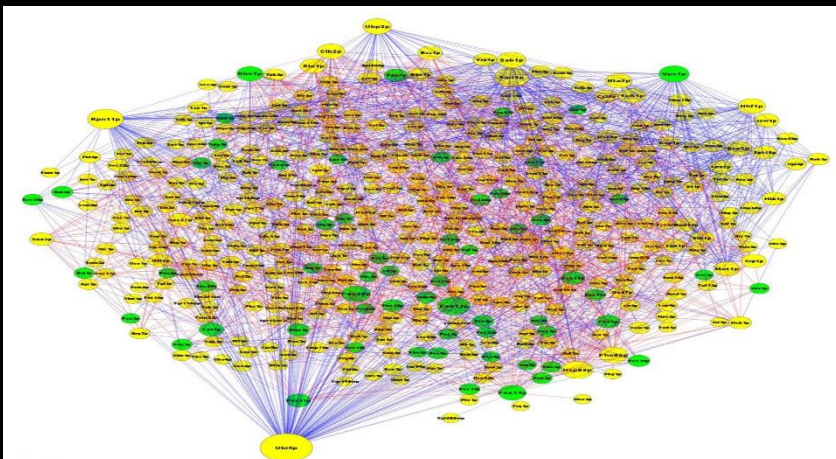
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# Smart Farming 3.0?!



## Space & Time





# Next level



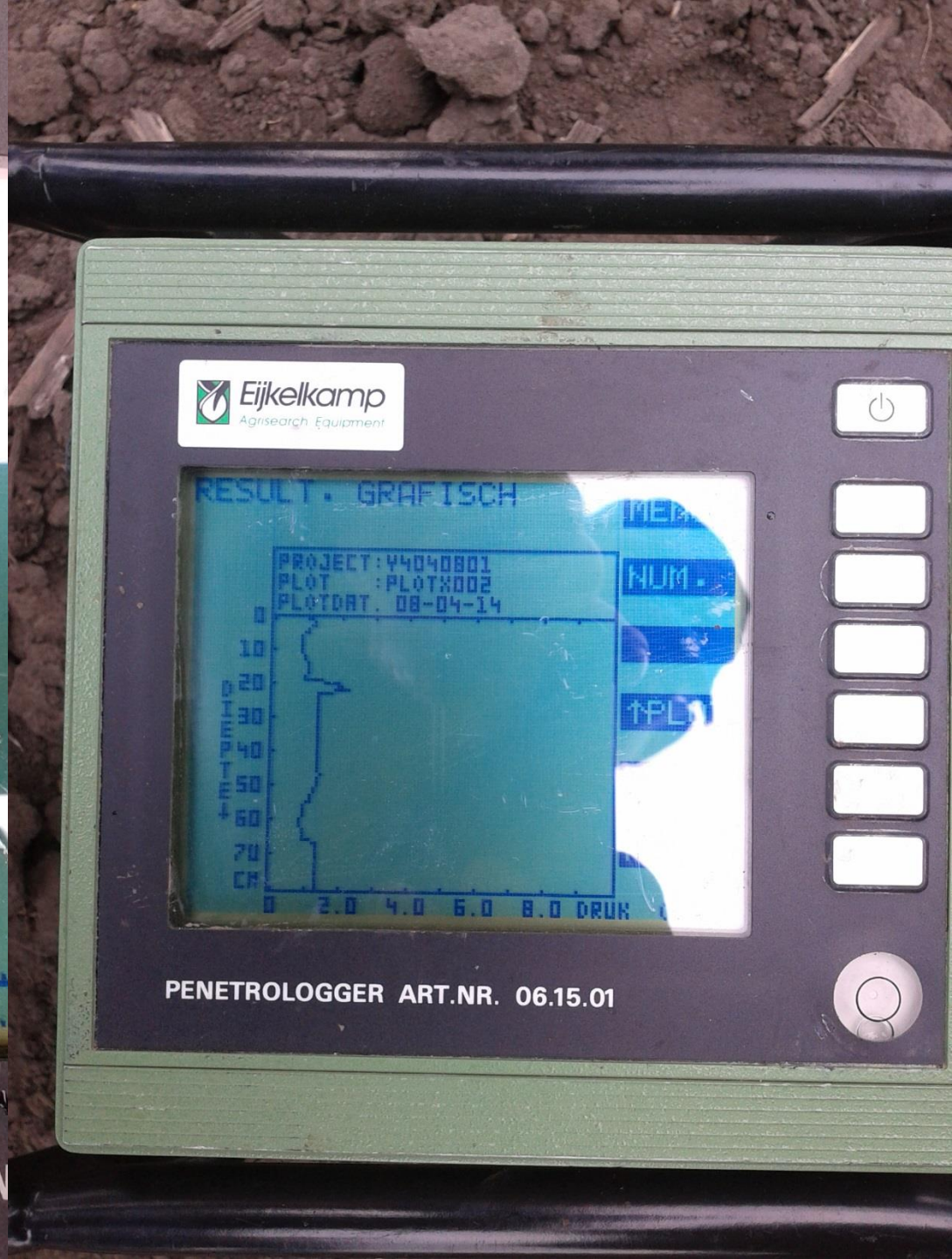
















PROJECT: W40403001

66

↑FLOT

↓PLOT

PRINT

ED: 1.31  
CH: HPB

**PENETROLOGGER ART.NR. 06.15.01**

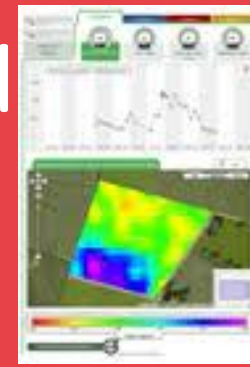








# Fieldlook to help to understand the crop growth



Online, every week, for all types of crops

10 growth parameters

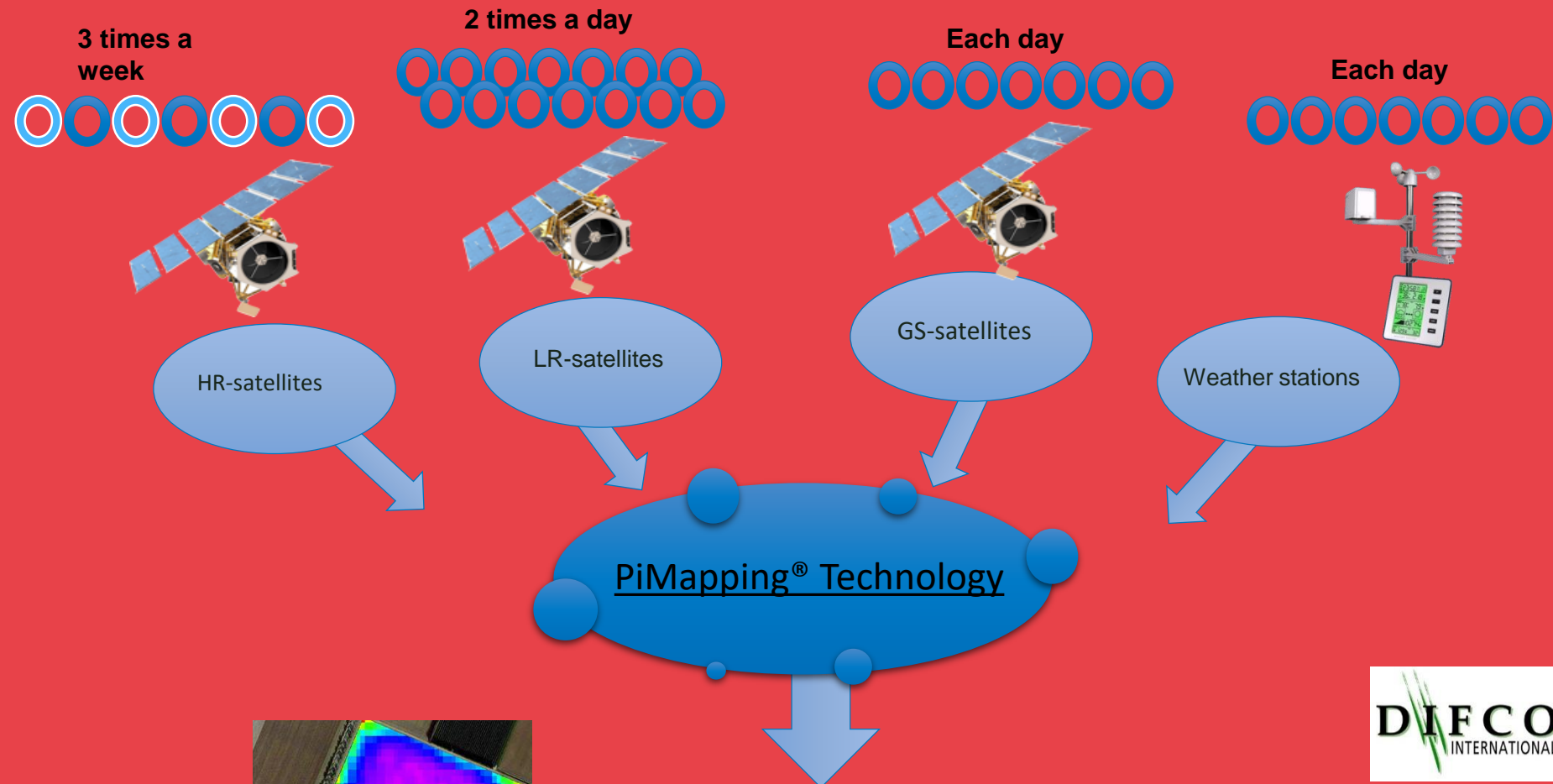
Every week during the growth season from April t/m October

Is measured every day two times and weekly averages are summarized

Your starting point for further analyses, interpretation and action

Available around the world

# Collecting data from different sources





Print this page

Crop : Fluecigs Size (ha) : 27.1

Strain :

Planting/sowing date : 01-09-2012

Type :

Surfacing date : 15-09-2012

Harvesting/lifting date : 01-03-2013

Parameter Overview in R2P format

Analytic parameter of current field

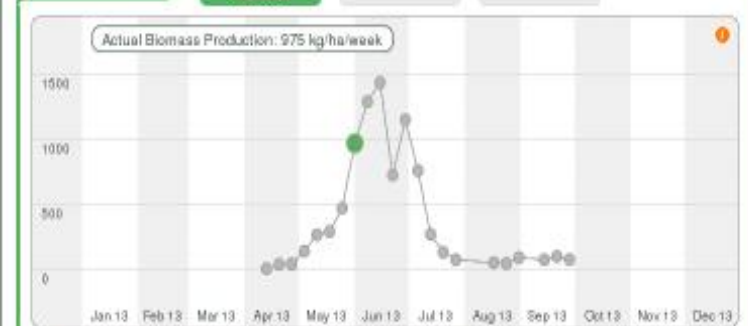
FIELDLOOK ADVICES

**GROWTH** **MOISTURE** **WATER USE** **EXTRA**

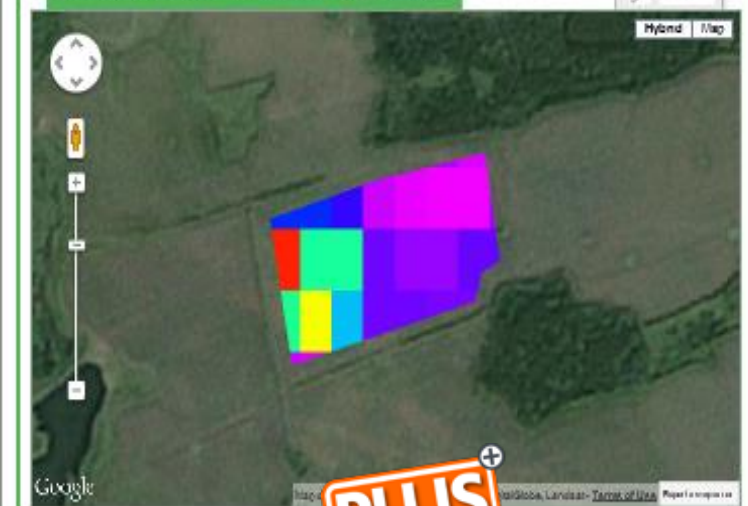
Actual Biomass Production: 975 kg/ha/week

Leaf Area Index: 5.27 m2 leaf/m2 soil

Yield: 5.60 ton/ha



Actual Biomass Production over the period of 26 May to 1 June 2013



Print this page

Crop : Fluecigs Size (ha) : 27.1

Strain :

Planting/sowing date : 01-09-2012

Type :

Surfacing date : 15-09-2012

Harvesting/lifting date : 01-03-2013

Parameter Overview in R2P format

Analytic parameter of current field

FIELDLOOK ADVICES

**GROWTH** **MOISTURE** **WATER USE** **EXTRA**

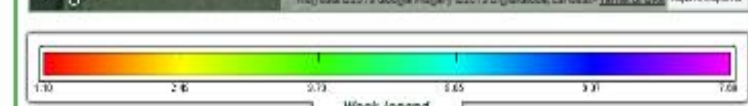
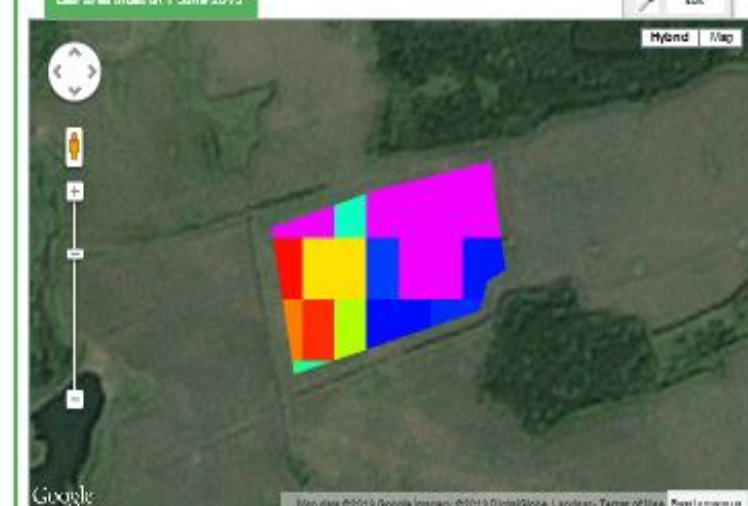
Actual Biomass Production: 975 kg/ha/week

Leaf Area Index: 5.27 m2 leaf/m2 soil

Yield: 5.60 ton/ha



Leaf Area Index on 1 June 2013



Print this page

Crop : Fluecigs Size (ha) : 27.1

Strain :

Planting/sowing date : 01-09-2012

Type :

Surfacing date : 15-09-2012

Harvesting/lifting date : 01-03-2013

Parameter Overview in R2P format

Analytic parameter of current field

FIELDLOOK ADVICES

**GROWTH** **MOISTURE** **WATER USE** **EXTRA**

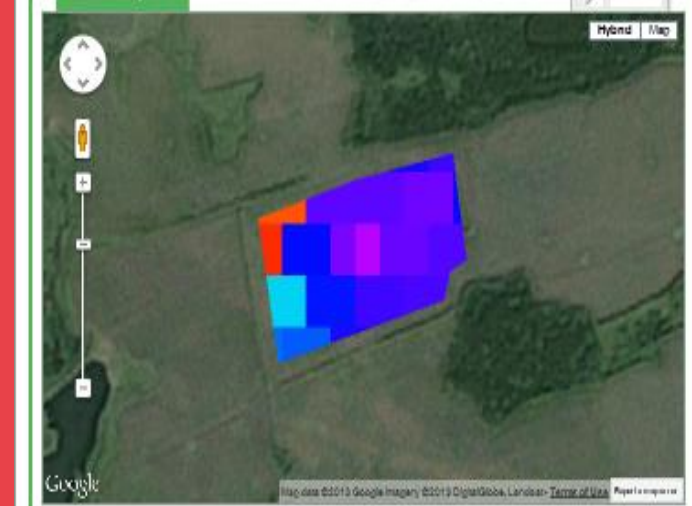
Actual Biomass Production: 975 kg/ha/week

Leaf Area Index: 5.27 m2 leaf/m2 soil

Yield: 5.60 ton/ha



Yield on 6 July 2013





# Check by eye needed for interpretation

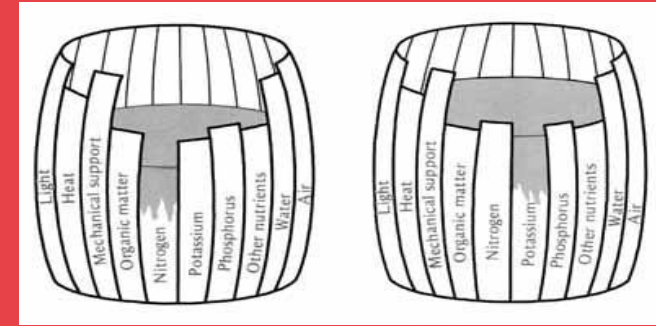
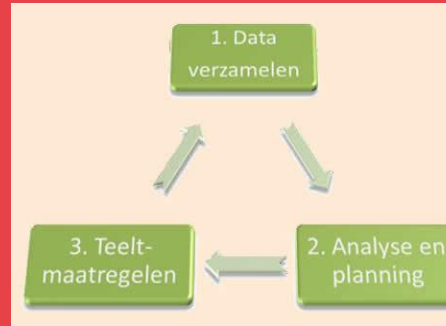
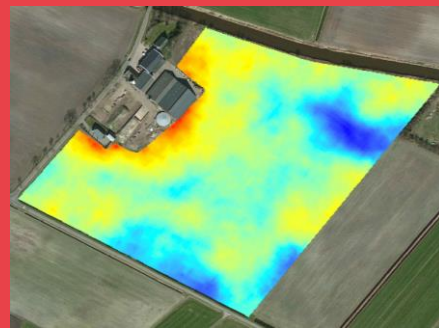
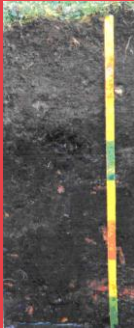
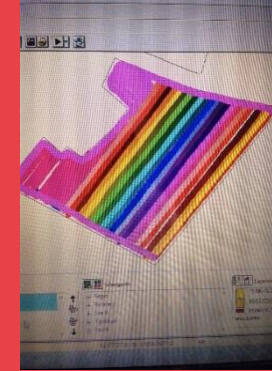




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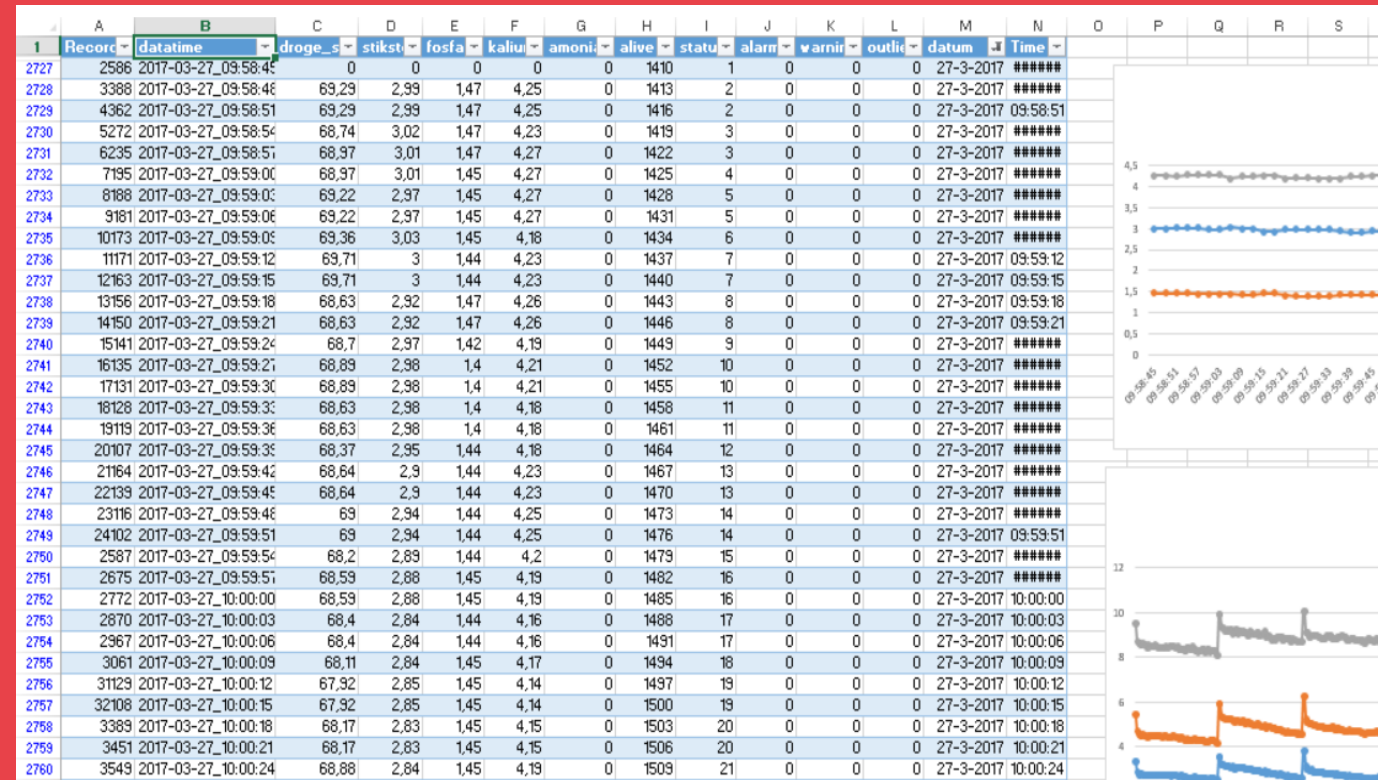


Big Data input  
Limiting factors?  
Heterogeneity of factors?

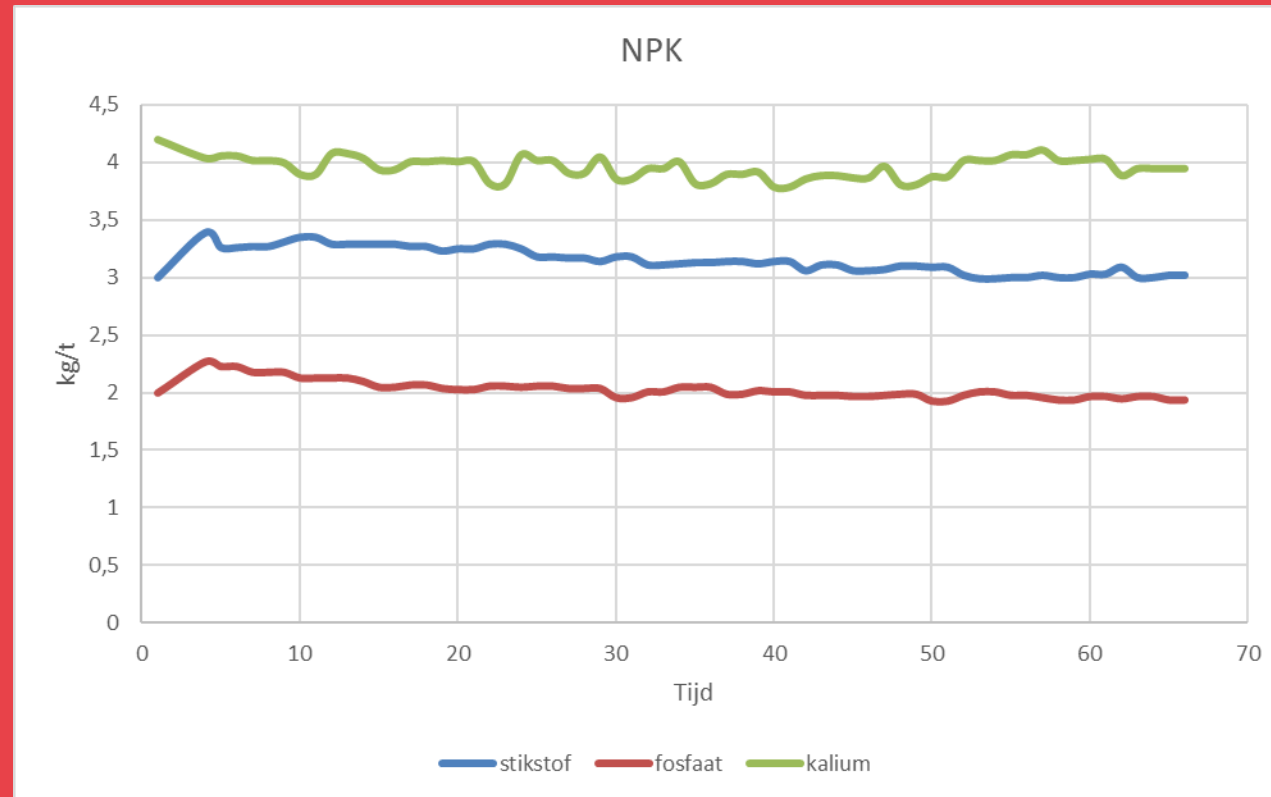
# YIELD LIMITING FACTORS

Yield maps can establish relationships between yield variability and yield limiting factors i.e.

- ☐ diseases
- ☐ soil type differences
- ☐ problems associated with fertility
- ☐ weed control
- ☐ drainage
- ☐ soil compaction



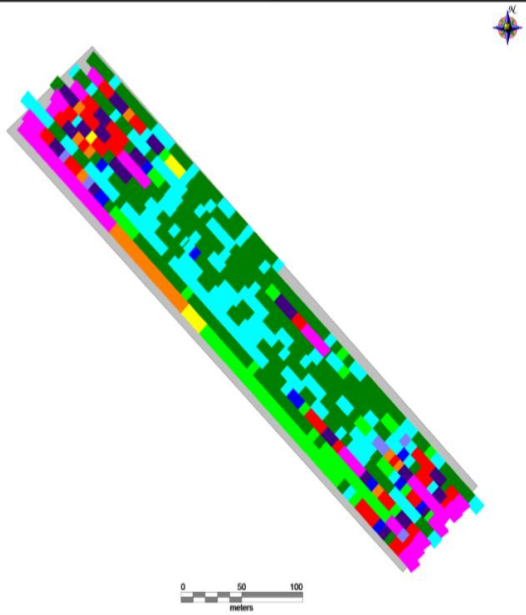
# Variation within one tank





# NPK during application

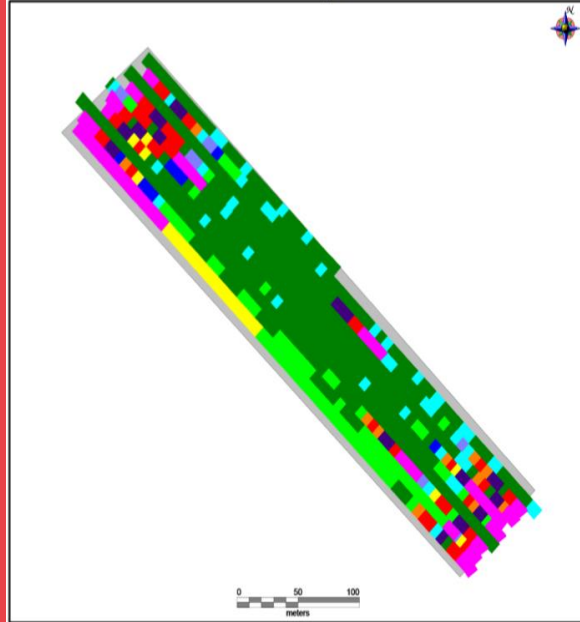
ZORGBOERDERIJ: Spreading  
act.rate Nitrogen



Klant: WILTING  
Bedrijf: WILTING  
Perceel: ZORGBOERDERIJ  
Naam: VEENHUIS GRASLAND\_20'  
Type: Spreading  
Oppervl: 3,68 ha  
Begindatum: 25-7-2017 13:47  
Einddatum: 25-7-2017 15:34  
Motoruren: 1,8 u.  
In bedrijf: 1,8 u.

65,1 - 149,4 kg/ha  
60,1 - 65,0 kg/ha  
55,1 - 60,0 kg/ha  
50,1 - 55,0 kg/ha  
45,1 - 50,0 kg/ha  
40,1 - 45,0 kg/ha  
35,1 - 40,0 kg/ha  
30,1 - 35,0 kg/ha  
5,2 - 30,0 kg/ha

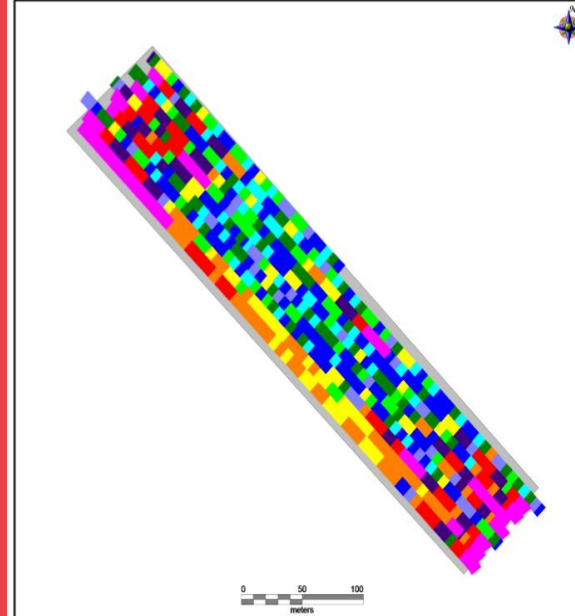
ZORGBOERDERIJ: Spreading  
act.rate Phosphor



Klant: WILTING  
Bedrijf: WILTING  
Perceel: ZORGBOERDERIJ  
Naam: VEENHUIS GRASLAND\_20'  
Type: Spreading  
Oppervl: 3,68 ha  
Begindatum: 25-7-2017 13:47  
Einddatum: 25-7-2017 15:34  
Motoruren: 1,8 u.  
In bedrijf: 1,8 u.

50,1 - 97,5 kg/ha  
45,1 - 50,0 kg/ha  
40,1 - 45,0 kg/ha  
35,1 - 40,0 kg/ha  
30,1 - 35,0 kg/ha  
25,1 - 30,0 kg/ha  
20,1 - 25,0 kg/ha  
15,1 - 20,0 kg/ha  
3,6 - 15,0 kg/ha

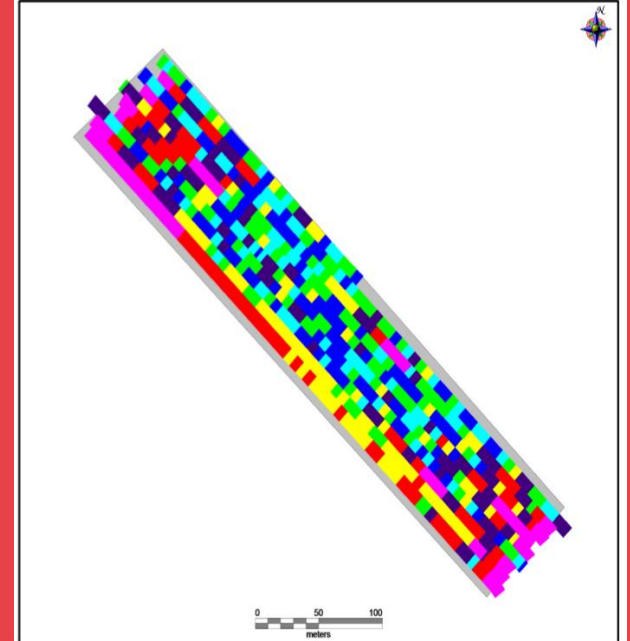
ZORGBOERDERIJ: Spreading  
act.rate Potassium



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Bedrijf: WILTING  
Perceel: ZORGBOERDERIJ  
Naam: VEENHUIS GRASLAND\_20'  
Type: Spreading  
Oppervl: 3,68 ha  
Begindatum: 25-7-2017 13:47  
Einddatum: 25-7-2017 15:34  
Motoruren: 1,8 u.  
In bedrijf: 1,8 u.

75,1 - 188,0 kg/ha  
70,1 - 75,0 kg/ha  
66,7 - 70,0 kg/ha  
65,4 - 66,6 kg/ha  
64,2 - 65,3 kg/ha  
62,6 - 64,1 kg/ha  
59,5 - 62,5 kg/ha  
46,5 - 59,4 kg/ha  
6,9 - 46,4 kg/ha

ZORGBOERDERIJ: Spreading  
act.rate Drymatter

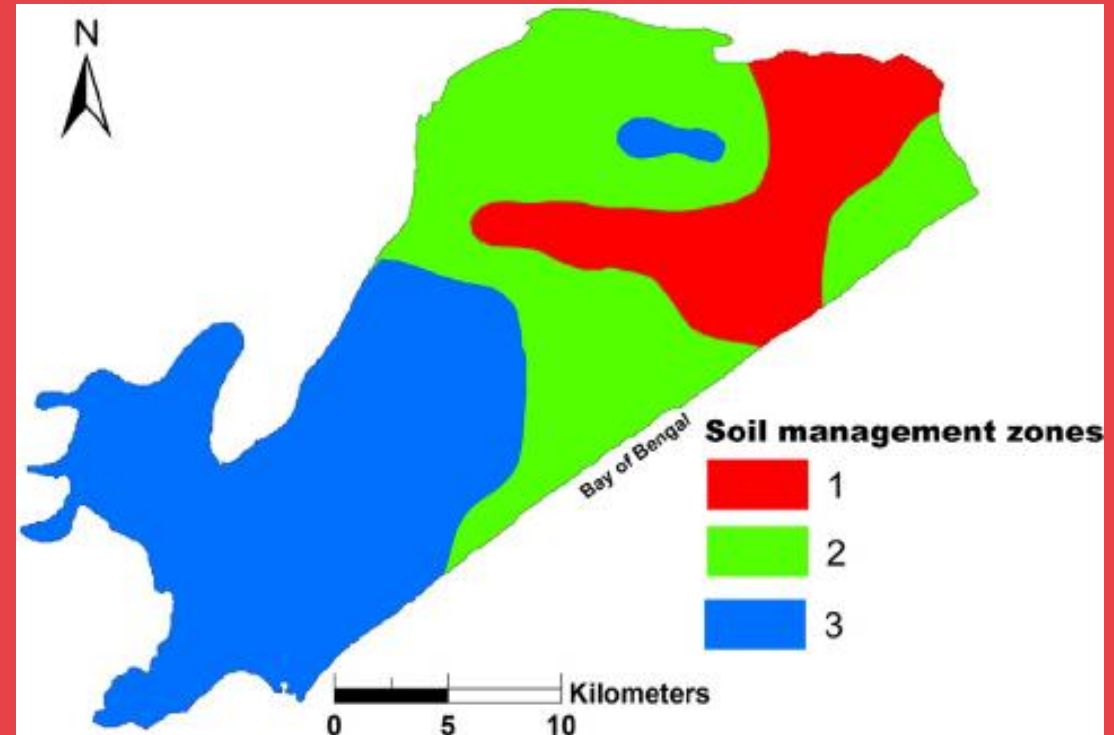


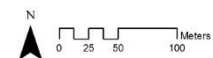
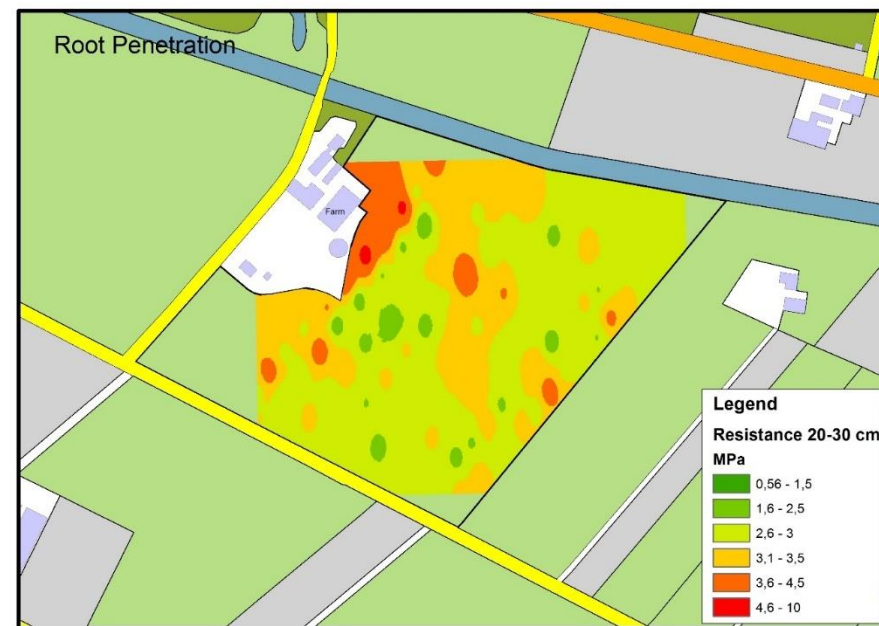
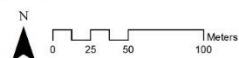
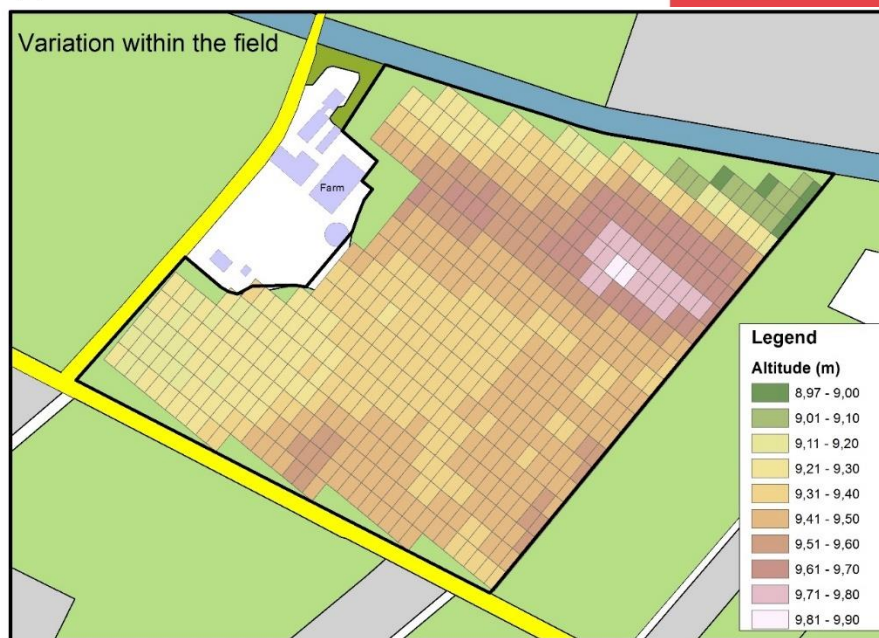
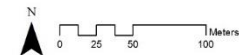
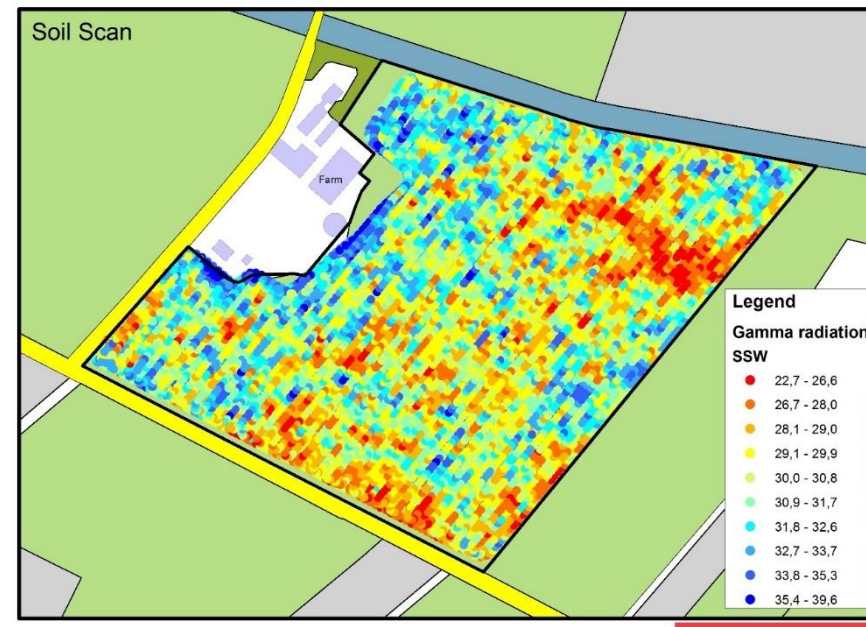
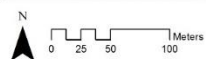
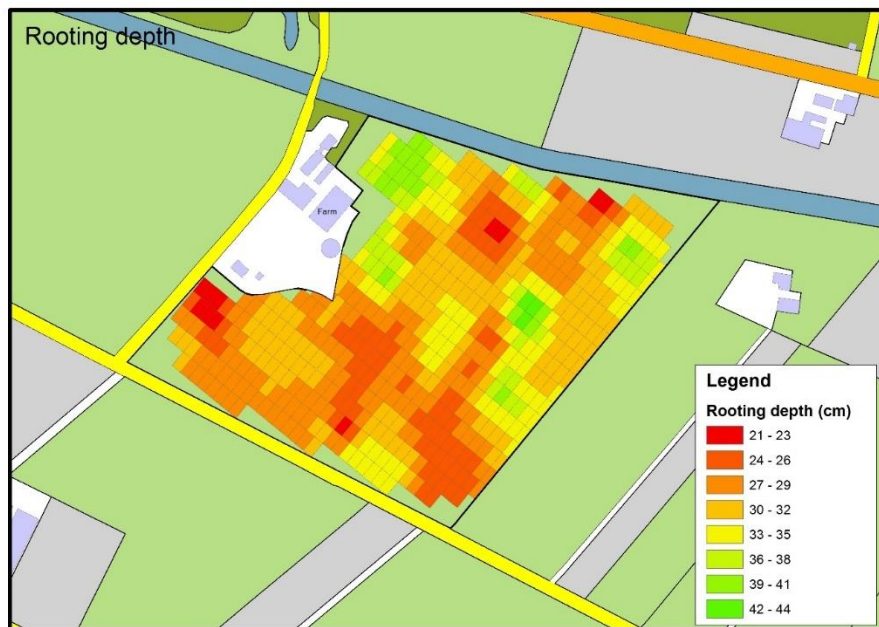
Klant: WILTING  
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Perceel: ZORGBOERDERIJ  
Naam: VEENHUIS GRASLAND\_20'  
Type: Spreading  
Oppervl: 3,68 ha  
Begindatum: 25-7-2017 13:47  
Einddatum: 25-7-2017 15:34

11,4 - 31,3 %  
11,0 - 11,3 %  
10,7 - 10,9 %  
10,3 - 10,6 %  
9,3 - 10,2 %  
1,1 - 9,2 %  
0,0 - 1,0 %

# Management zones

Knowledge farmer  
Soil analysis  
Altitude  
Soil scans (Veris)  
Satellite images





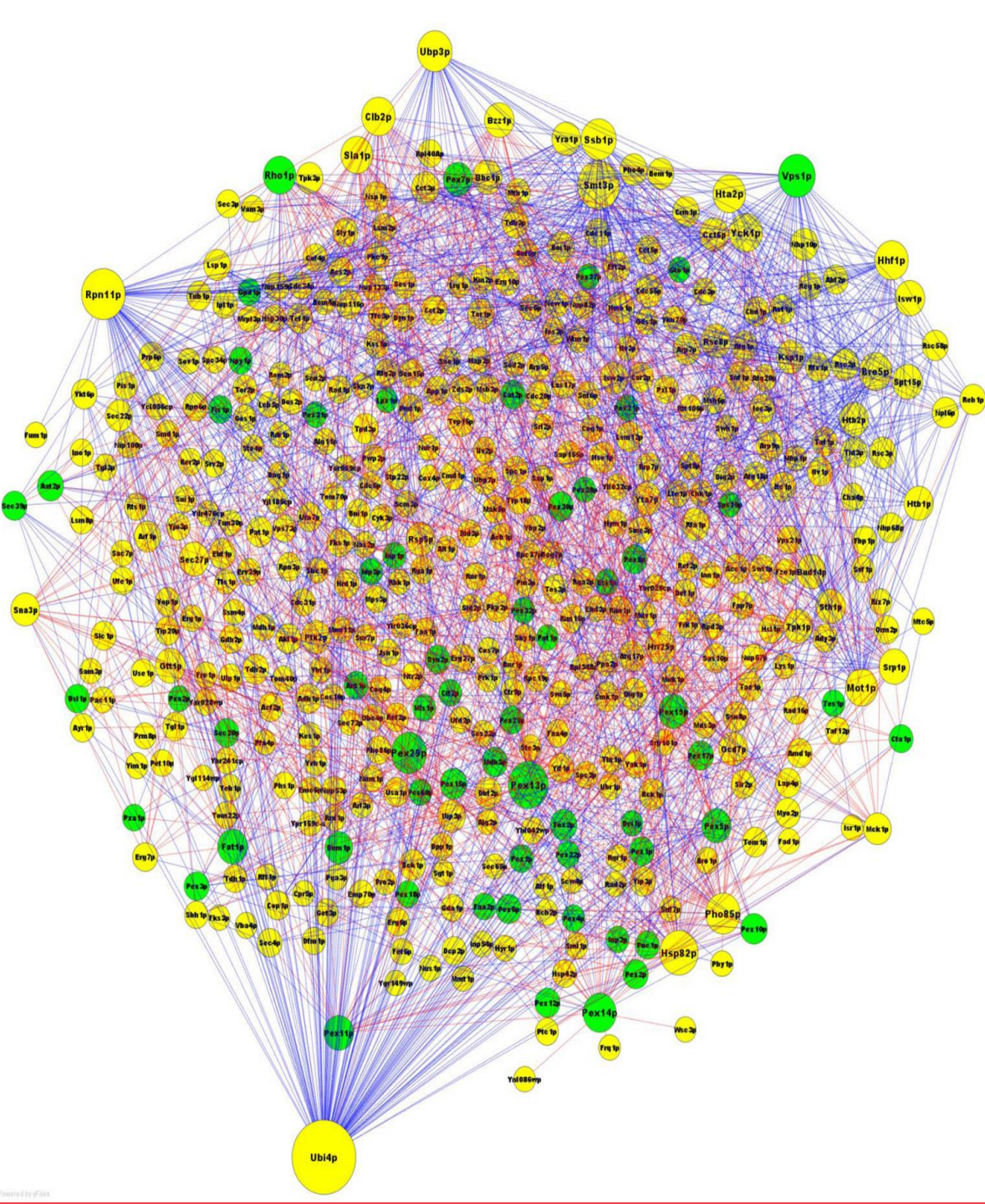


# Smart Farming Technologies

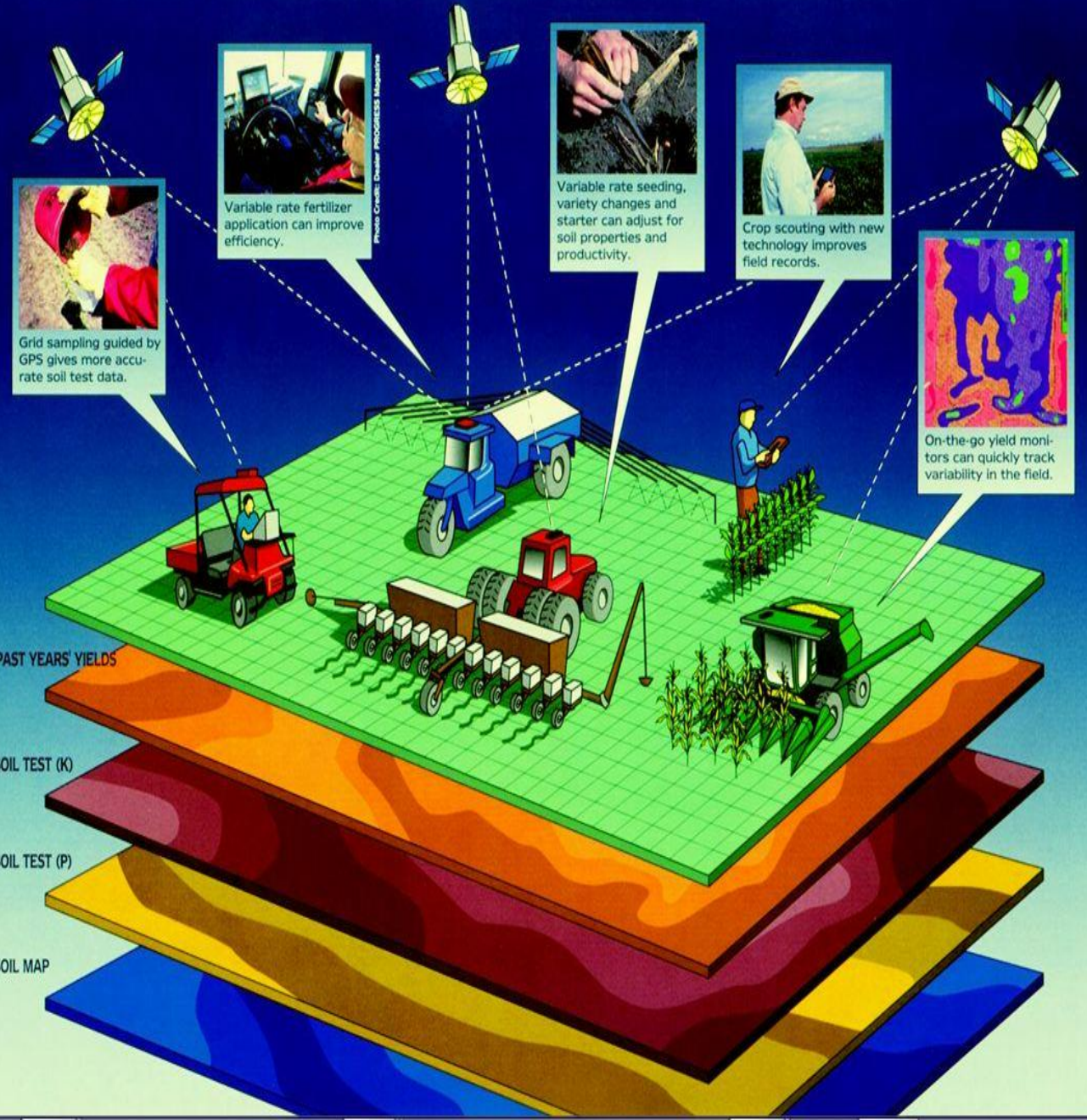
A zone has different yield potential



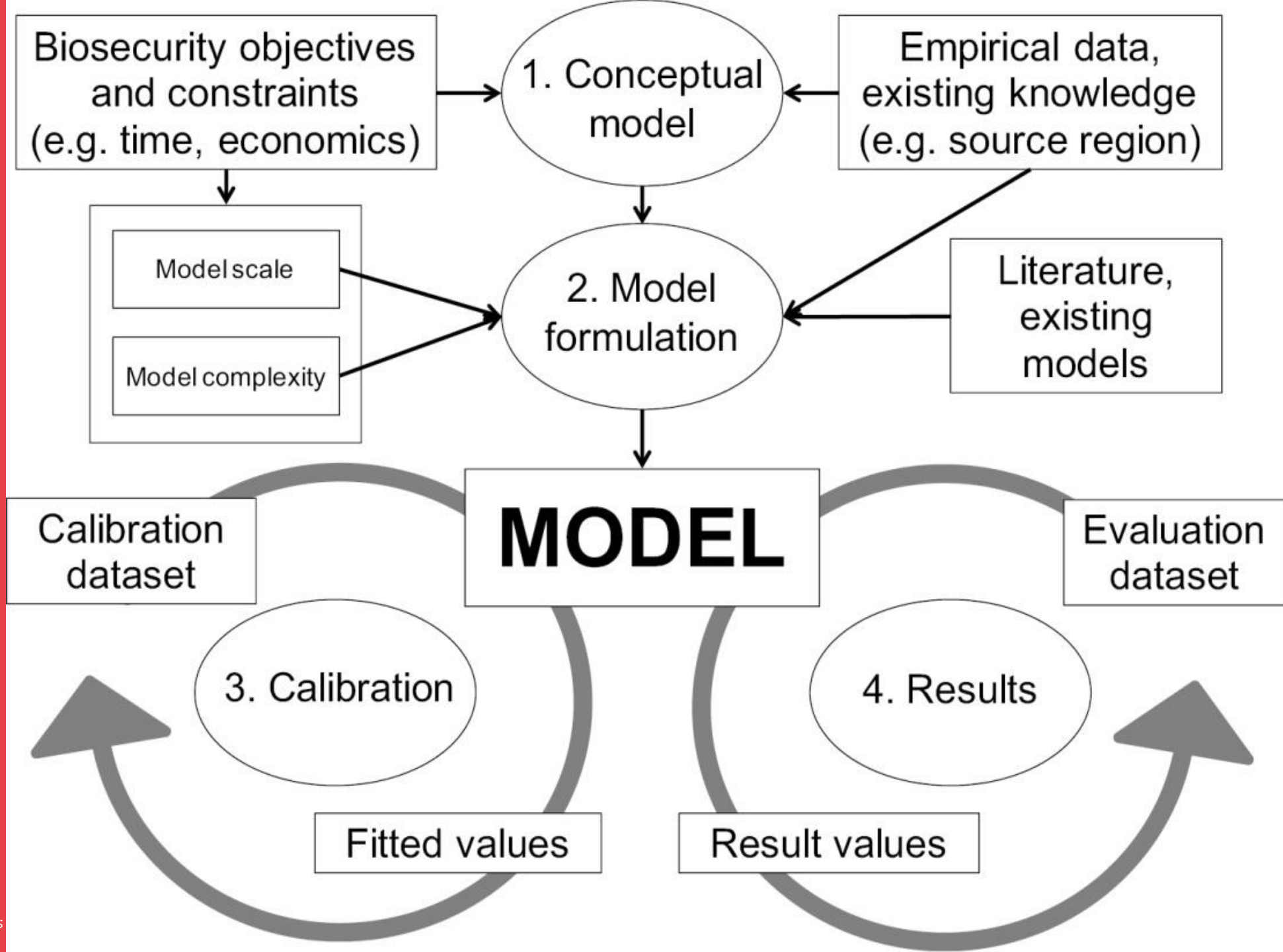




# 





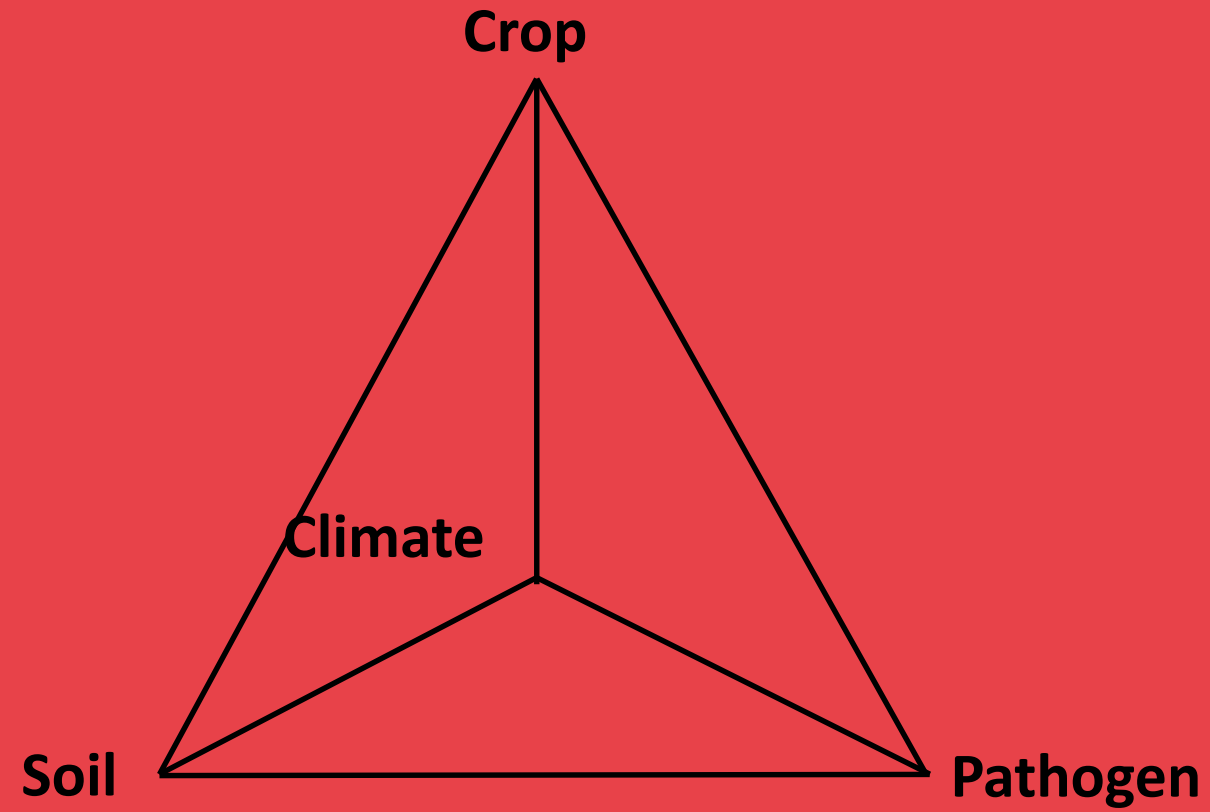


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**Be smart**  
**Think before act**







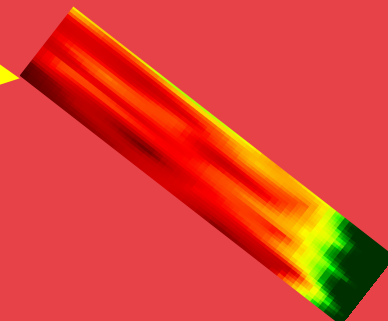
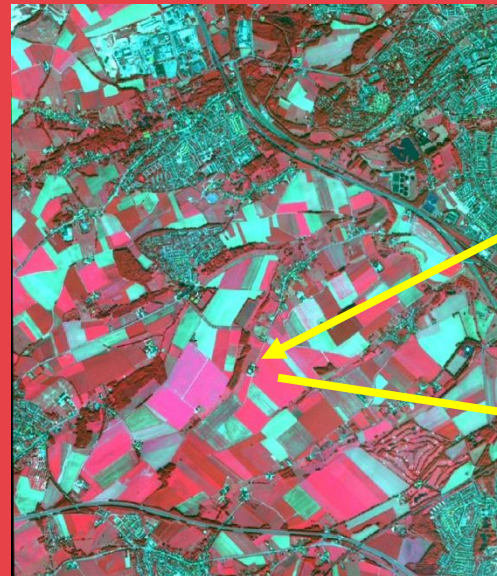
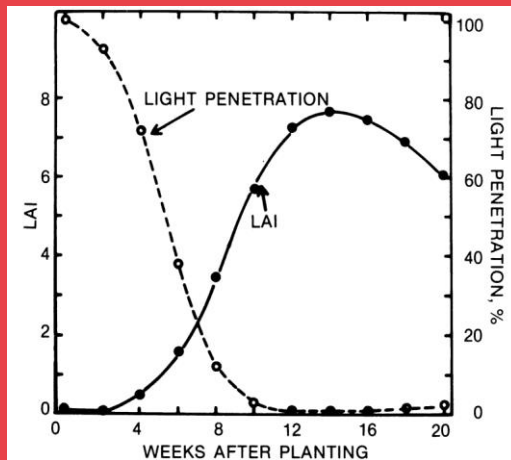


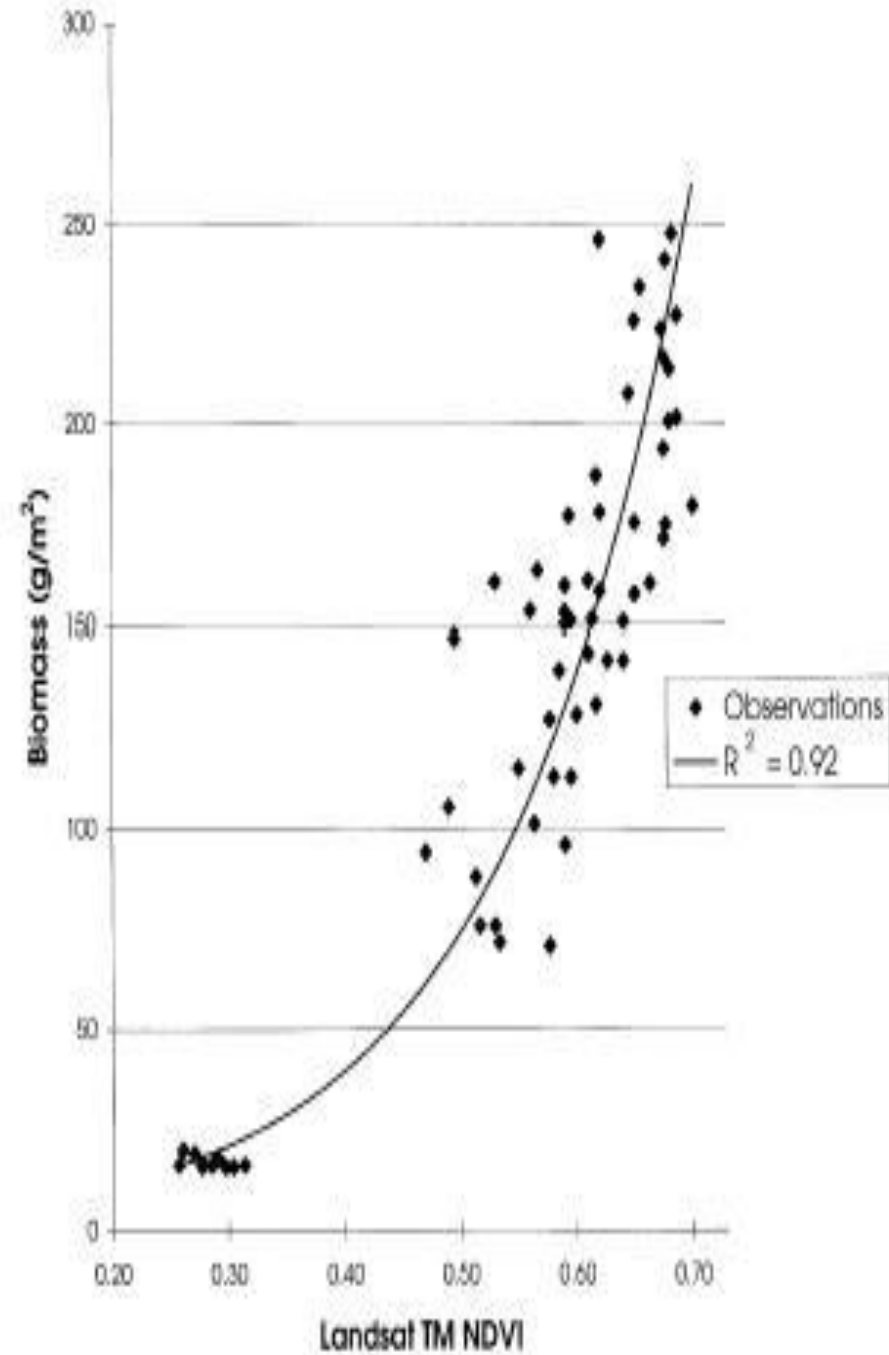
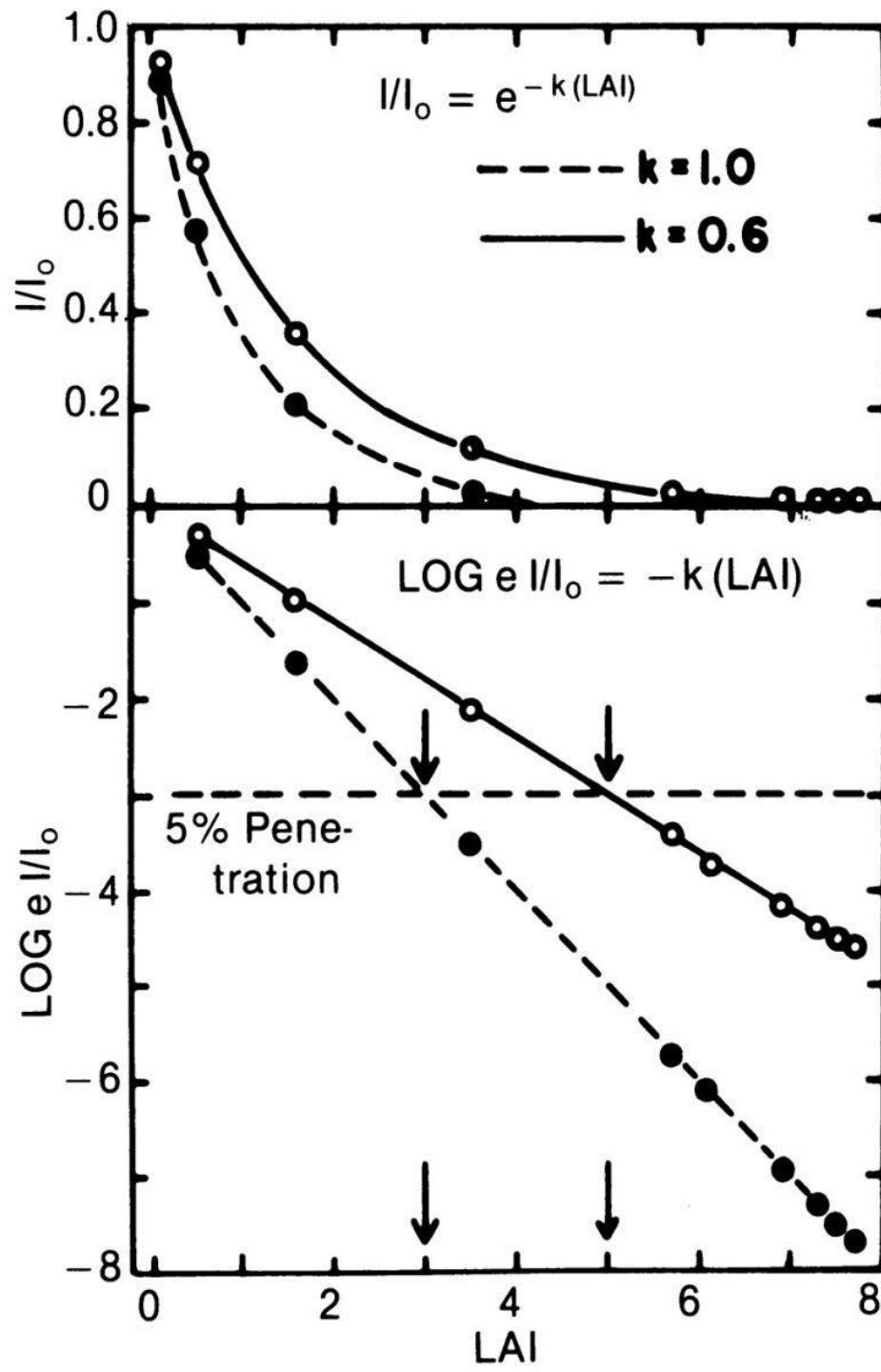




# CROP GROWTH MONITORING SYSTEM

Crop Growth Model sugar beet  
combined with  
Optical Remote Sensing Data







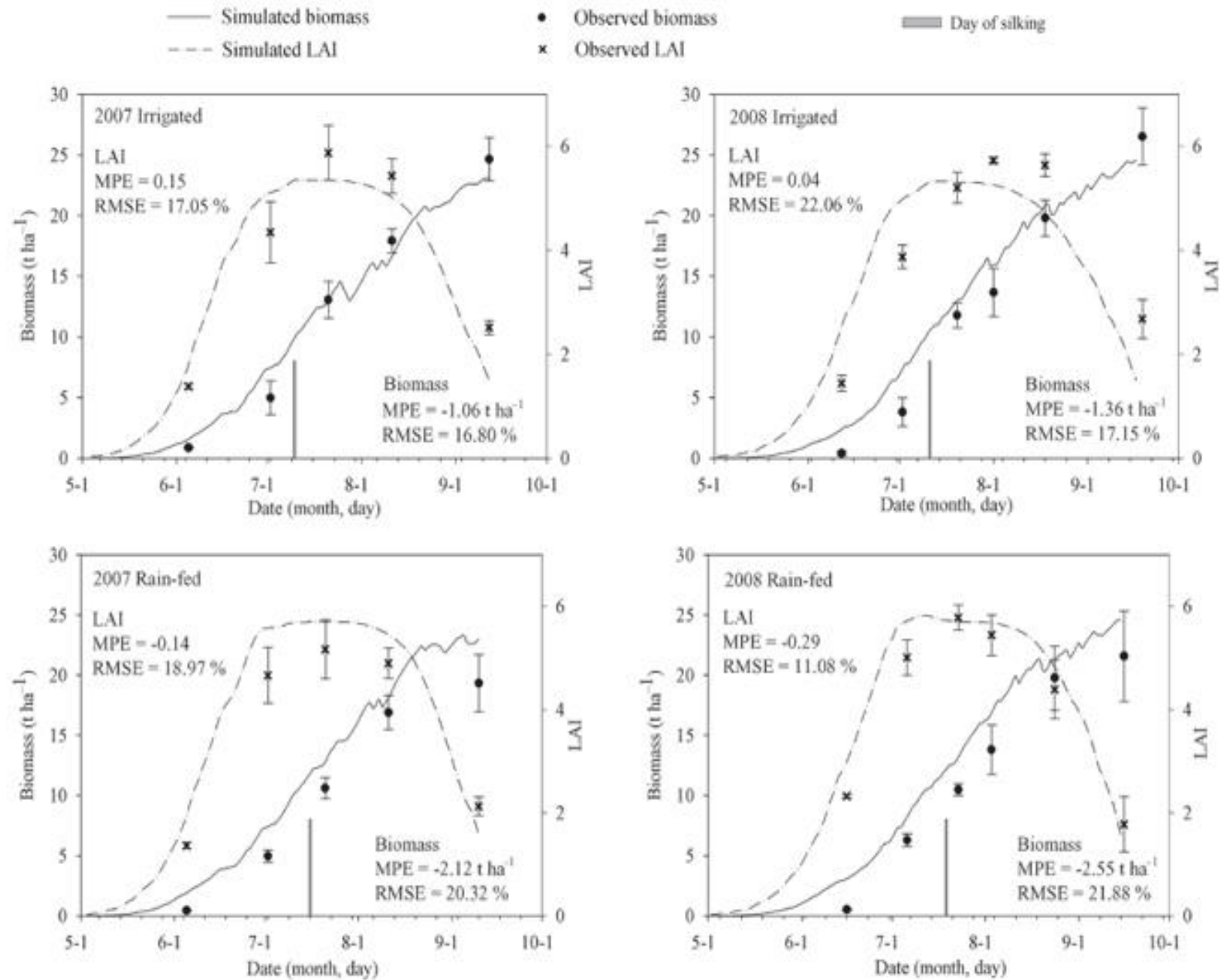


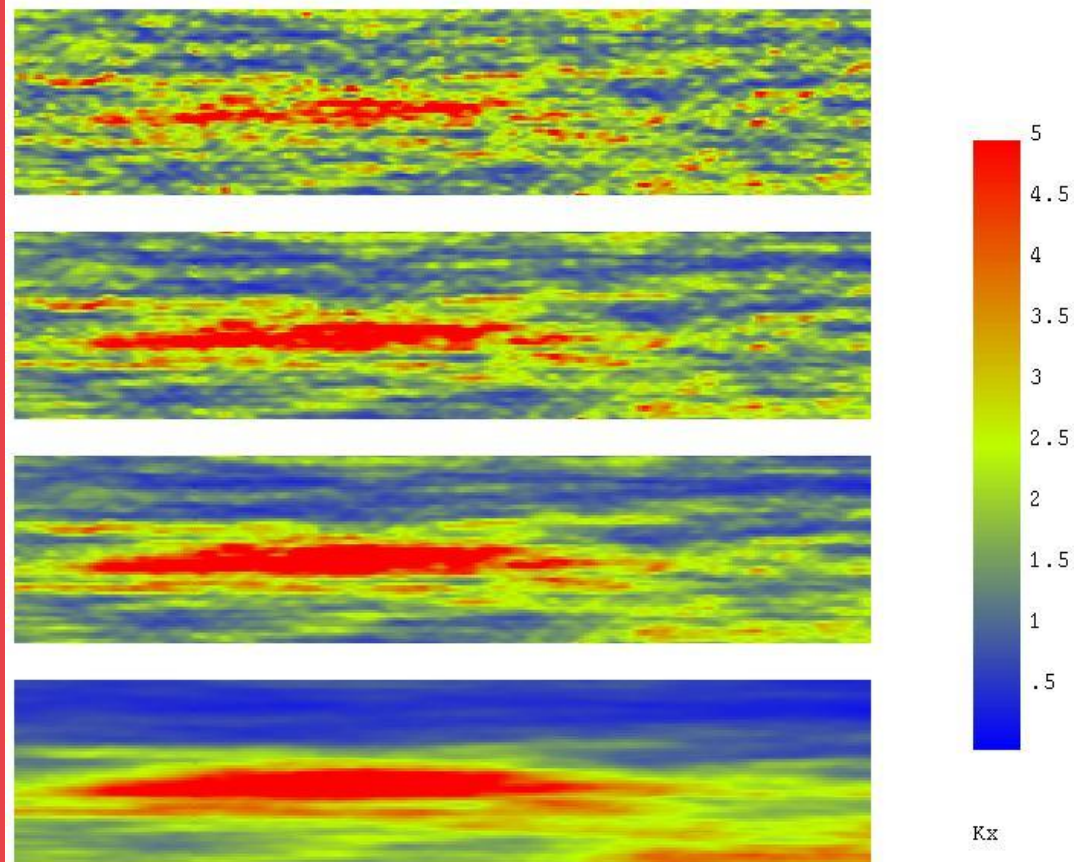
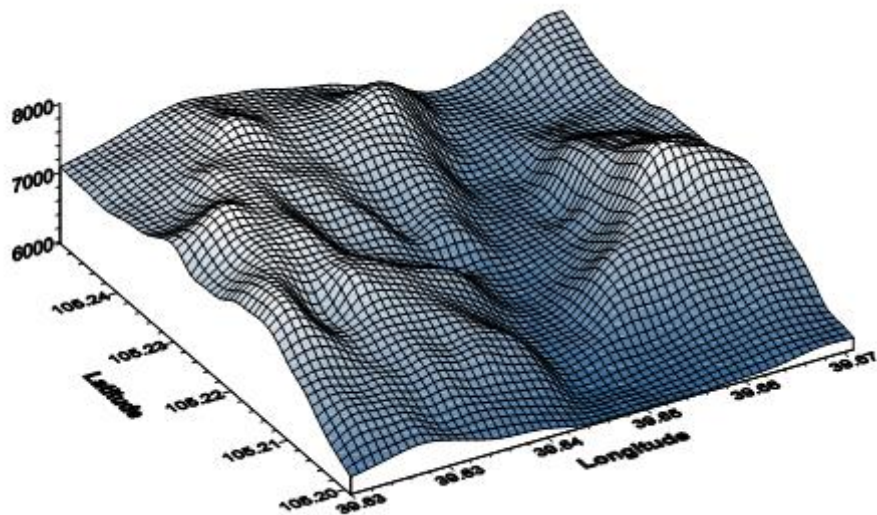
Figure 2 – Observed and simulated leaf area index (LAI) and biomass under irrigated and rain-fed conditions during the growth seasons in 2007 and 2008. Error bars of the observed values are twice the standard error of the mean; MPE = mean prediction errors; RMSE = root mean square errors.

# Spatial dependancy

**HOW TO HANDLE?**

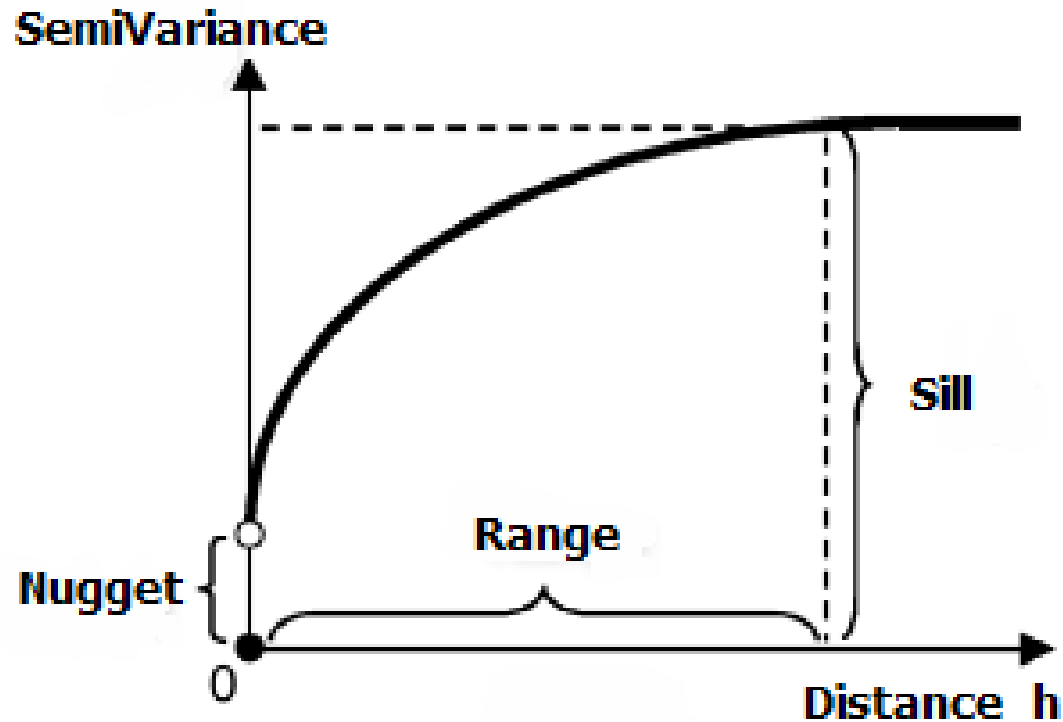






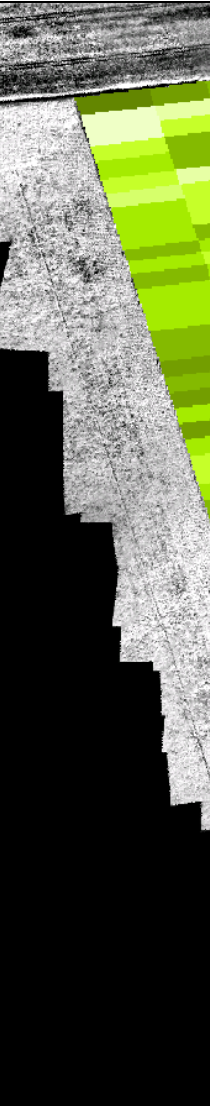
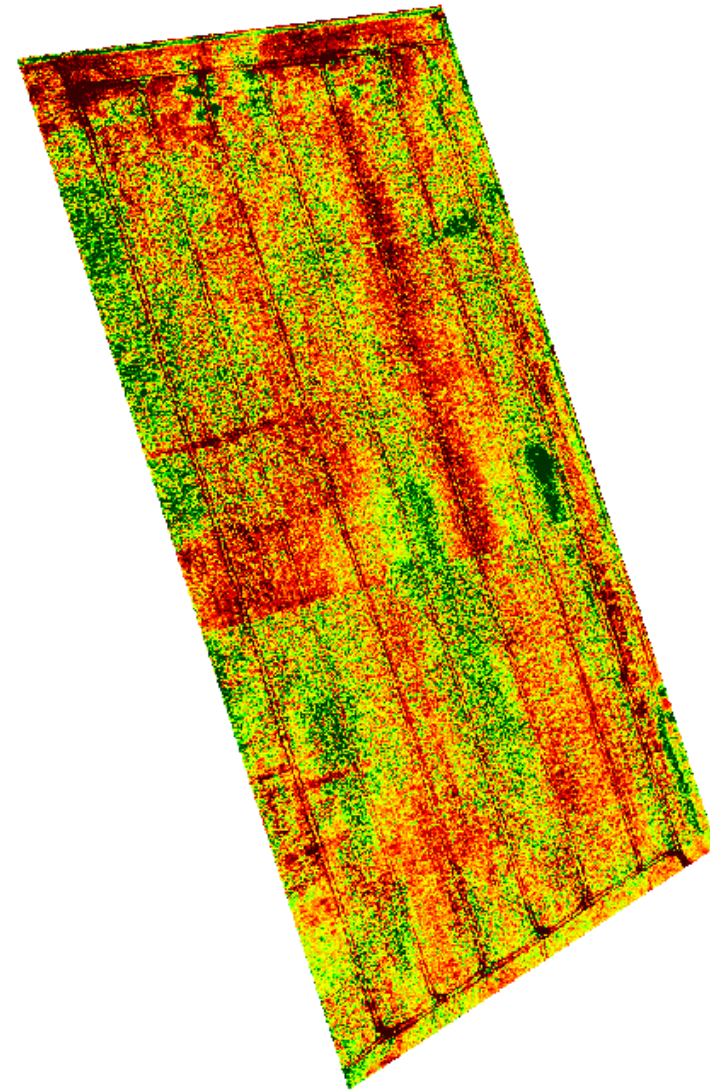


# ANALYSING SPATIAL PATTERNS

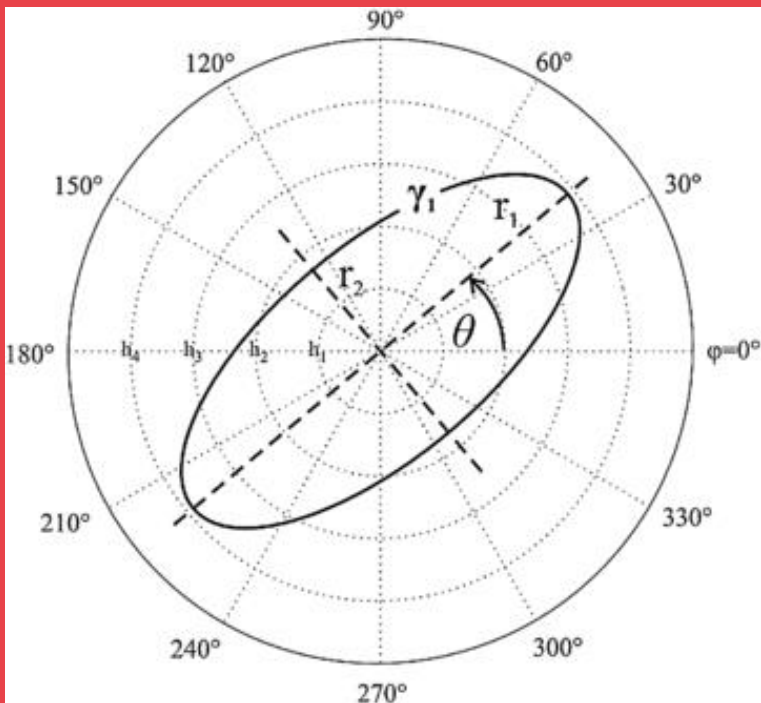
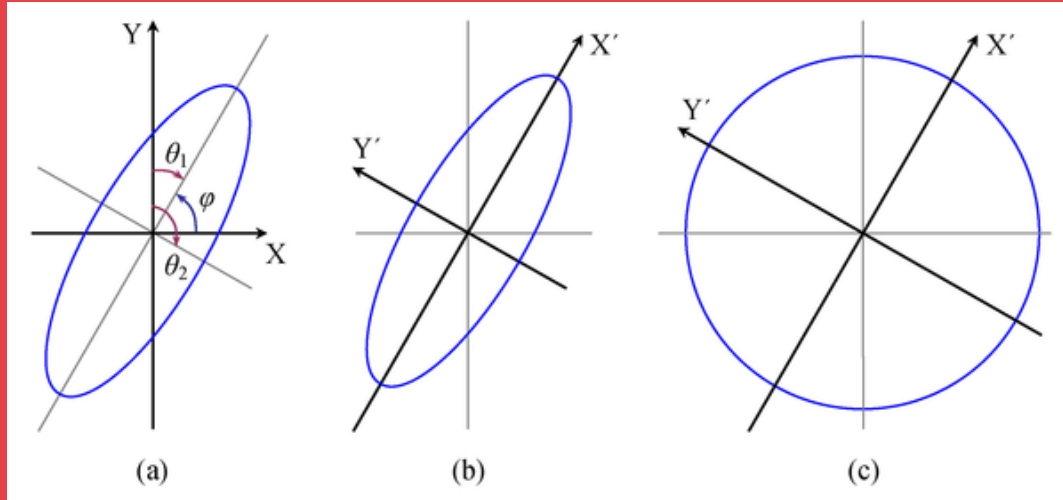


$$\gamma(h) = \frac{1}{2N(h)} \sum_{(i,j) | d_{ij}=h} (v(x)_i - v(x)_{i+h})^2$$

$v_i$ : variable value  
 $x$ : location



# ANISOTROPY

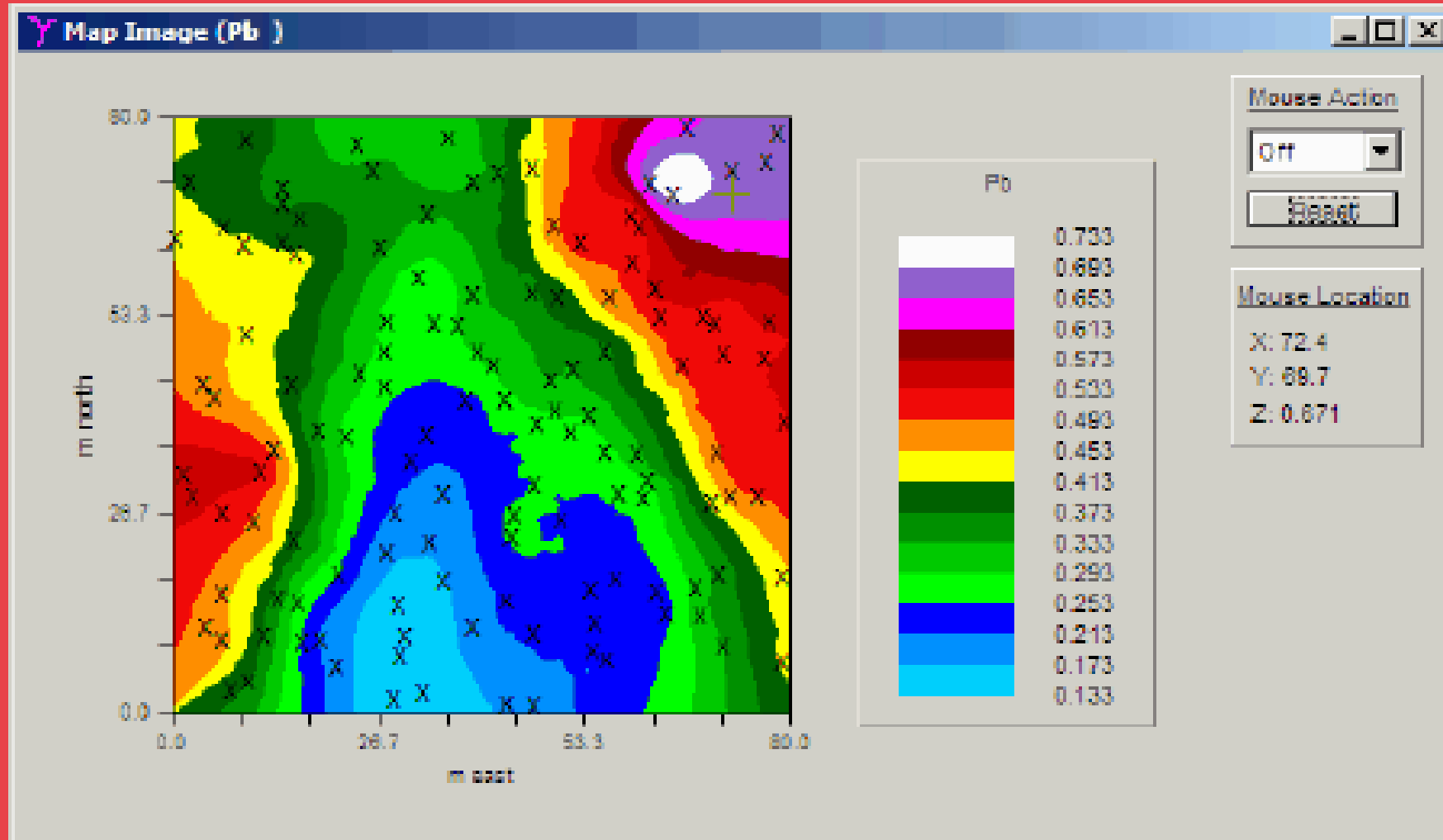




$$\bar{x} = \sum_{i=1}^n (x_i * w_i)$$

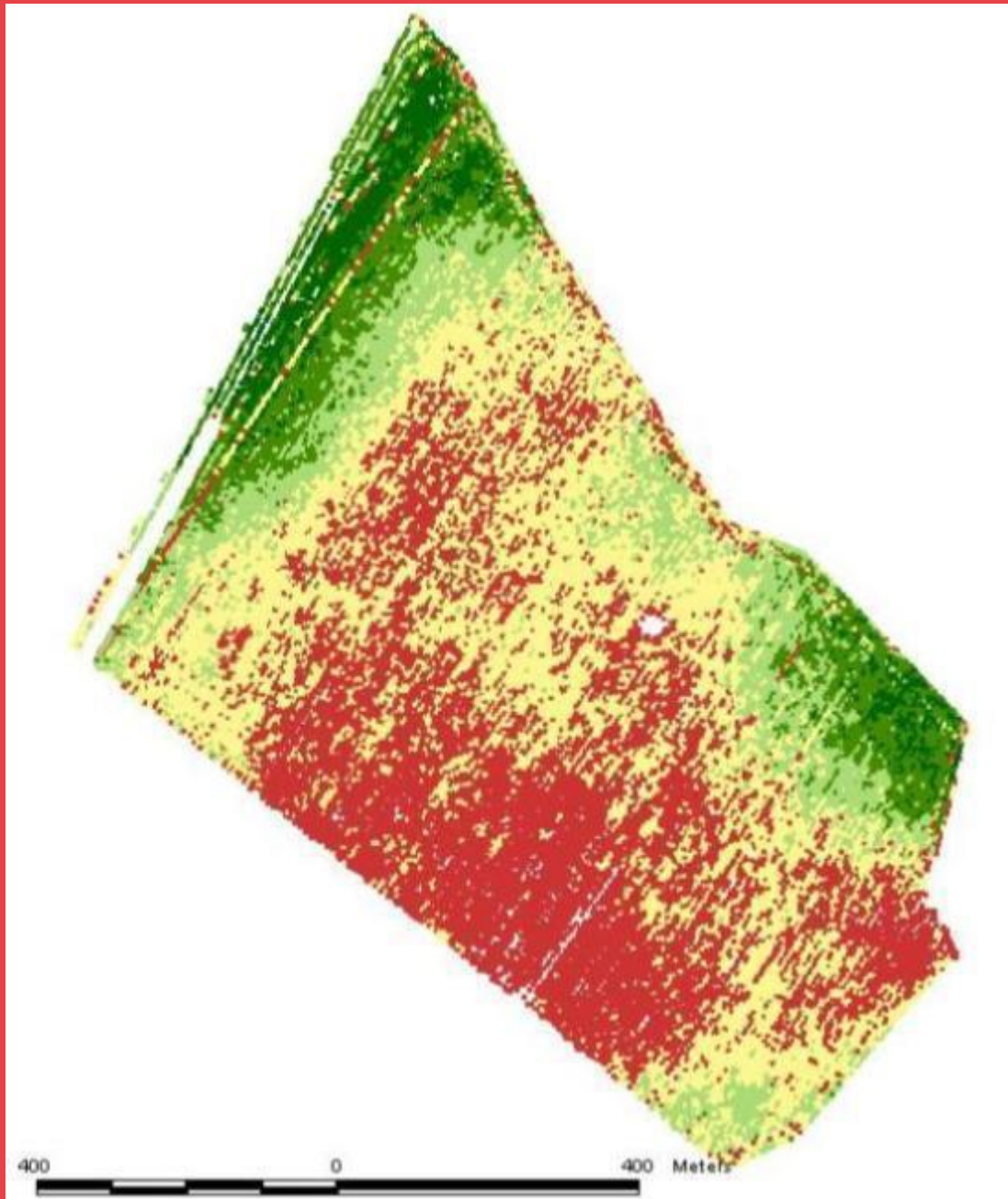
where:  $\bar{x}$  = kriged estimate  
 $x_i$  = ith measured value  
 $w_i$  = ith weighting factor

What's in a name?



**How to show  
yield maps?**

**.....points**

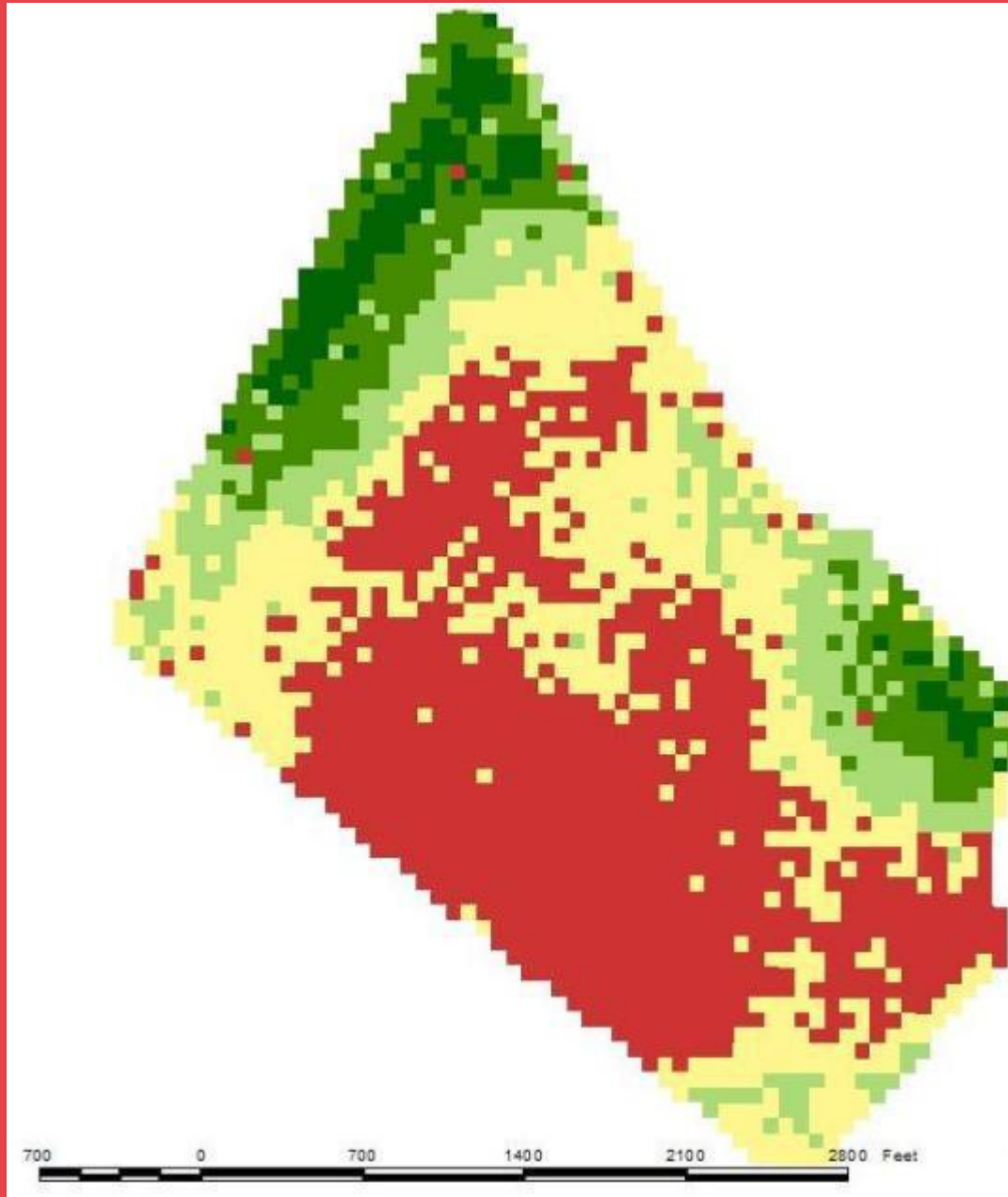
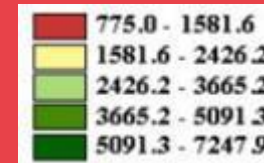




How to show  
yield maps?

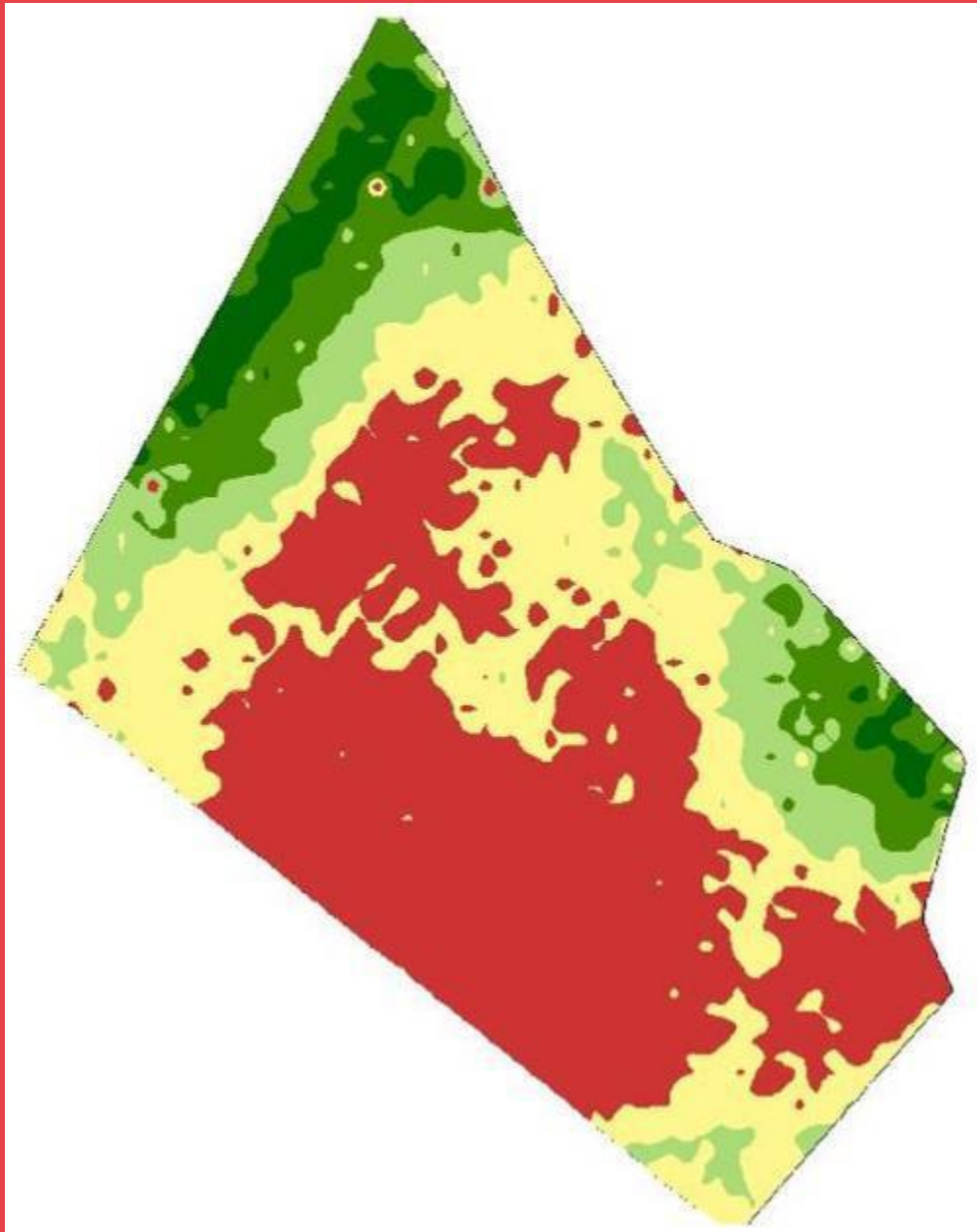
Raster surface  
(pixels)

Corn (kg ha<sup>-1</sup>)

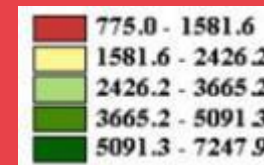


**How to show  
yield maps?**

**Vectorial surface  
(isolines)**

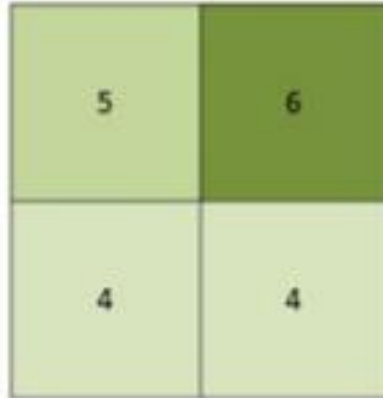


**Corn (kg ha<sup>-1</sup>)**

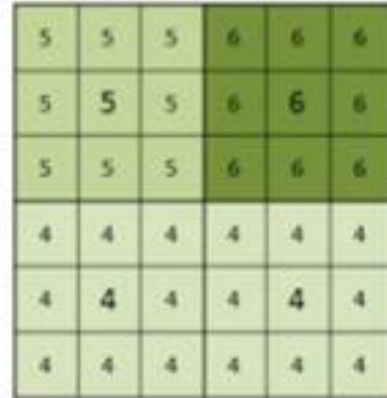




Original SRTM/CGIAR DEM  
(90 m cell size)



Decreased cell size: 30m  
(resolution remains the same)



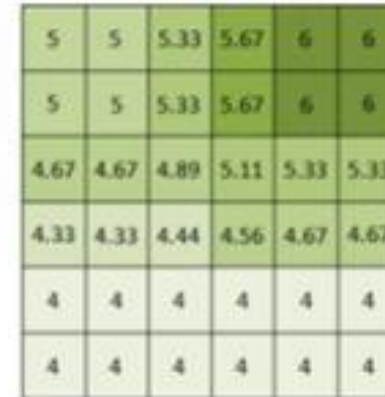
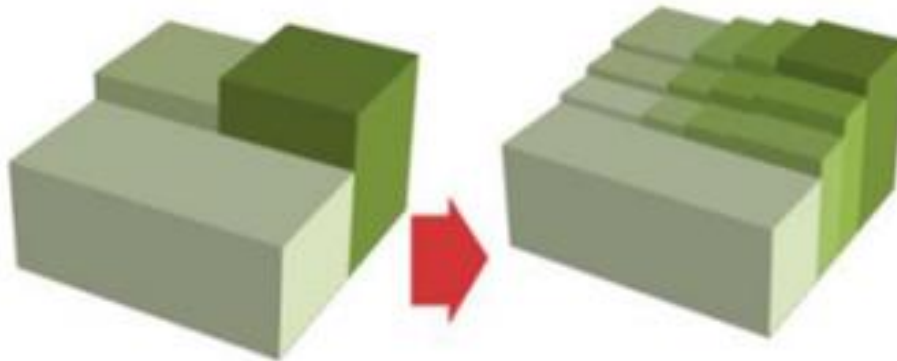
Neighbourhood (3X3) Operation:  
Mean



Nearest  
Neighbour  
resampling

Cubic  
convolution

3D Visualisation of the Above Steps



Resampled SRTM/CGIAR DEM  
(increase resolution)

# What is precision?

- ☐ Each m2?
- ☐ Width of my spreader?

**Think logical**

**Think as a user**

**Be smart**

**Analyse, think, conclude, analyse, conclude, act**







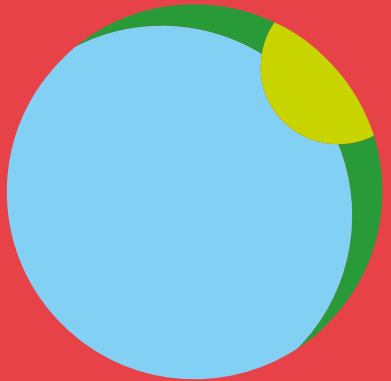
A photograph of a sunset over a field of tall grass. The sun is low on the horizon, casting a warm, golden glow across the sky and the field. The sky is filled with soft, wispy clouds. The grass in the foreground is tall and green, with some white flowers visible. The overall scene is peaceful and serene.

**A bad farmer with models, sensors and precision farming is still a bad farmer.**

**An intelligent farmer understands the logic of models. Therefore he can improve his way of farming**



*Everyone said it was  
impossible,  
until someone came by  
who did not know that*



**AERES**  
HOGESCHOOL  
DRONTEN

*Thank you*

