



# Precision agriculture in Serbia – a short overview

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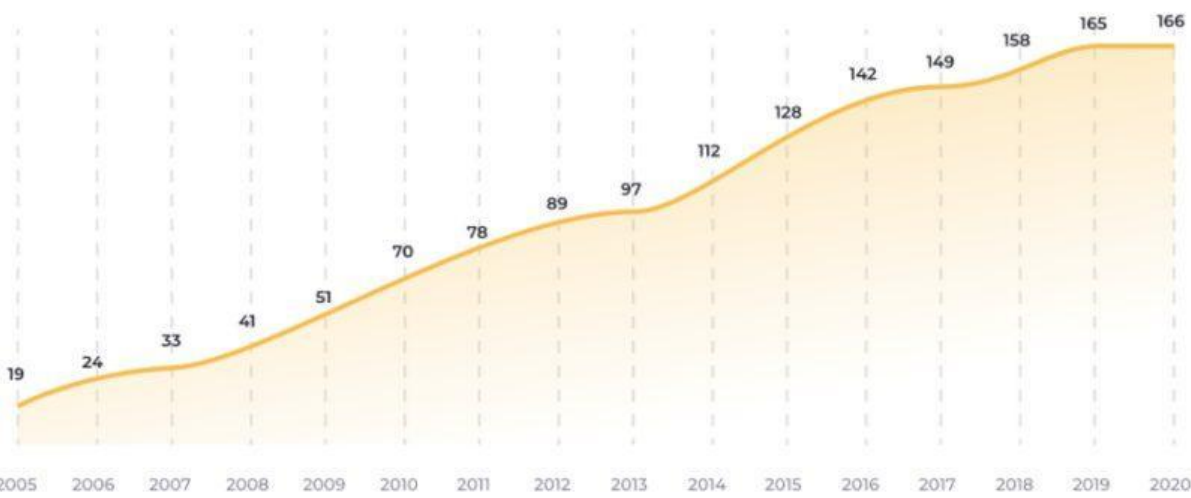
University of Novi Sad – Faculty of agriculture

# Actual trends in Ag

In 2015, the precision agriculture market is estimated at \$ 23 billion, and by 2050 it will reach a value of \$ 240 billion (AgWeb, 2016). Sales of automated systems and robots in 2016 were at the level of 32,000 units, and it is predicted that in 2024 there will be 594,000 units with a value of 74 billion dollars a year.

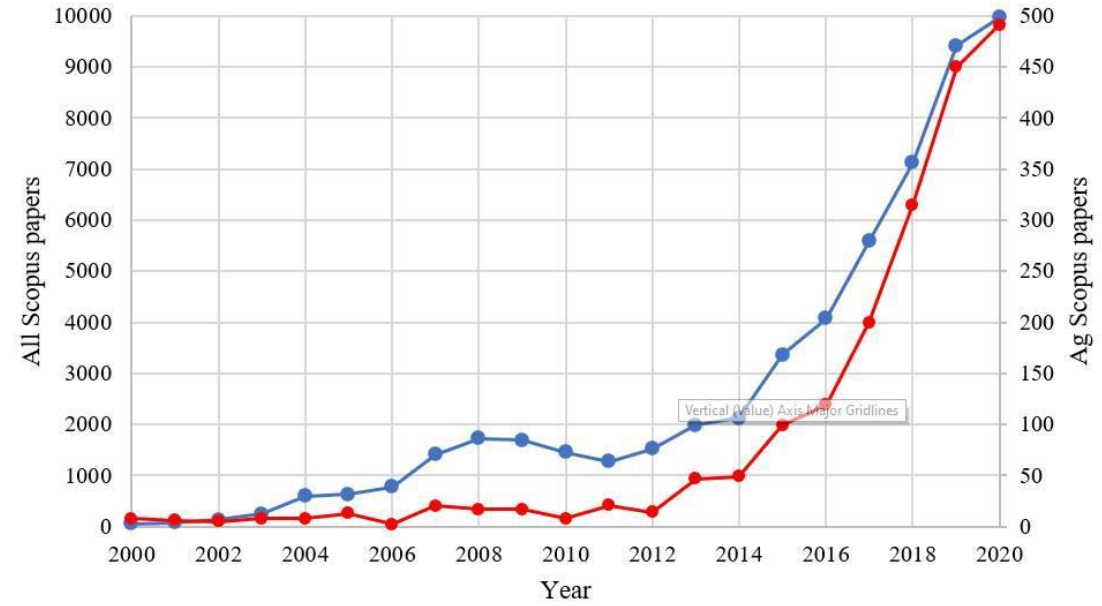
In the last 50 years, the price of agricultural land in England has risen by 5,182%, or 187% in the last 10 years. The average price of agricultural land at the end of 2014 was € 21,000 / ha (Shirley, 2014).

Evolution in The Number of Farmland Funds by Region



Source: Valoral Advisors

Farmland-focused investment funds, 2005-2020. Source: Valoral Advisors



—●— All Scopus papers —●— Ag Scopus papers

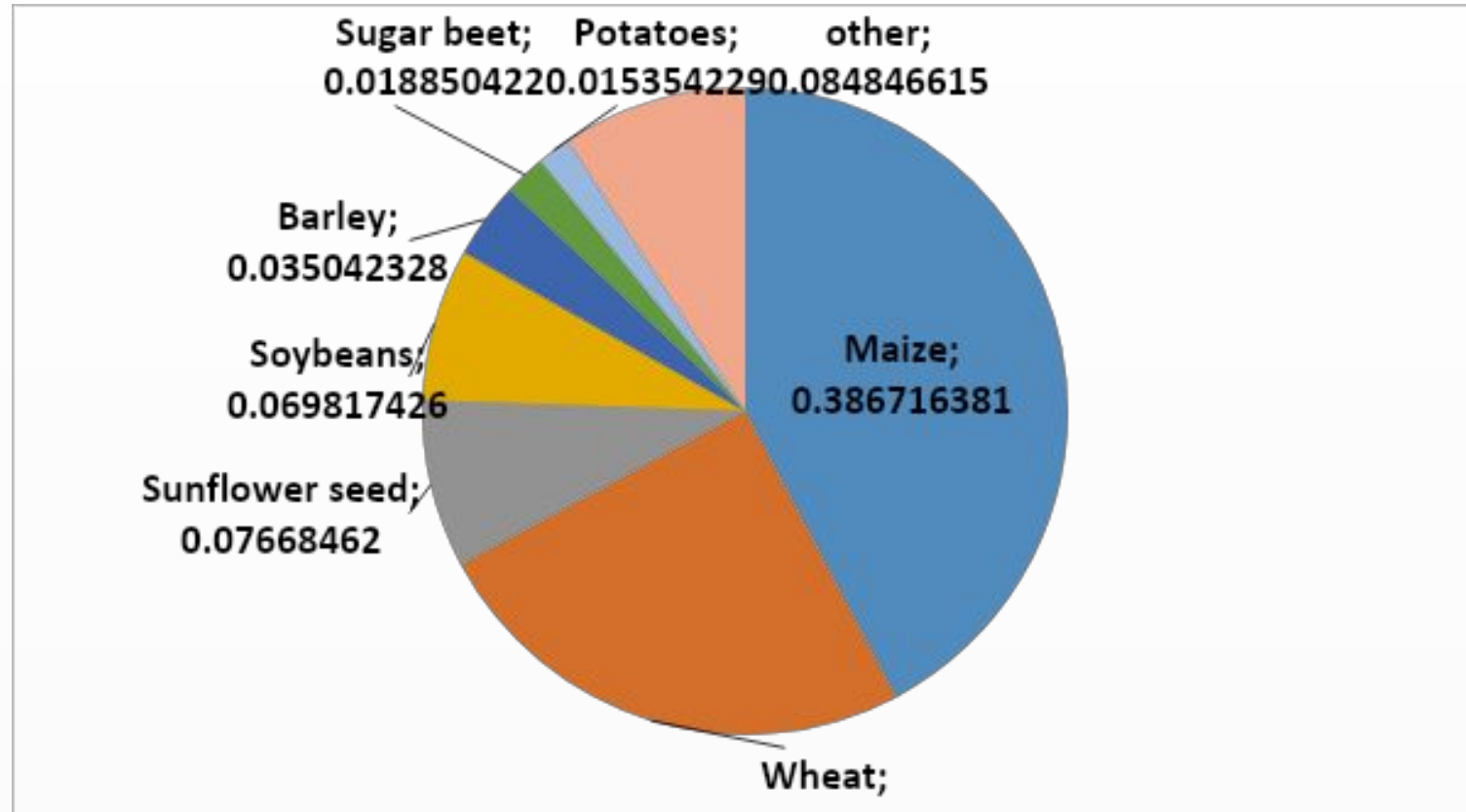
# Agriculture in Serbia

- The most important export sector for the economy of the Republic of Serbia
- 19.4% of the total value of exports
- Engages more than one third of the working population
- The results of agricultural production largely depend on climatic factors, which is the main reason for instability



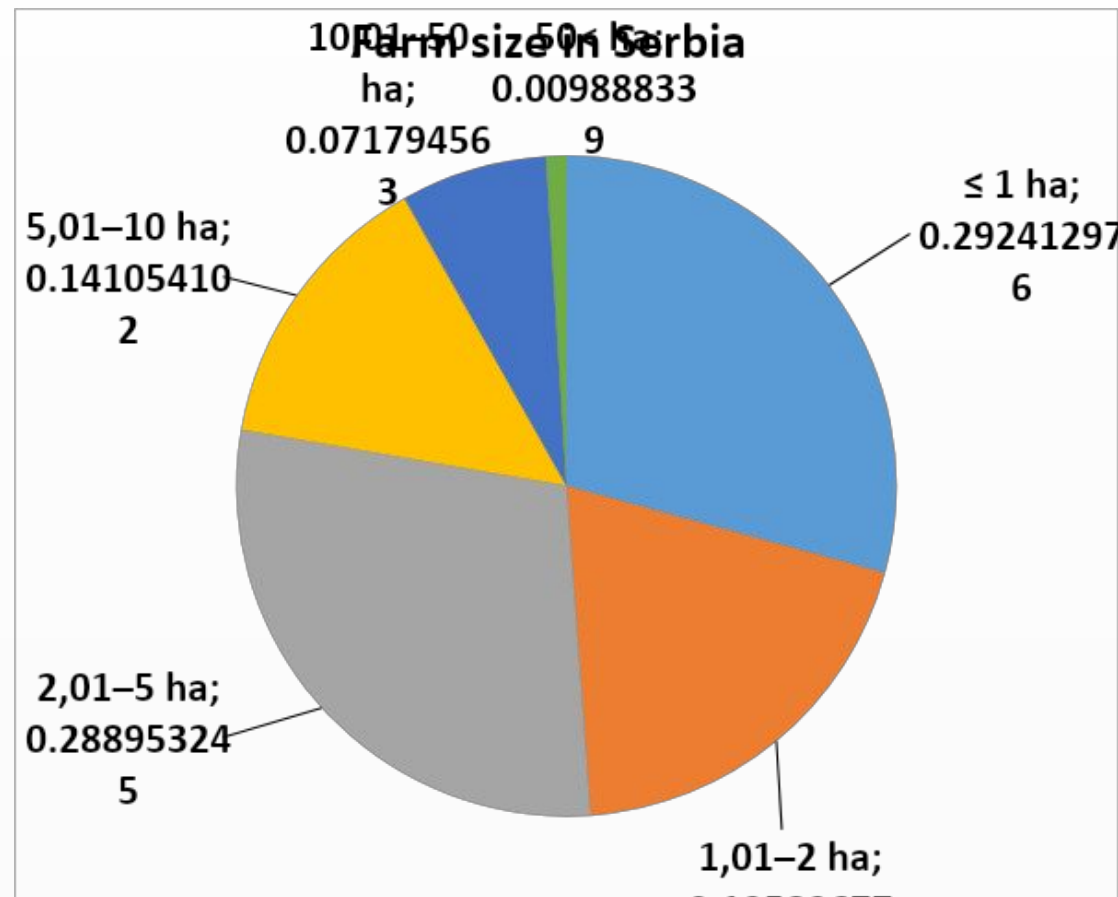
# Agriculture in Serbia

- Agricultural land use
- Arable crops 73% of total agricultural land
- Cereals 68% of arable land
- Dominated by low-profit crops
- Poor starting point for investing in new technologies



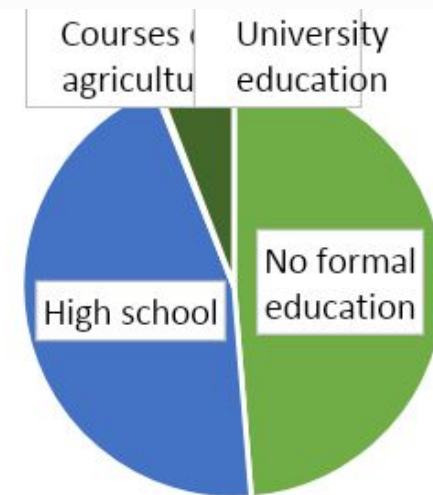
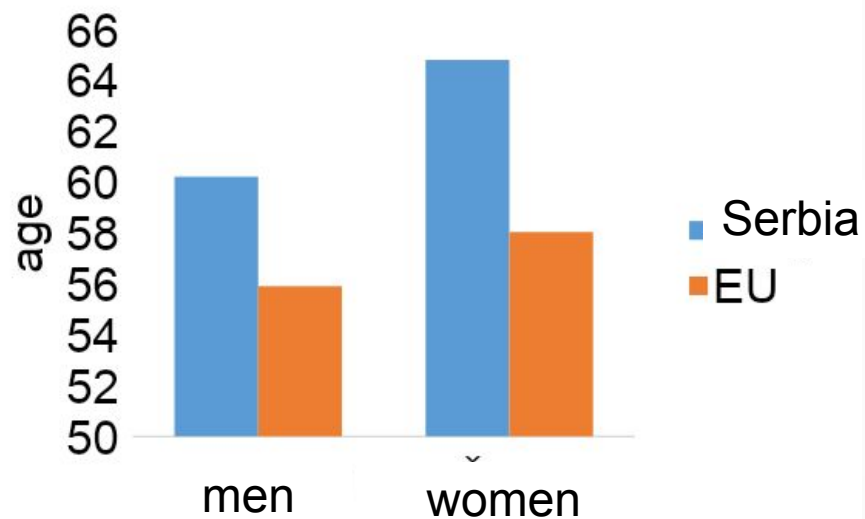
# Why adoption of advanced technologies in agriculture in Serbia is low

- Farm size and type
- Family owned and operated farms 99.5%
- Legal entities and enterprises 0.5%
- 78% less than 5 ha of agricultural land
- Average utilized area per holding 5.4 ha
- Age
- Average farmers' age 59 years



# Why adoption of advanced technologies in agriculture in Serbia is low

- Decreased interest in the agricultural profession among the younger generations
- Decrease in the number of educated staff
- More and more sophisticated equipment in the field, less and less agile maintenance operatives

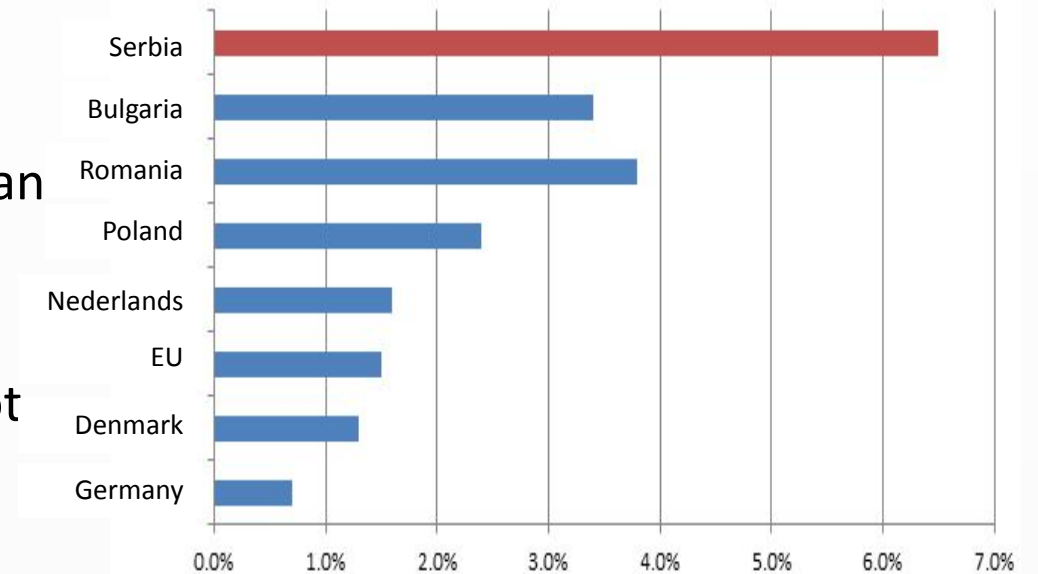




# Why adoption of advanced technologies in agriculture in Serbia is low

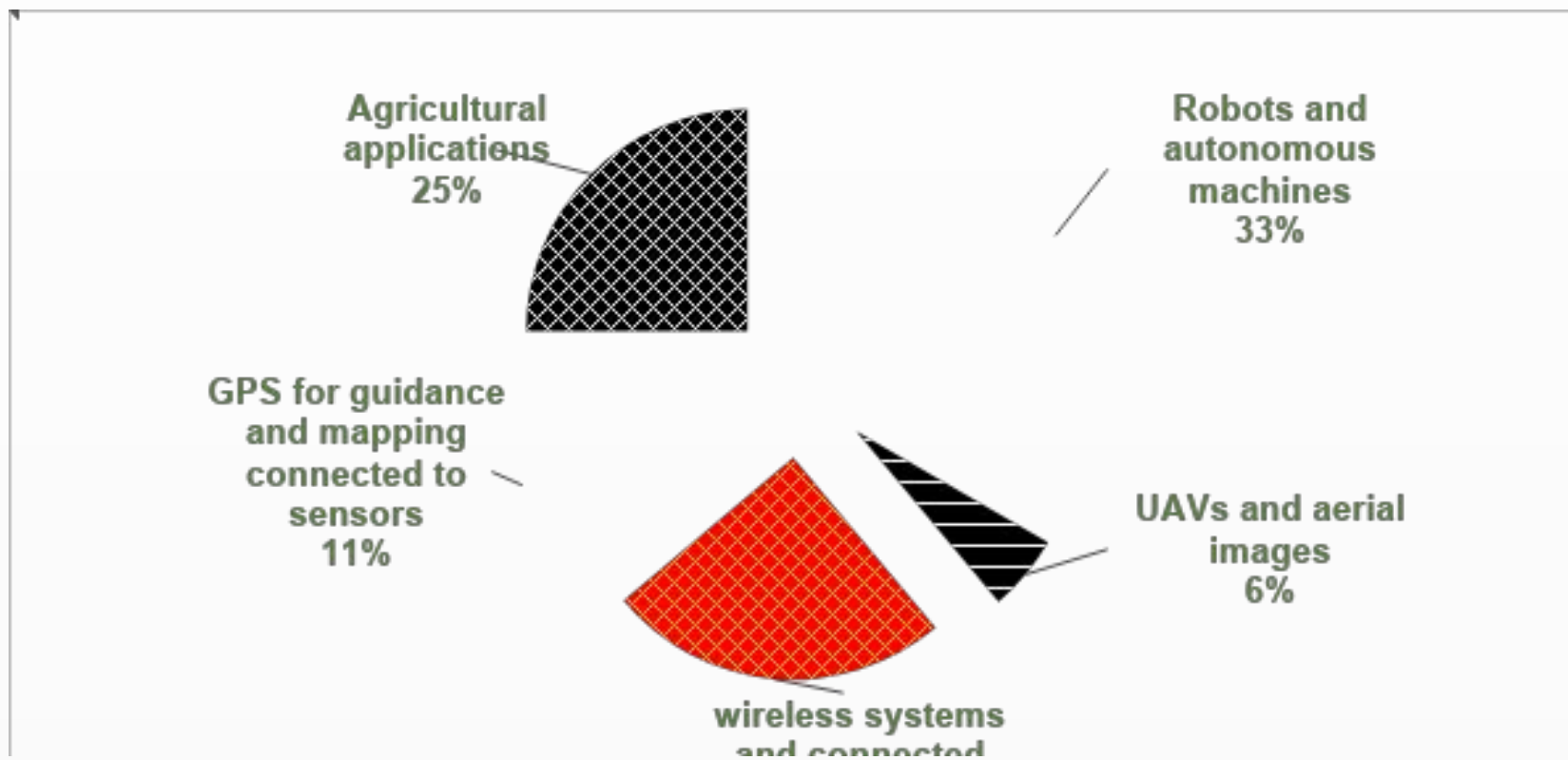
- BioSense Institute survey
- 14% of the interviewed farmers were adopters of smart farming technologies (SFTs)
- 92% agreed that the inclusion of technology in agriculture can improve farming
- 36% agreed that SFTs can increase income
- 81% recognized the cost as the most important factor for not adopting SFTs
- 94% would adopt SFTs if supported through subsidies

Participation of agriculture in GDP generation, selected countries. Source: World Bank.



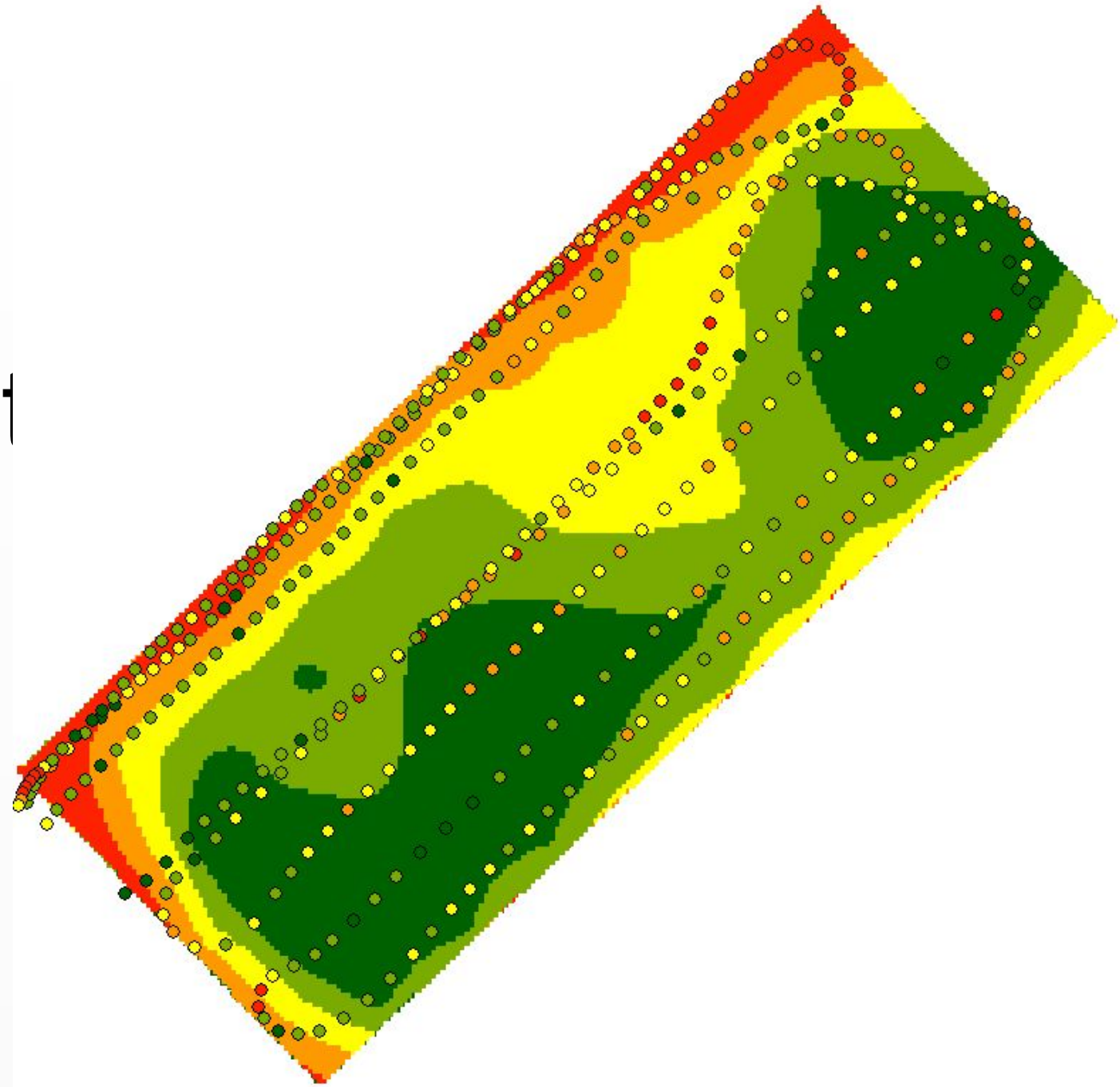
# Why adoption of advanced technologies in agriculture in Serbia is low

- BioSense Institute survey
- Which technologies are most important?

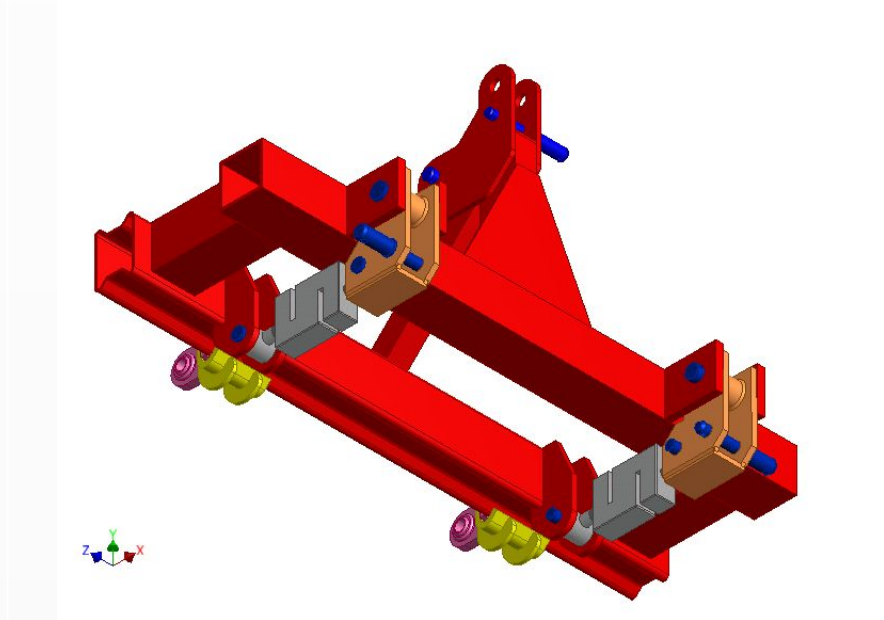
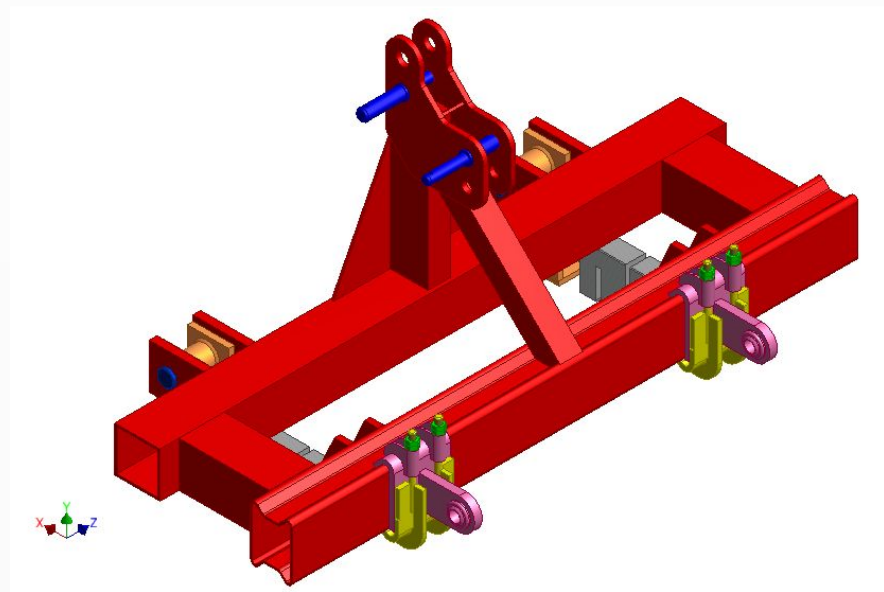
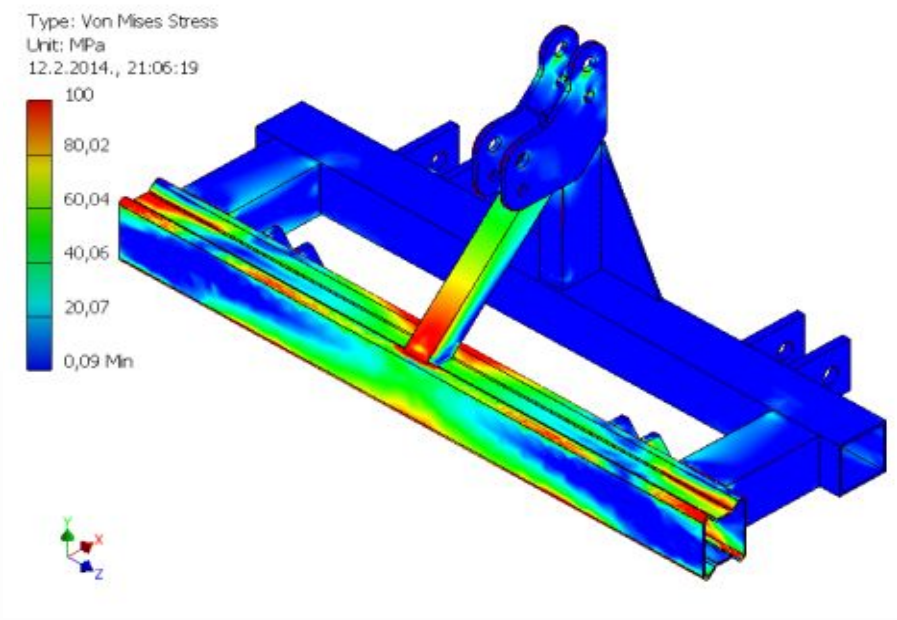




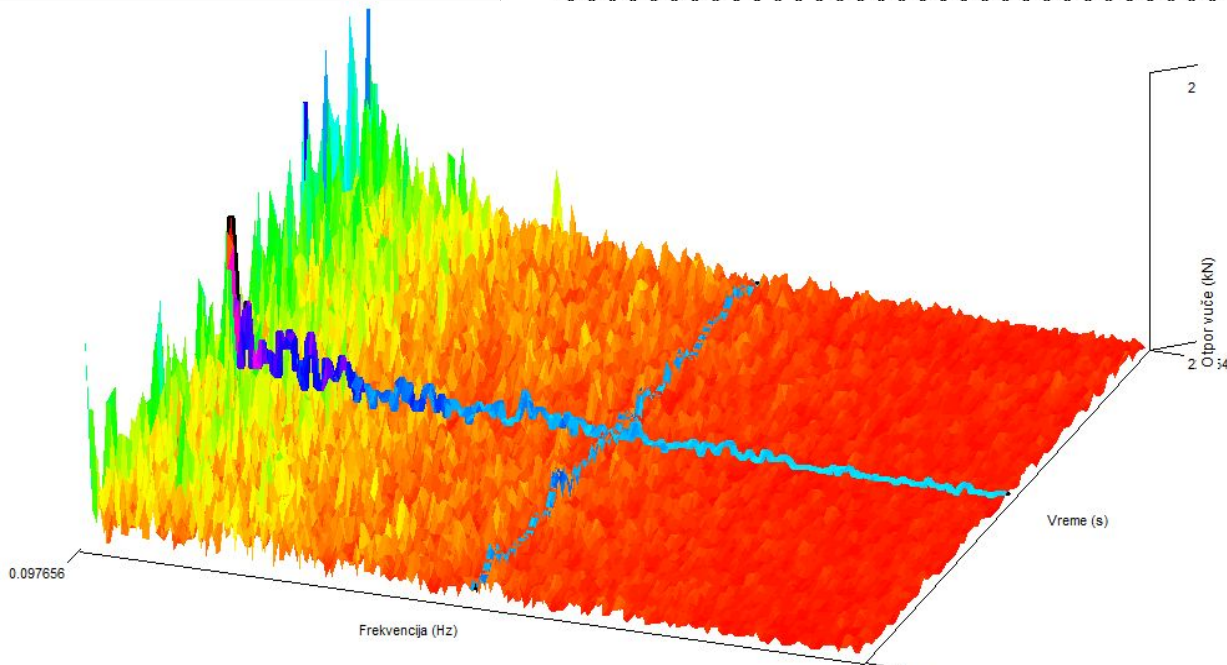
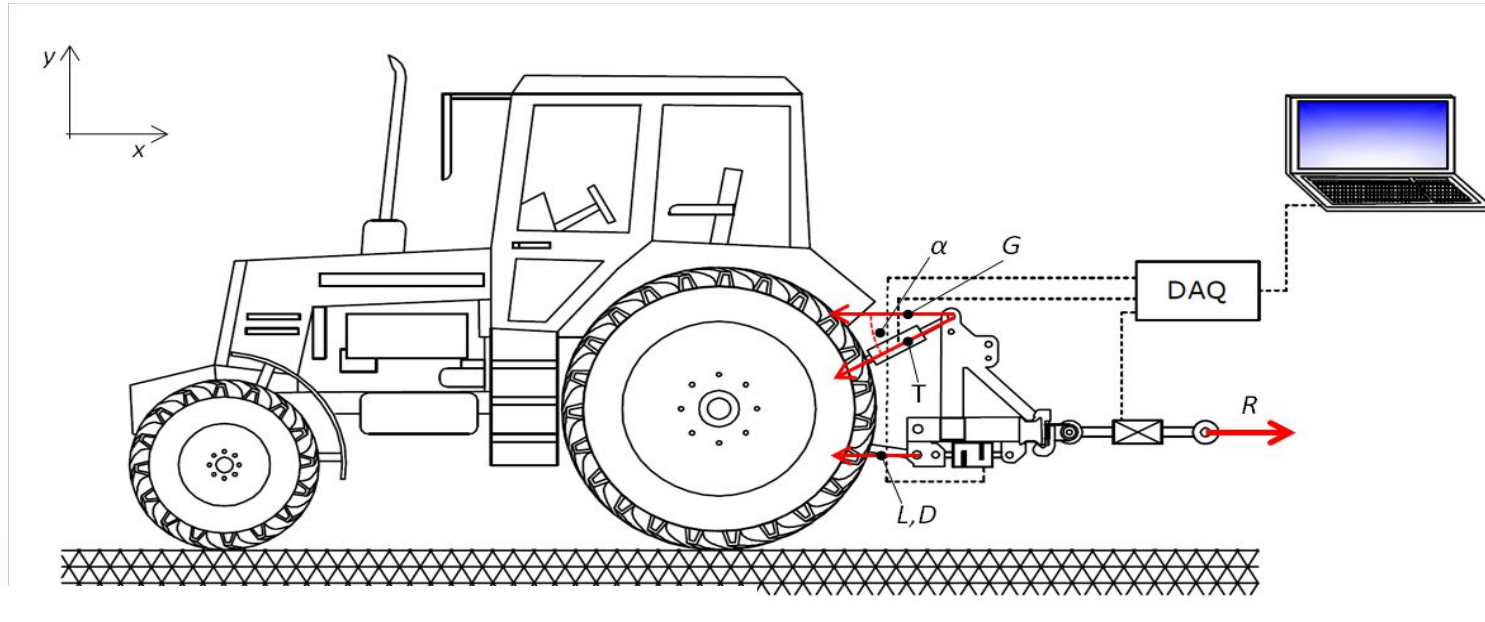
# Review of Scientific works



# Development of on-the-go system for a measuring soil mechanical resistance with geopositioning



# Static calibration of measuring system



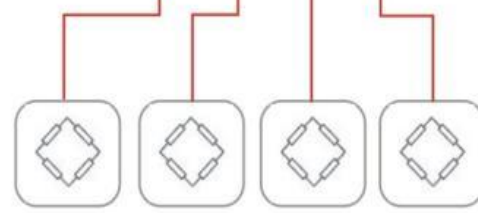


# Universal Measuring Amplifier

PC software for data acquisition



Ethernet

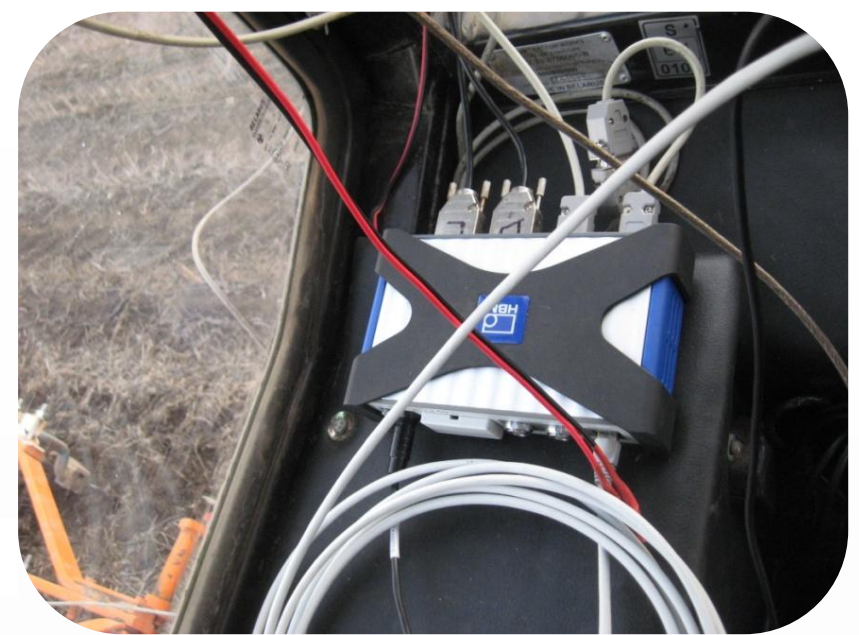


Analog signal from sensors

sa RS232 na USB

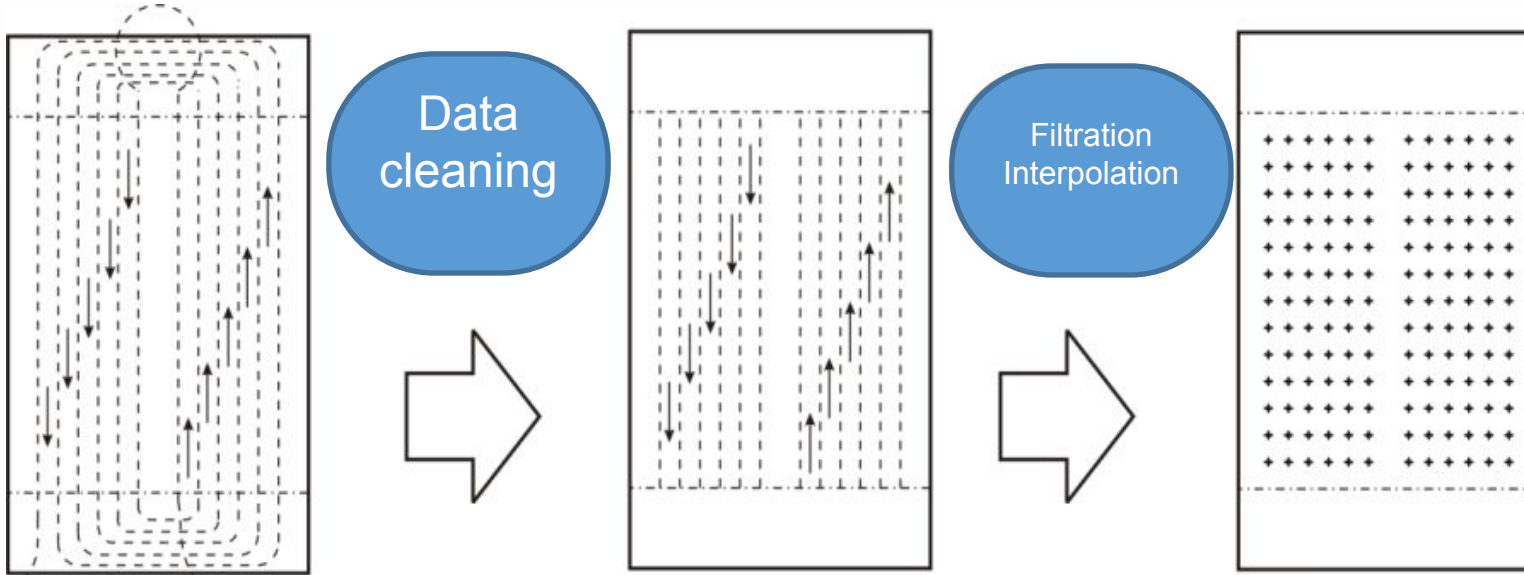


GPS for geopositioning  
NMEA output

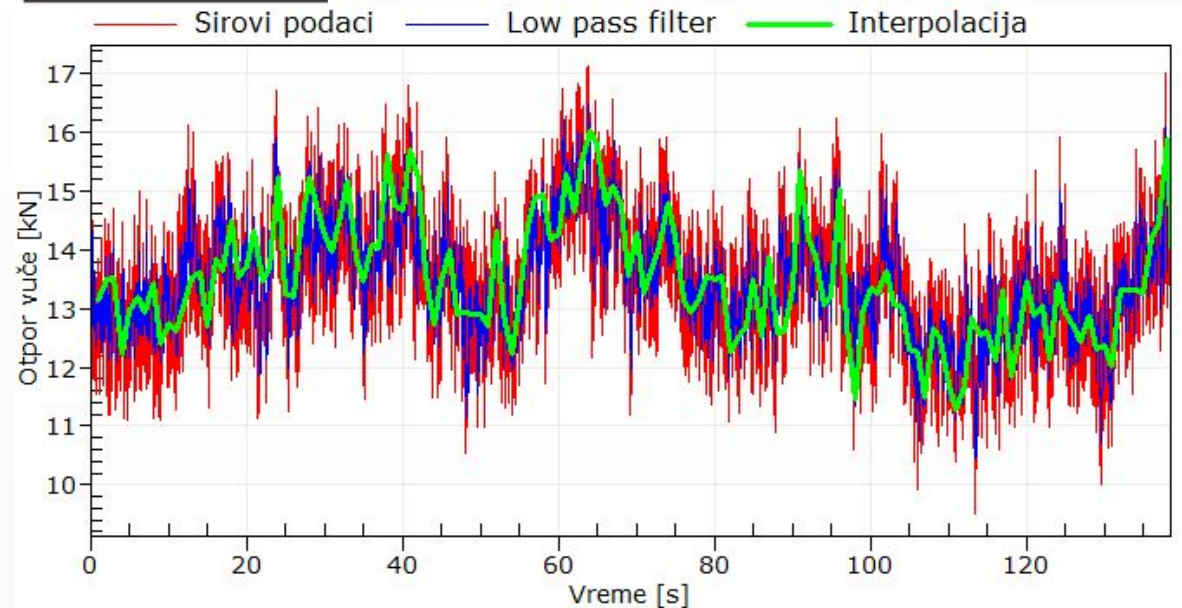


# Data preprocessing

$$R_{kor} = R_{tr} + 5(v_R - v_{tr})$$

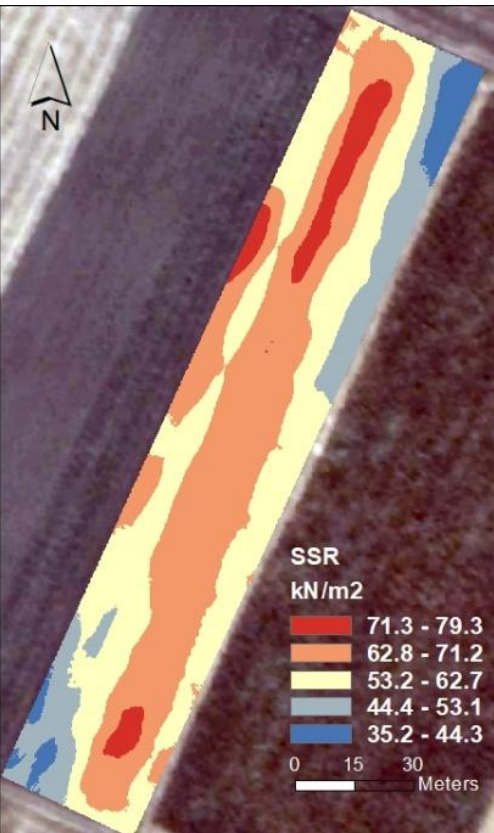


All values of soil resistance were normalized to a referent speed of 1,8 m/s to make them comparable

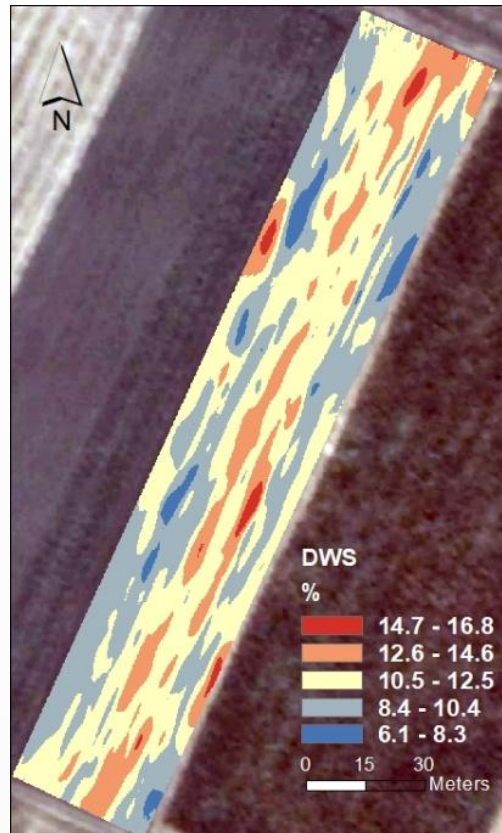




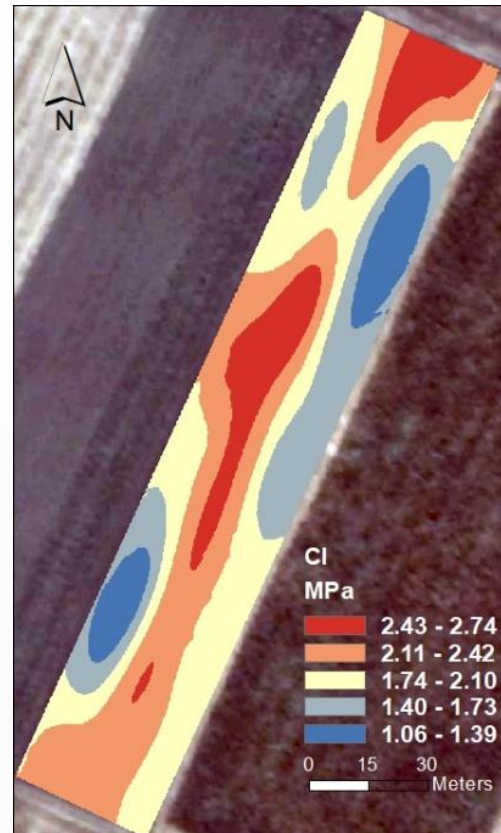
# Spatial maps



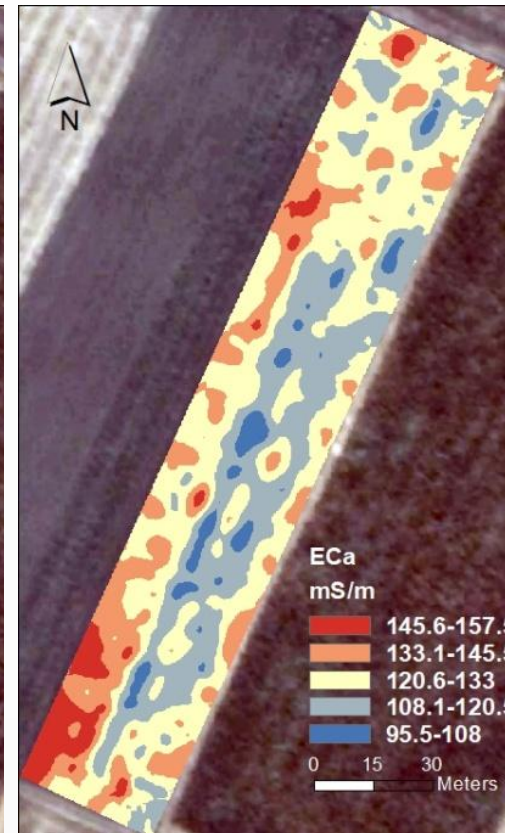
Specific soil resistance map



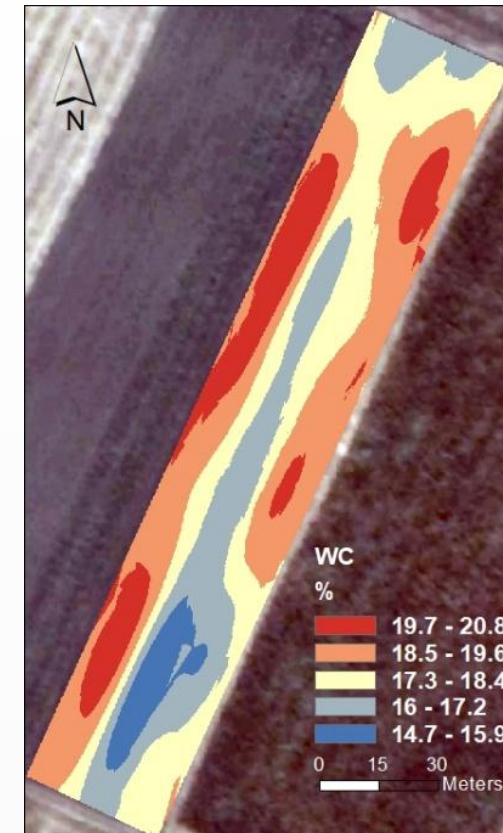
Drive wheel slippage map



Soil compaction map

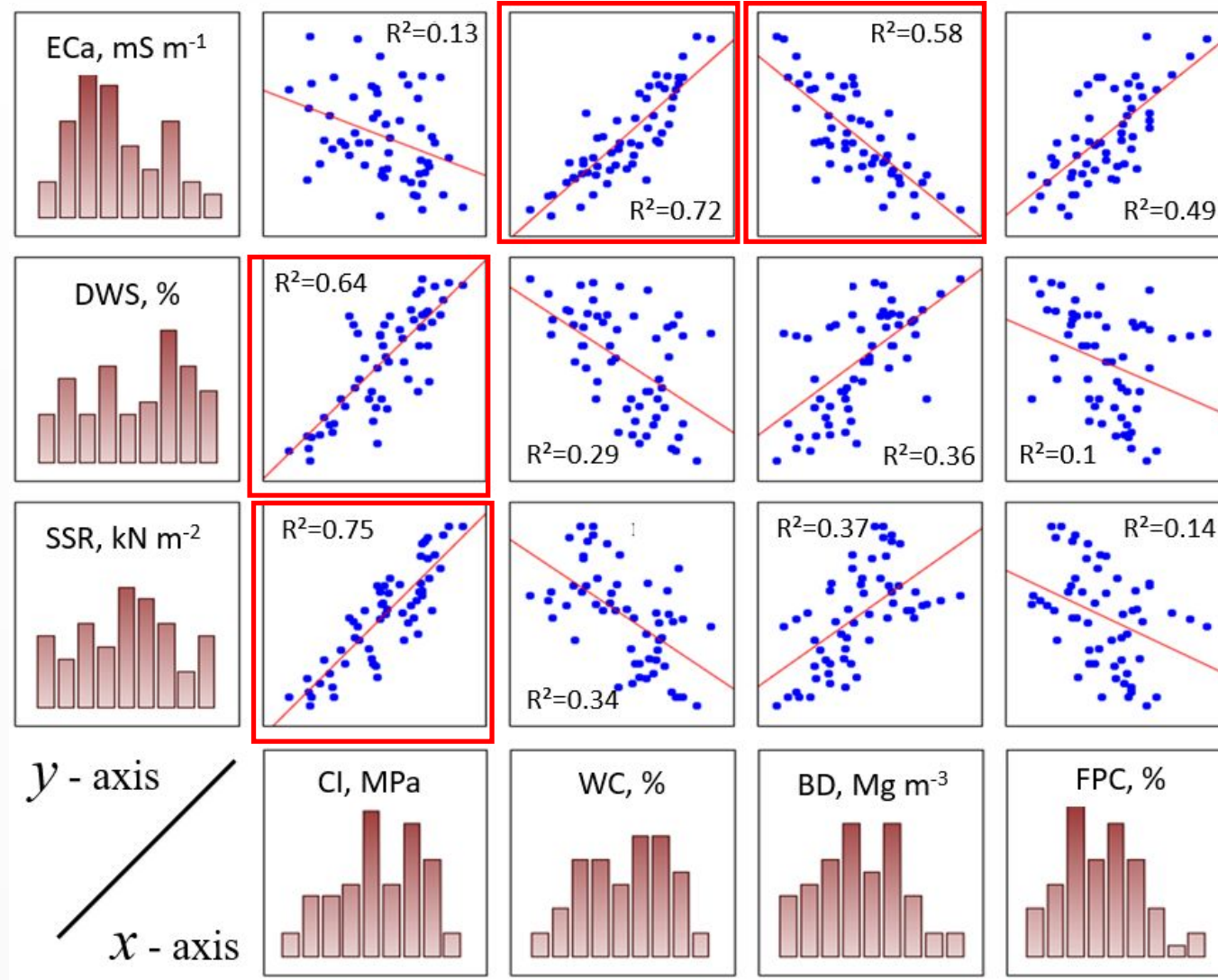


Soil electrical conductivity map



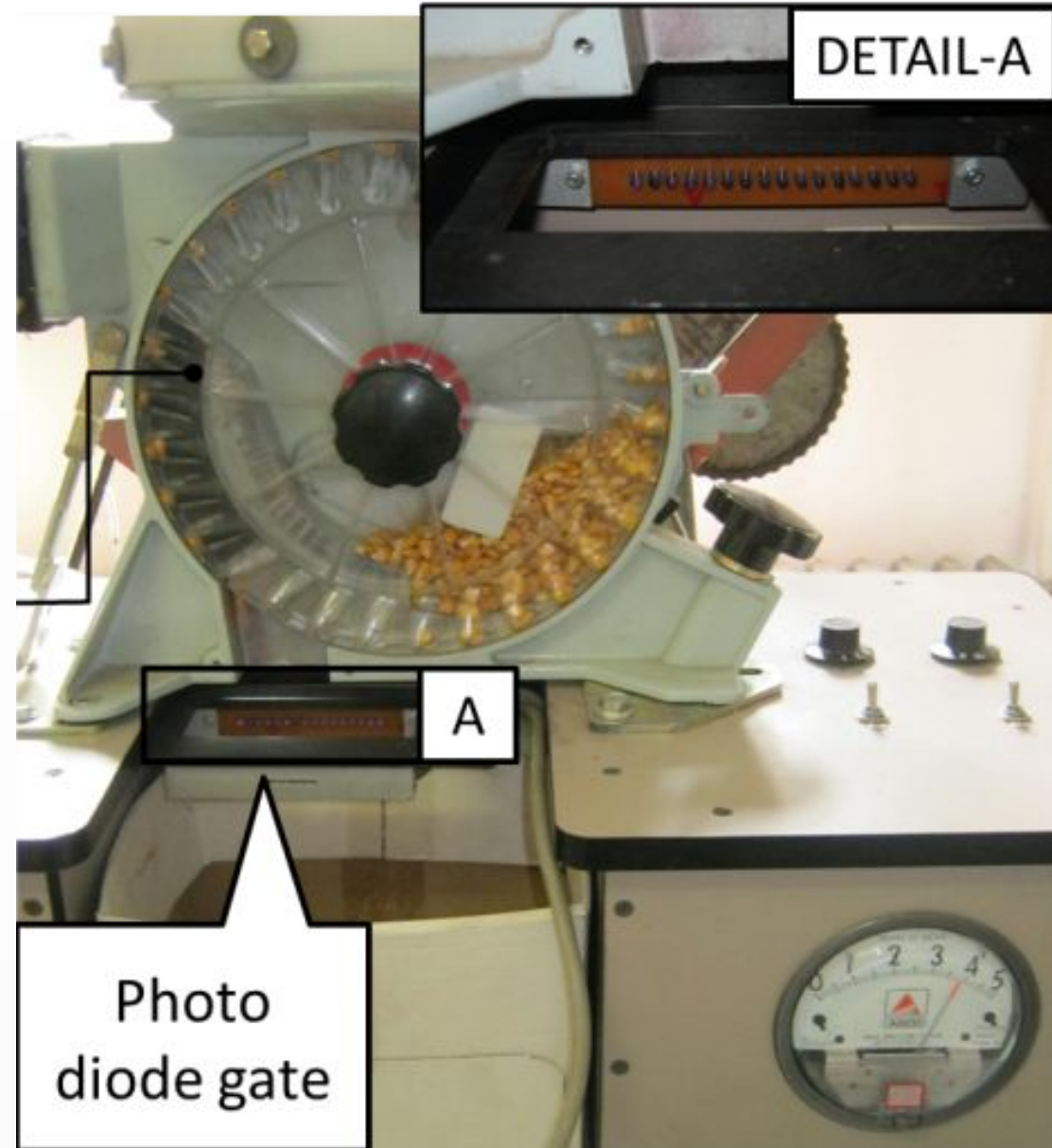
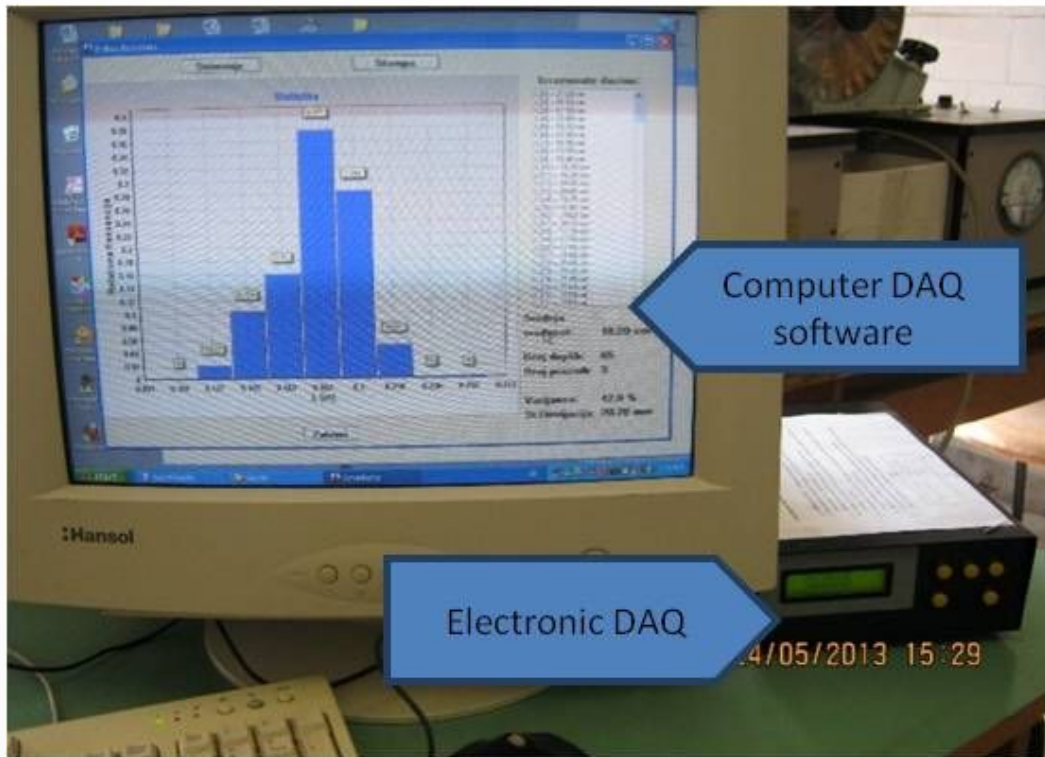
Soil water content map

# Correlations

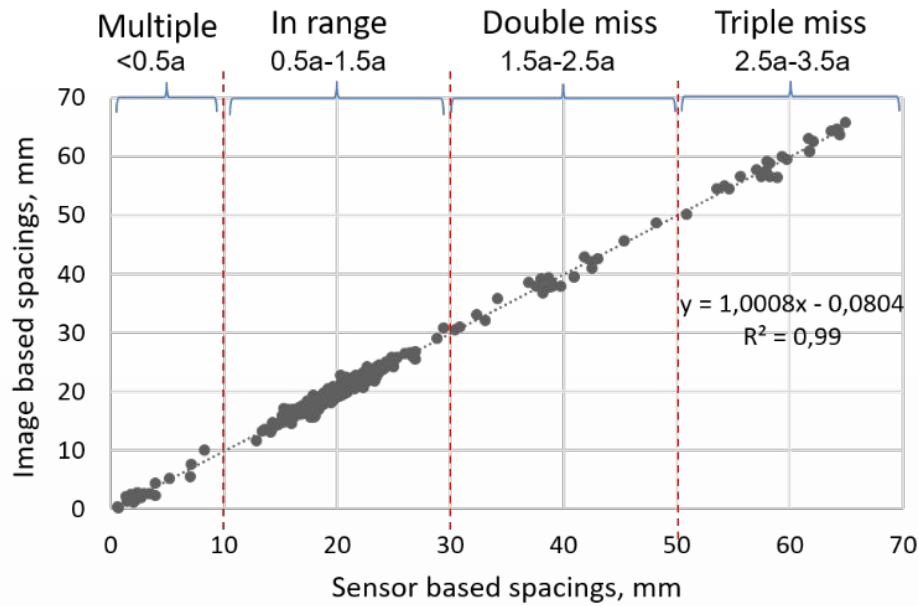




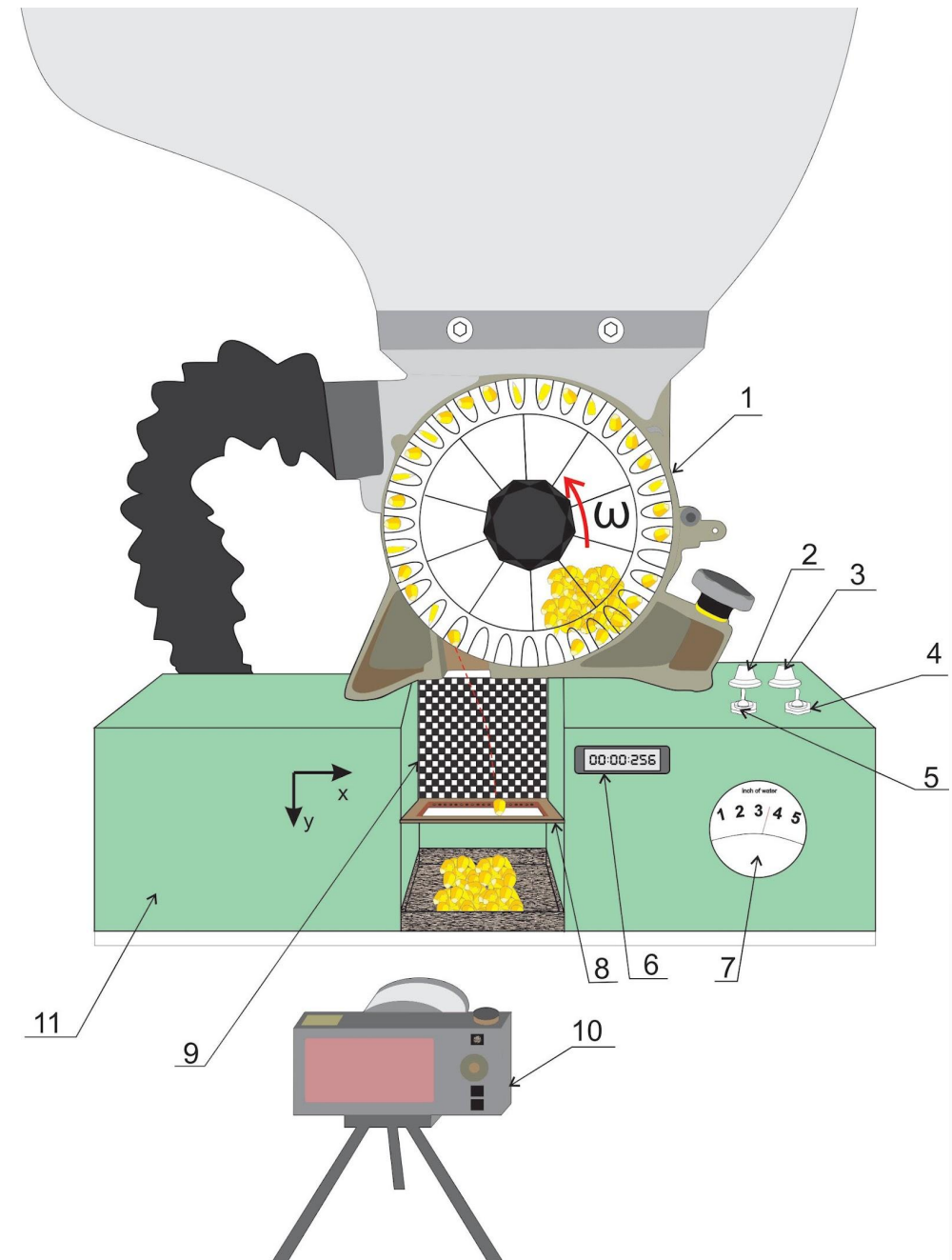
# Internal structure of the control unit



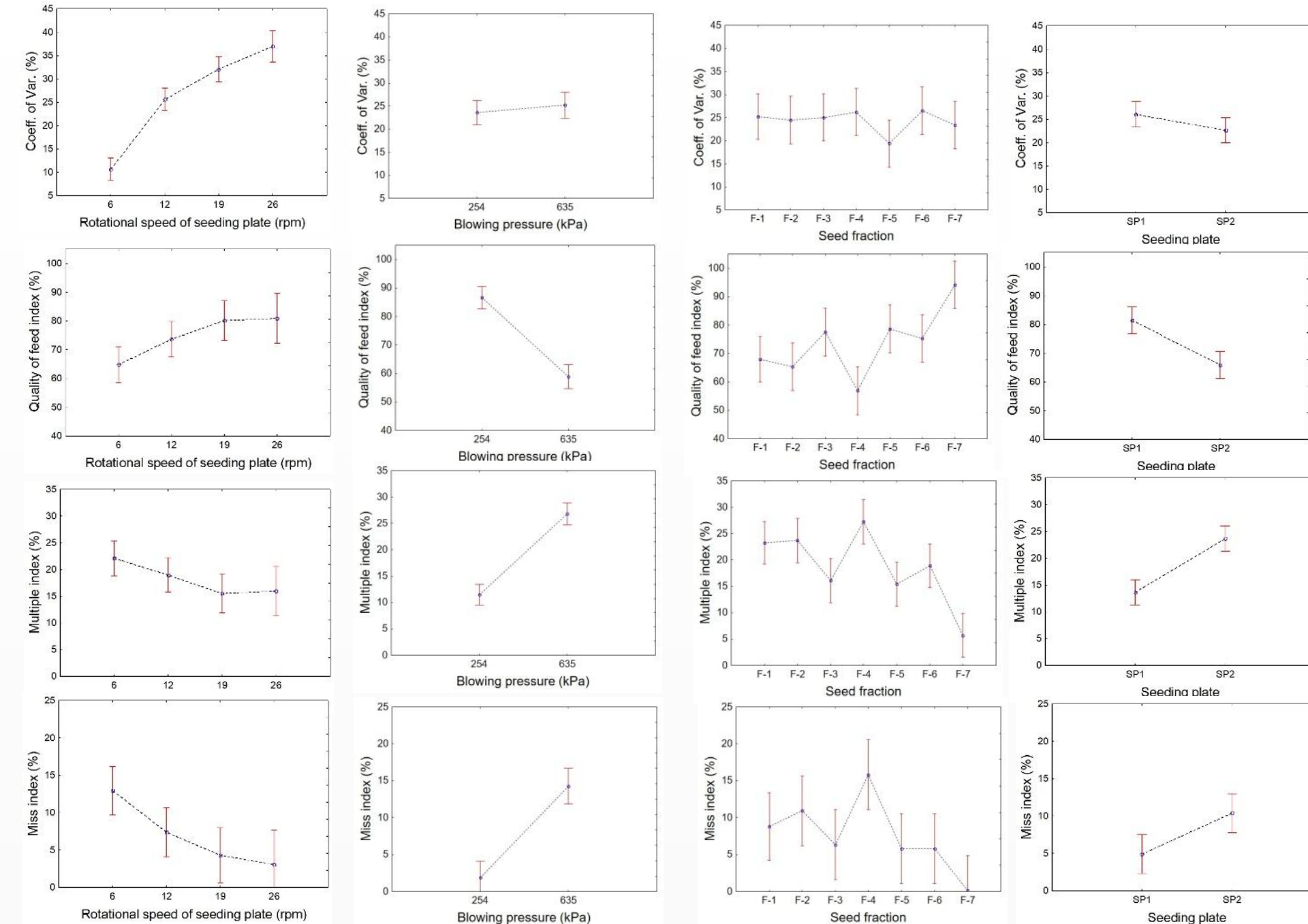
Seed metering device with installed photo-sensor (diode panel) with seeding plates SP1 and SP2



Comparison of seed spacings measured with photo-electronic system and camera system during validation process

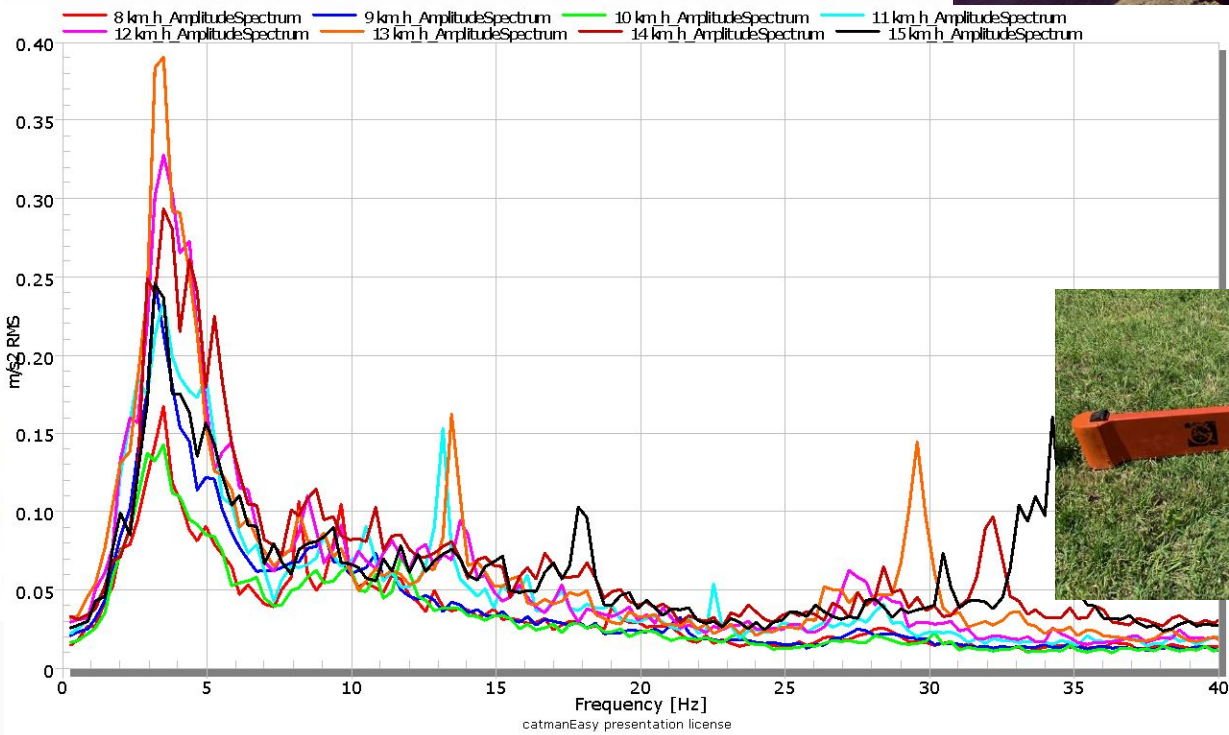
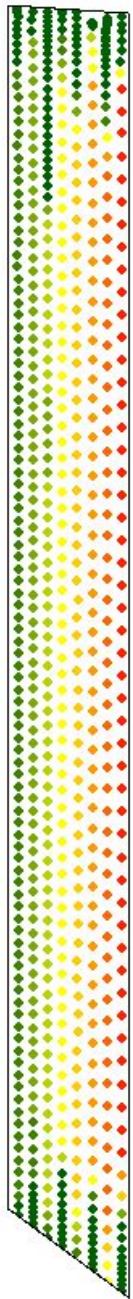


An overview of verification concept: 1- seeding mechanism; 2 – regulation of seeding plate revolution speed; 3 – fan speed regulation; 4 – on/off fan; 5 – on/off electric motor; 6 – high precision timer; 7 – analogue pressure gauge; 8 – photo sensor; 9 – background raster plane; 10 – camera; 11 - housing

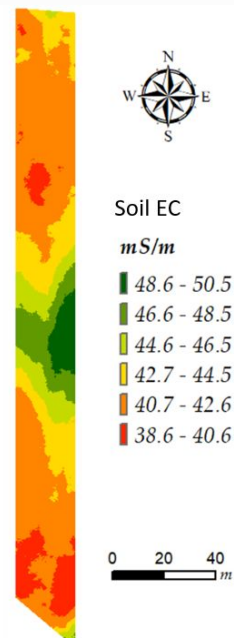
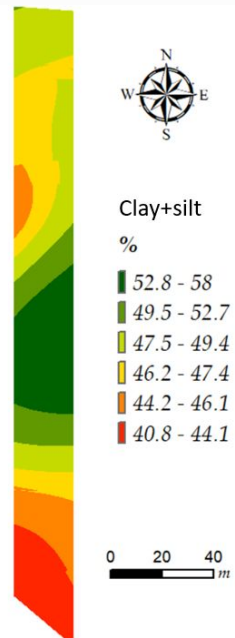
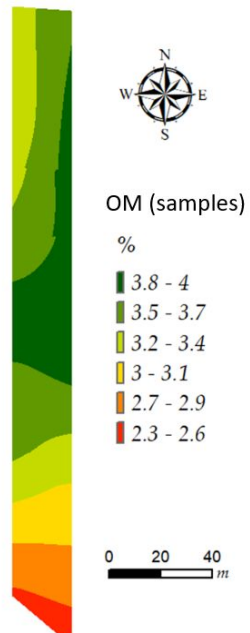
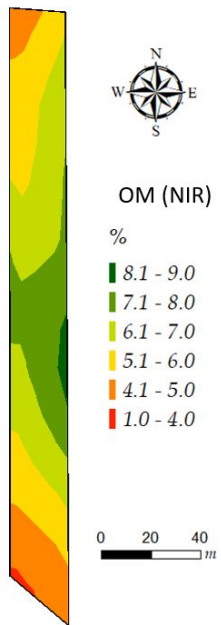
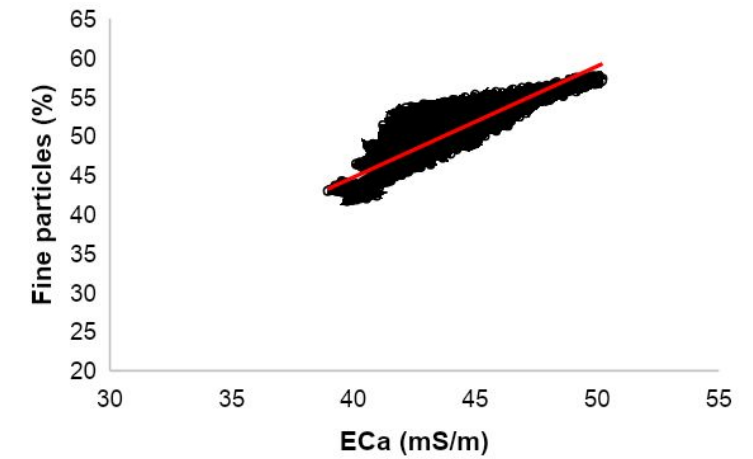
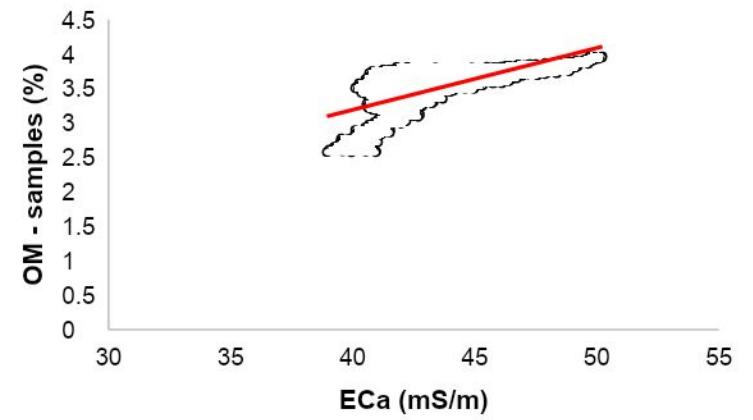
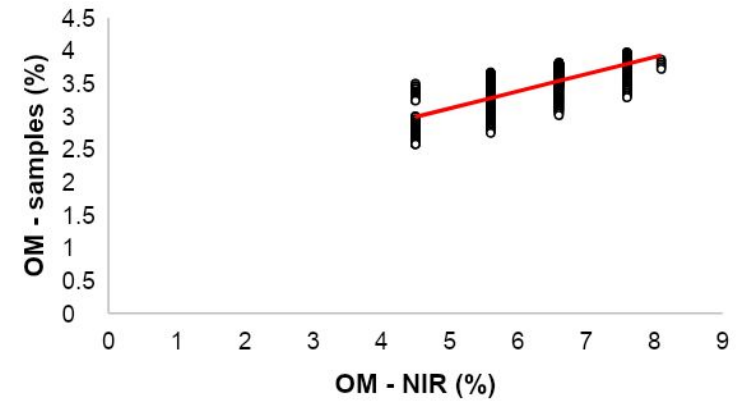
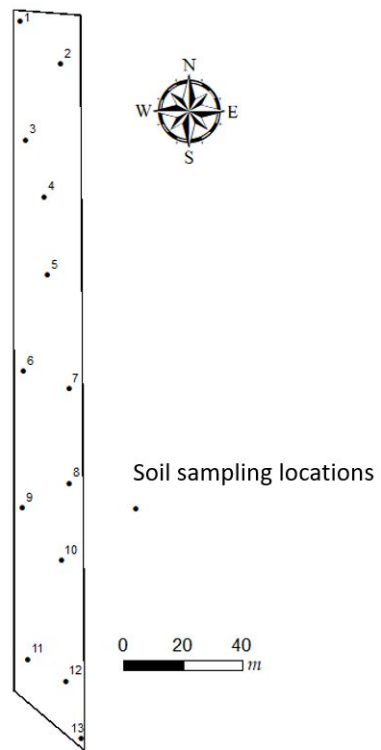
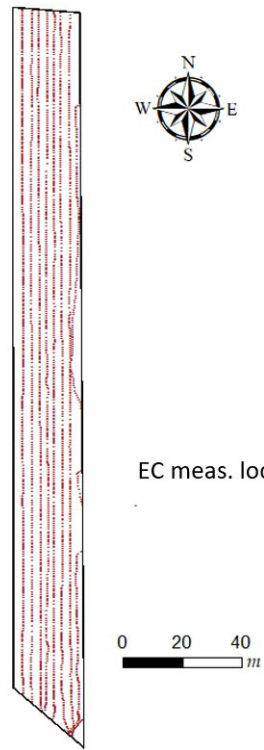
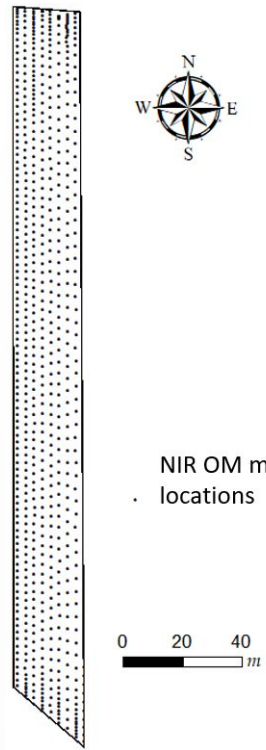


Effects of variables on calculated parameters





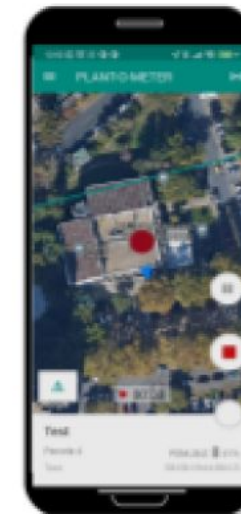
NIR sensor mounted on "SmartFirmer" device



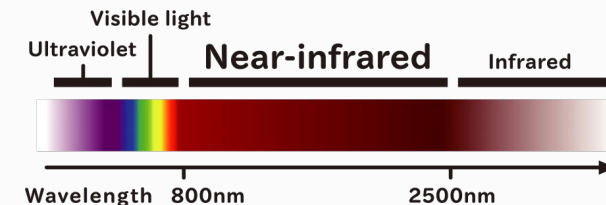
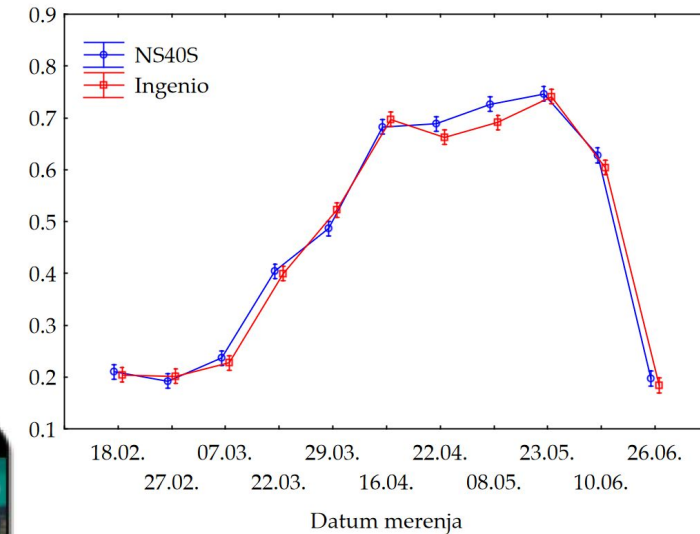


# BioSense Institute-Faculty of agriculture

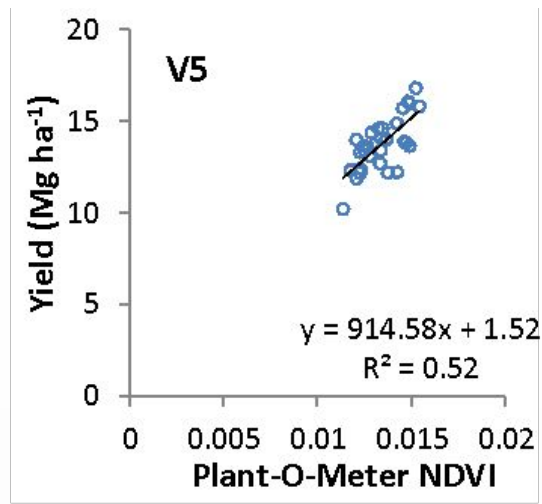
- Portable multispectral optical device for precise plant stress measurement with georeferencing
- High accuracy cost-effective solution
- 30 to 70 cm measurement range
- Three modes of measurement
- Active illumination of the plant - can work in complete dark
- Designed to block influence of the sunlight in every condition
- Provides numerous vegetation indices
- Provides row data measurement for user defined indices
- Works in conduction with smartphone application
- Can be extended with wired or wireless connection for different communication interfaces and protocols<sup>1</sup>



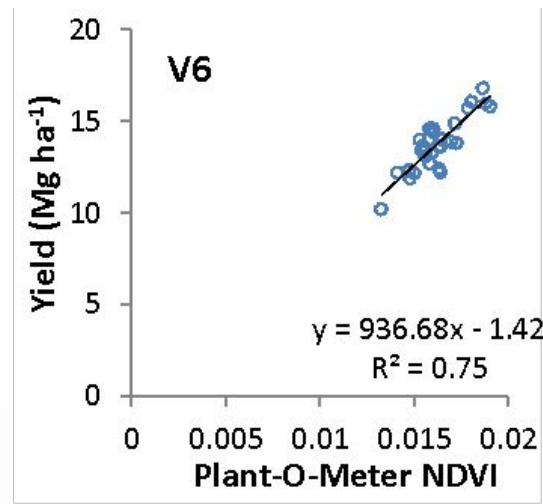
Blue  
Green  
Red  
Red Edge  
Infrared  
Near Infrared



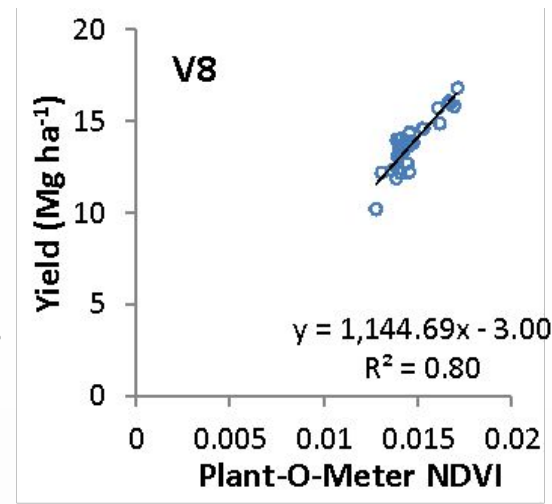
The wavelength range of near-infrared is 800–2500nm



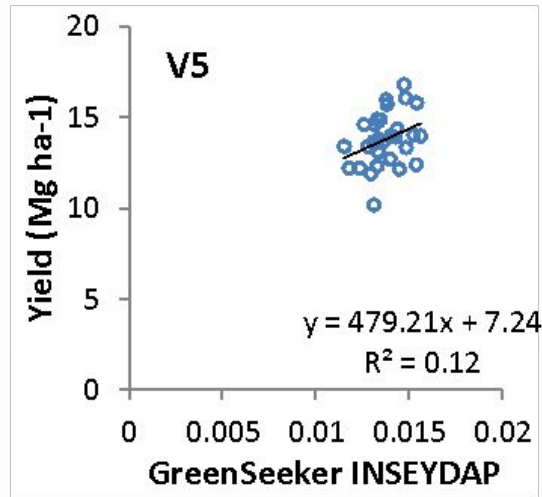
(a)



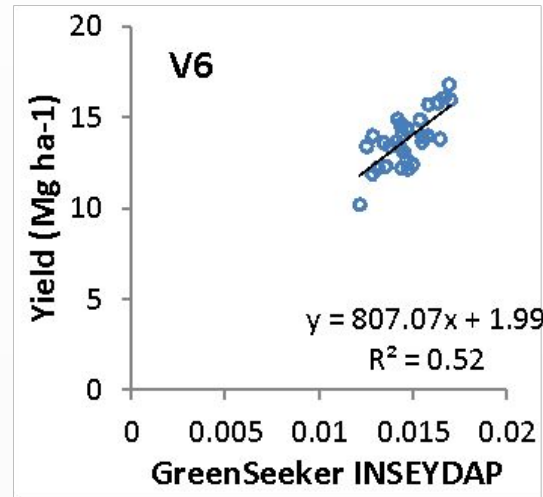
(b)



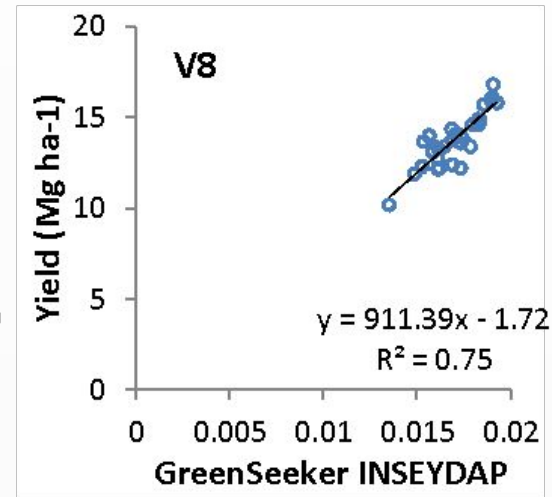
(c)



(d)



(e)



(f)



# Final notes from personal experience

- Adoption of SFTs in Serbia is low
  - High potential to increase profit using better management
  - Small farms unable to invest in technologies
  - Farmers are not able to estimate the effects of the new technology
  - Modern equipment has significantly reduced effort and increased comfort at work.
  - The rights in the use of data generated in agriculture by farmers are not clearly defined. All companies that develop applications require farmers to allow them to use the data.
- 
- **New technologies that are developed require more cognitive and intellectual abilities than manual ones.**
  - **By shifting most of the farmer tasks (equipment maintenance, decision-making, etc.) to external services, it can lead to the loss of traditional knowledge in mechanics, electrical engineering, physics, etc.**
  - **It is possible that data from agriculture will be more valuable than the crop itself, because you only have the opportunity to get data once a year.**

In order to understand the achievements in agriculture, the dynamics of acceptance / non-acceptance of precision agriculture technology, the elements that participate must be comprehensively considered, not only thinking of natural resources, but also the main actor, the man-farmer, ie. his perception.

## Conclusion

On one occasion when they asked a farmer "which farmer is a big farmer" he answered "everyone who is dedicated to working in the fields"



# Thank you

## Questions?

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