SZÉCHENYI ISTVÁN EGYETEM
MEZŐGAZDASÁG- ÉS ÉLELMISZERTUDOMÁNYI KAR

Motto: **The up to date crop production technologies can contribute to reduce the impact of climate change**

KUKORICA HOZAMÉRZÉKENYSÉGÉNEK VIZSGÁLATA A DSSAT DÖNTÉSTÁMOGATÓ TECHNOLÓGIATRANSZFER-MODELLEL

CLIMATE CHANGE AND SUSTAINABLE PRECISION CROP PRODUCTION WITH REGARD TO MAIZE *(ZEA MAYS L.)*

M. Neményi - A. Nyéki – G. Milics – A. J. Kovács

DEPARTMENT OF BIOSYSTEMS AND FOOD ENGINEERING

SZÉCHENYI ISTVÁN UNIVERSITY,
FACULTY OF AGRICULTURAL AND FOOD SCIENCES
MOSONMAGYARÓVÁR, HUNGARY

BUDAPEST, 2016. NOVEMBER 17.

Norman Borlaug "the father of the **Green Revolution**"

1980-2009: he was elected honorary member of the Hungarian Academy of Sciences.

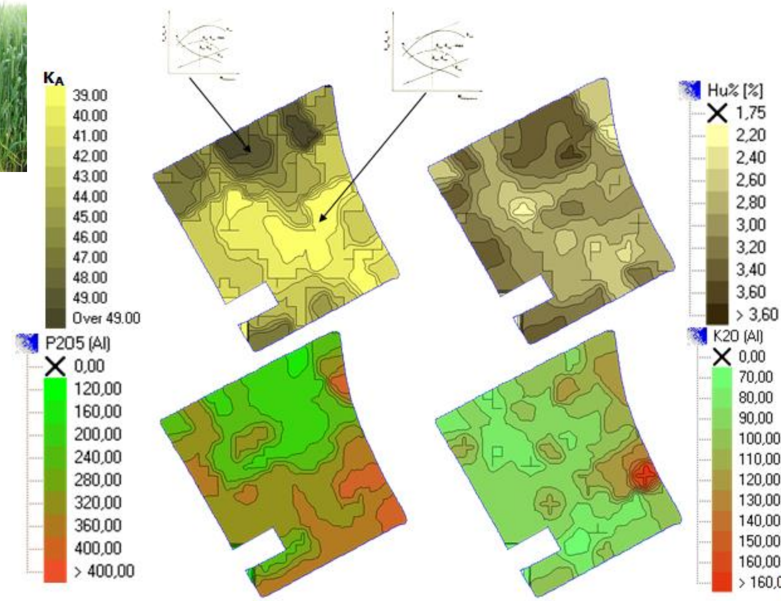
NOBEL PEACE PRIZE: 1970

1914-2009

The results of Drinkwater and colleagues[4] are a step in the right direction. What may lead to further progress? The green revolution turned developments in crop genetics, inexpensive pesticides and fertilizers, and mechanization into greater yields. *Further advances, such as precision agriculture,* in which fertilizer application rates and timing are adjusted differentially across a field to meet crop needs, will increase agricultural

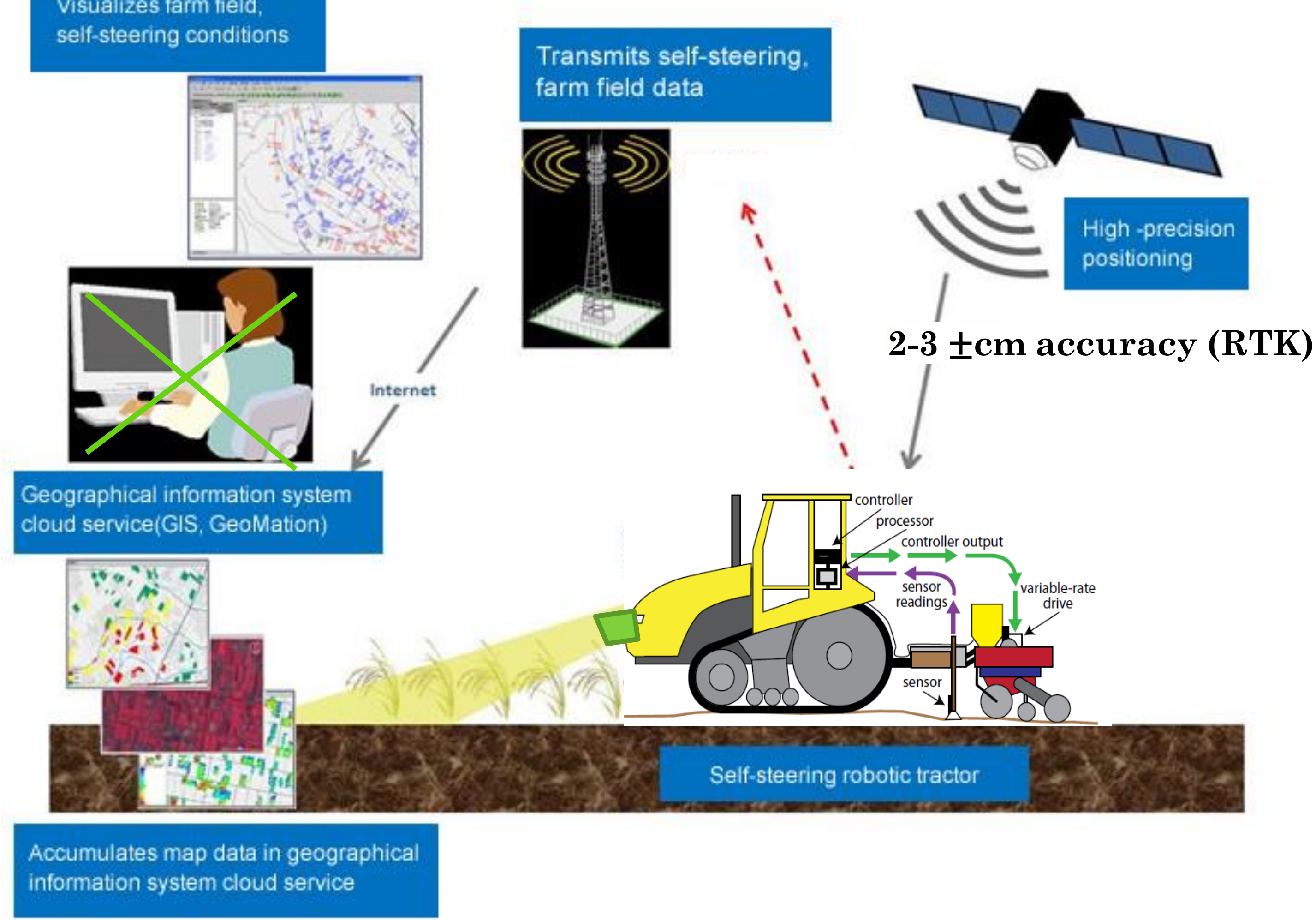
DEFINITION OF PRECISION CROP PRODUCTION

PA is a site specific treatment: The fields are divided into management zones (100-2500 m2). For the collection of data we use remote sensing and another on-the go methods (different platforms). The GPS RTK provides ± 2-3 cm positioning accuracy, the data processing is done by GIS. Sustainable production can not be achieved without PA. It is not only a new technical system, but also a new approach of the managing the agro and natural ecology as a unit.



Soil property maps

UNMANNED AGRICULTURE



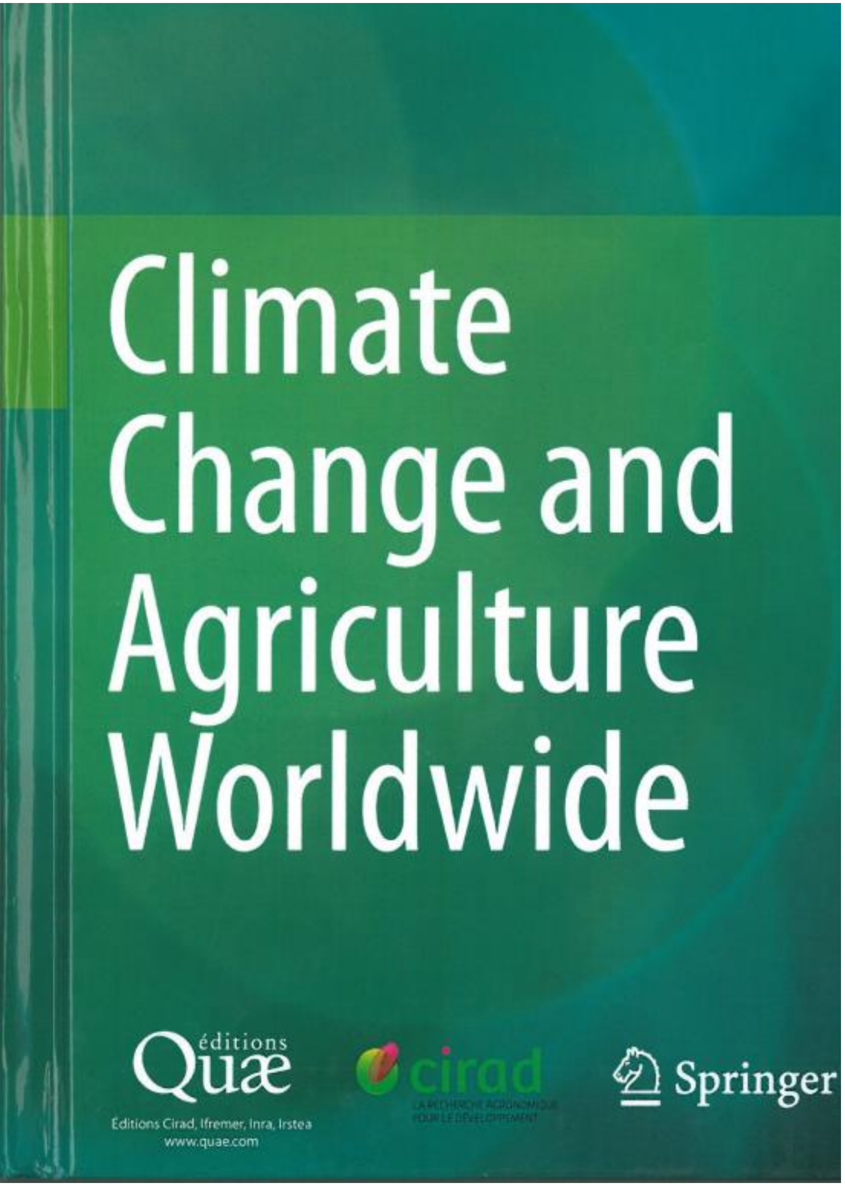
Forrás:http://www.yanmaragriculture.eu/News-detail/yanmar-conducts-feasibility-study-on-using-quasizenith-satellite-system-for-precision-farming/

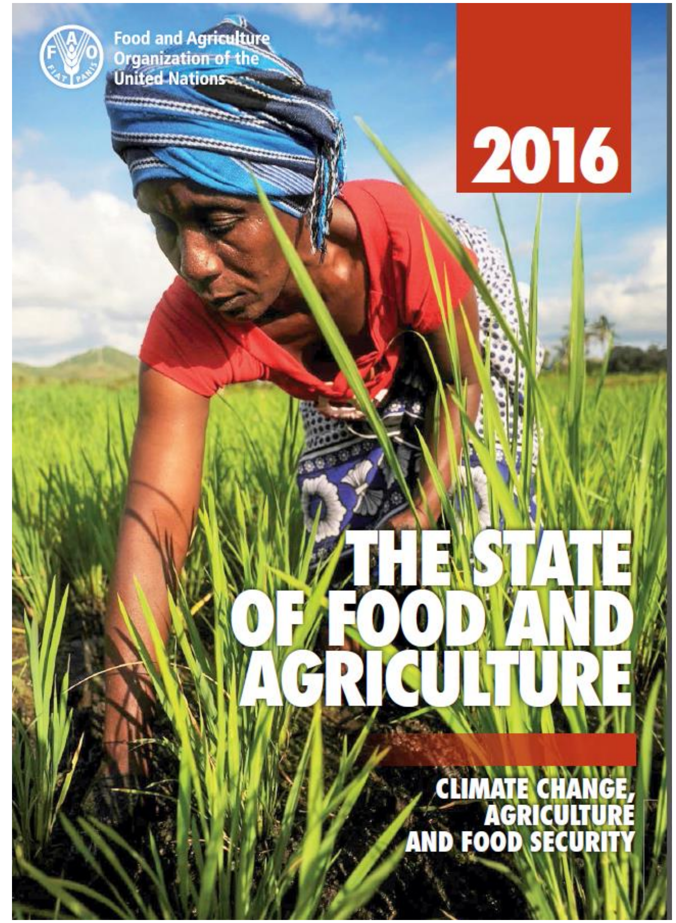
Precision Farming Tools: Variable-Rate Application, 442-505, Virginia

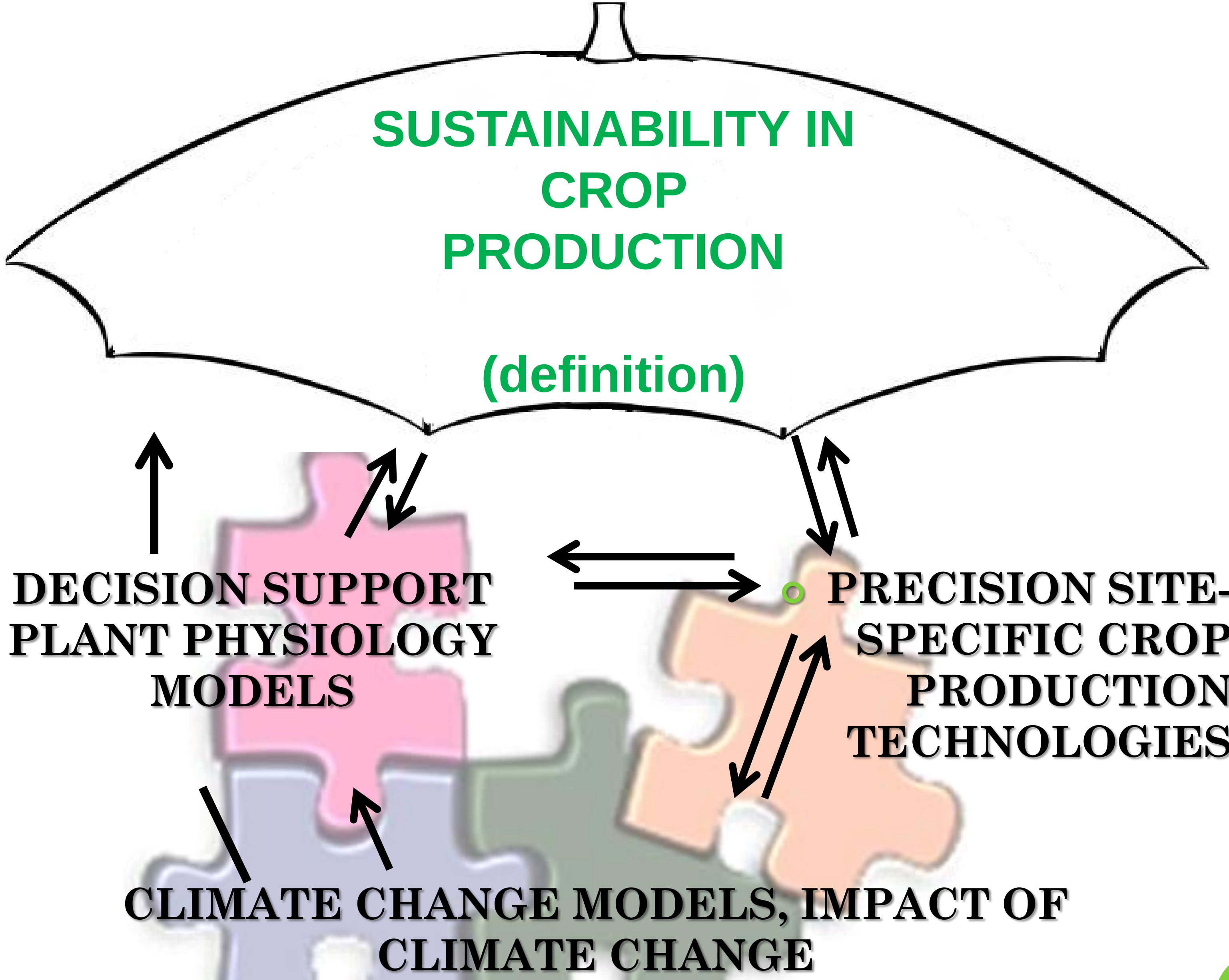
WORLD ECONOMIC FORUM

Does foreign aid always help the poor?

It sounds kind of crazy to say that foreign aid often hurts, rather than helps, poor people in poor countries, Angus Deaton, the winner of the Nobel Prize in economics (2015), has argued.


Climate Change and Agriculture Worldwide
éditions Quæ
Éditions Cirad, Ifremer, Inra, Irstea
www.quae.com
cirad
Springer


Food and Agriculture Organization of the United Nations
2016
THE STATE OF FOOD AND AGRICULTURE
CLIMATE CHANGE, AGRICULTURE AND FOOD SECURITY



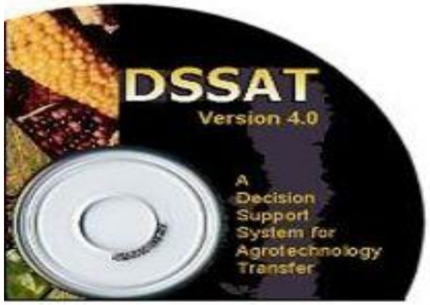
There are strong interaction between the participants:
e.g. The precision technologies can reduce the GHG emissions…

John von Neumann:

"The sciences do not try to explain, they hardly even try to interpret, they mainly make models."

Today, the situation is slightly changed:
not only the researchers but also the practice use models.
We can not give proper advice to farmers without models.

Decision Support System for Agrotechnology Transfer (DSSAT)



- **SOIL**: soil type, date of soil sampling; soil physical properties (silt, sand and clay content): organic matter %; CaCO3%; pH; KCl; P2O5 mg/kg; K2O5 mg/kg; salt content (%). **…..**
- **MANAGEMENT**: planting date, variety of crop, row spacing, irrigation and NPK fertilizer amounts and dates……
- **CROP DATA**: phenological characteristics,biomass of yield,dates of anthesis and maturity,, growth rate and Leaf area index, forecrop (type), main yield of forecrop, t/ha; secondary yield of forecrop (t/ha)…..
- **WEATHER**: daily maximum and minimum temperatures, wind speed, precipitation amounts, relative humidity, potential evaporation, sunshine duration and surface radiation….

More than 50 different properties are taken into consideration.

Point sampling methods are not suitable for the „feeding” such models

START OF ADAPTATION OF PRECISION TECHNOLOGIES (1996)

MODELING THE INTERACTION BETWEEN SUBSOILER AND SOIL

A FINITE ELEMENT METHOD

$$f = 3 \propto \sigma_m + \bar{\sigma} - k = 0$$

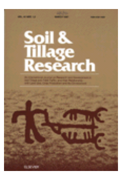
$$\frac{\partial \sigma_x}{\partial x} + \frac{\partial \tau_{xy}}{\partial y} + \frac{\partial \tau_{xz}}{\partial z} + F_x \rho = 0$$

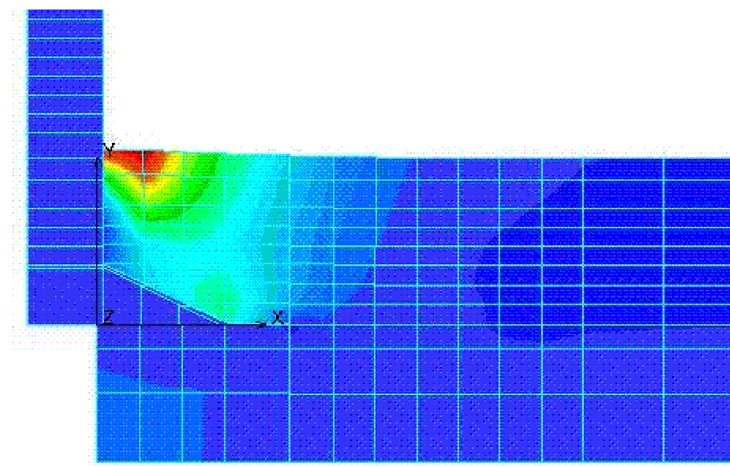
$$\frac{\partial \tau_{yx}}{\partial x} + \frac{\partial \sigma_y}{\partial y} + \frac{\partial \tau_{yz}}{\partial z} + F_y \rho = 0$$

$$\frac{\partial \tau_{zx}}{\partial x} + \frac{\partial \tau_{zy}}{\partial y} + \frac{\partial \sigma_z}{\partial z} + F_z \rho = 0$$

Abdul M. Mouazen PhD

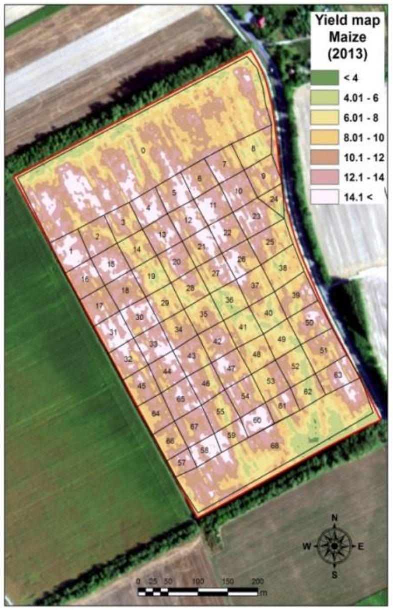
Cranfield University, UK

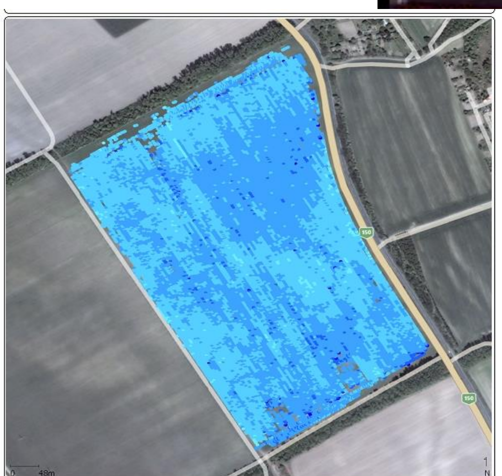


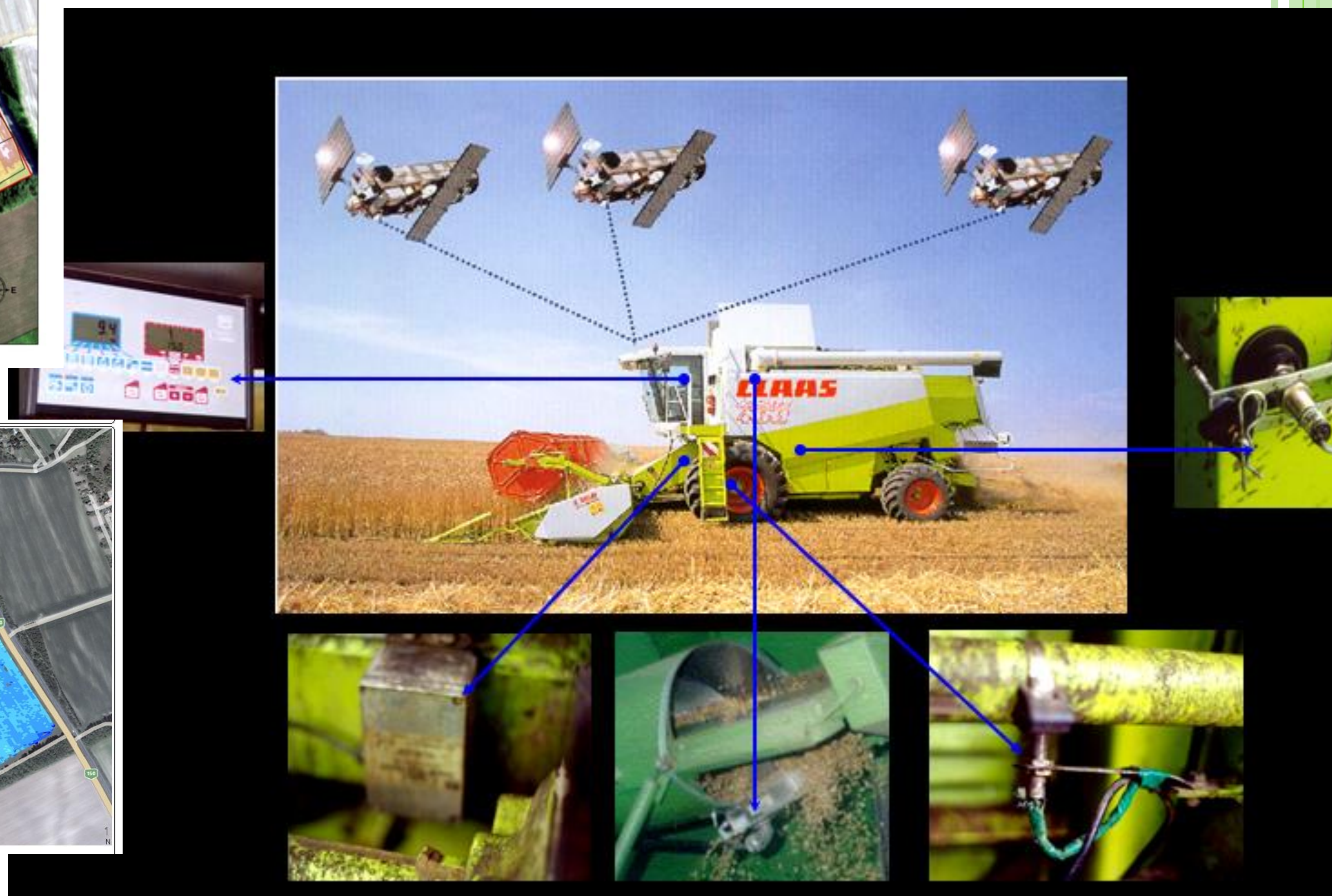


PRECISION, SITE-SPECIFIC YIELD MAPPING

(STARTED IN 1998)



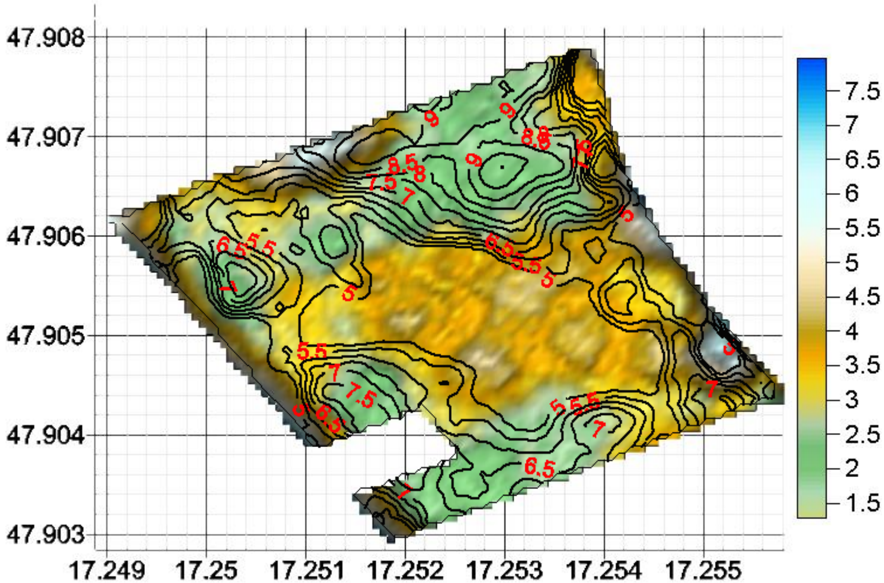


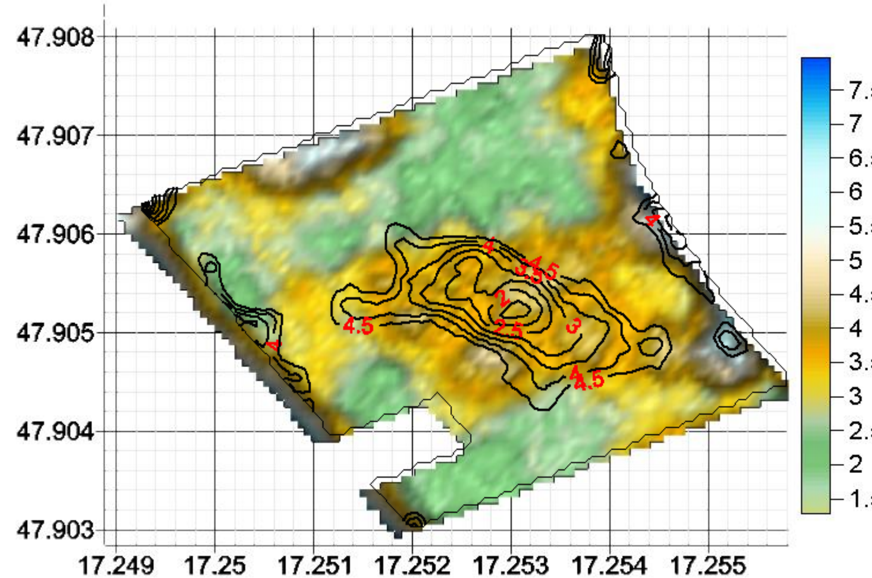


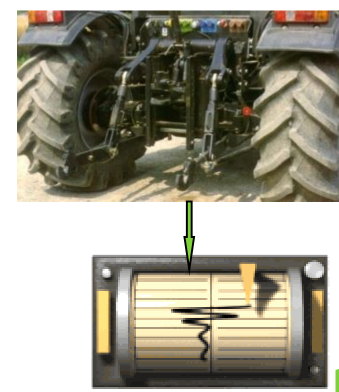
ON-THE-GO SOIL DRAUGHT FORCE MAPPING

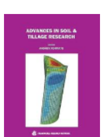
P. Á. Mesterházi PhD

Investigation the relationship between yield and soil compaction





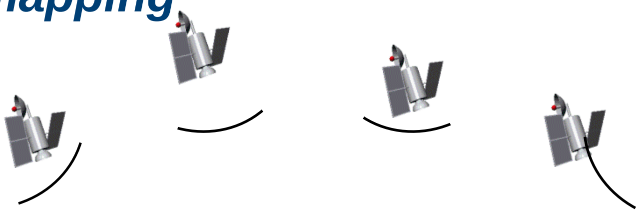


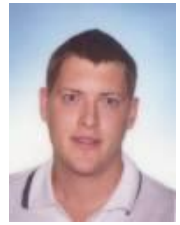


Neményi, M., Mesterházi, Á., Milics, G. (2006): An Application of Tillage Force Mapping as a Cropping Management Tool. **BIOSYTEMS ENGINEERING**. Vol. 94., pp. 351-357.

Neményi M.; Milics G.; Mesterházi P. Á. (2008): The role of the frequency of soil parameter database collection with special regard to on-line soil compaction measurment. In: Andrea Formato: **ADVANCE IN SOIL & TILLAGE RESEARCH**. **pp. 125-140. ISBN 978-81-7895-353-3**

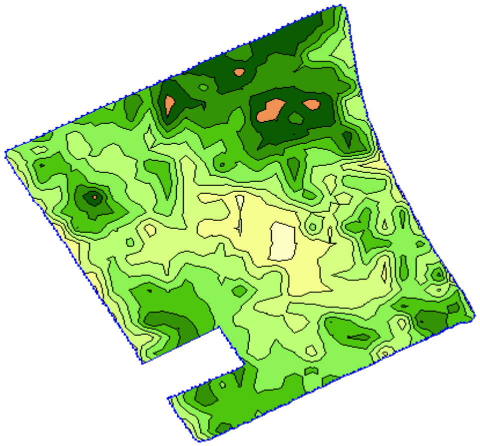
Improving of the accuracy of grain moisture content mapping

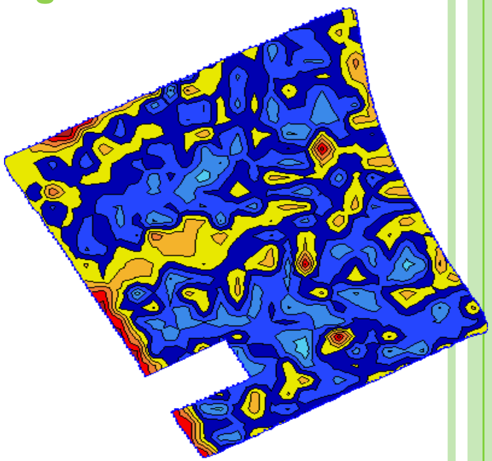


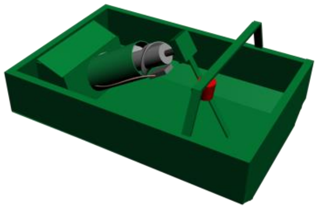


Csiba Mátyás PhD

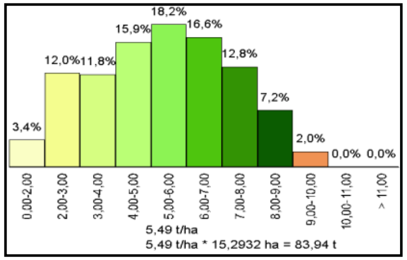
Virág István PhD



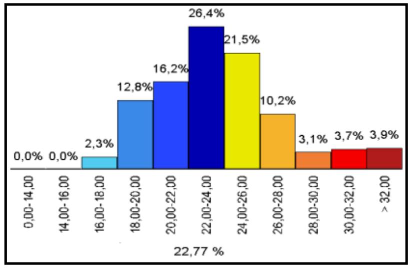


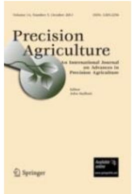


Maize yield mapping



Grain moisture content mapping



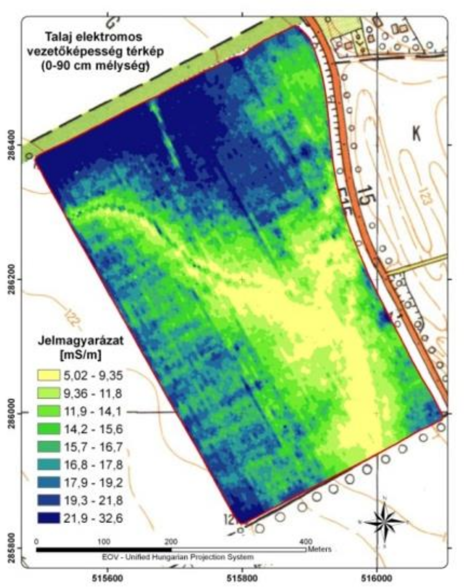


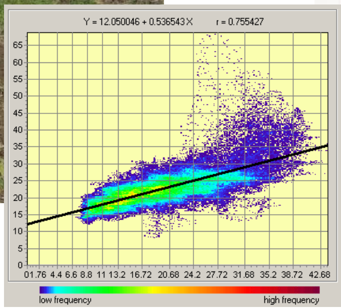
Csiba M, Kovács AJ, Virág I, Neményi M: **The most common errors of capacitance grain moisture sensors: effect of volume change during harvest**, PRECISION AGRICULTURE 14: (2) pp. 215-223.
Impakt faktor: 1.728*

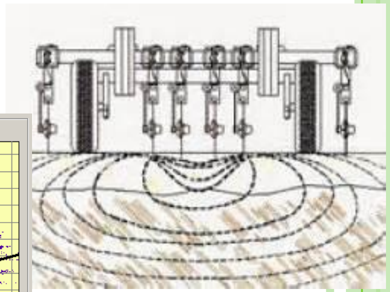
NEMÉNYI, M, MESTERHÁZI, Á., PECZE, ZS., STÉPÁN, ZS. (2003): The role of gis and gps in precision farming. **COMPUTER AND ELECTRONICS IN AGRICULTURE.** 40, PP. 45-55.

ON-THE-GO MAPPING OF SOIL ELECTRICAL CONDUCTIVITY (*ECa*) – pH, SOIL MOISTURE AND SOM CONTENT

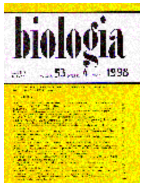
Dr. habil. Milics Gábor







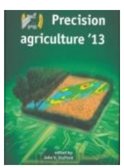
Nagy, V., Et al. (2013): Continuous field soil moisture content mapping by means of apparent electrical conductivity (*EC*a) measurement **. J. HYDROL. HYDROMECH**., 61, 4



Milics G. et al. (2017): Soil moisture distribution mapping in topsoil and its effect on maize yield **. BIOLOGIA (Acsepted for publication in 2017)**

ON-THE-GO MAPPING OF SOIL PHYSICAL AND CHEMICAL PARAMETERS

Abdul M. Mouazen
PhD Theses, 1998

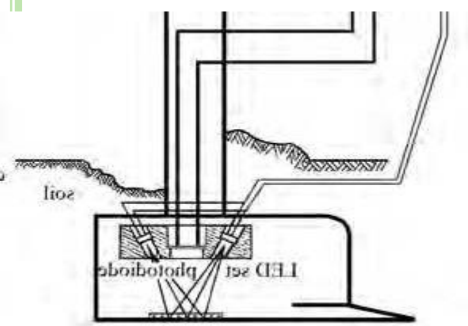


A.M. Mouazen, S.A. Alhwaimel, B. Kuang and T.W. Waine
Environmental science and technology department, National Soil Resources Institute, Cranfield University, Cranfield, Bedfordshire, MK43 0AL, United Kingdom; a.mouazen@cranfield.ac.uk

Fusion of data from multiple soil sensors for the delineation of water holding capacity zones

(VIR-NIR) spectroscopy:

- soil physical and
- chemical properties:
- organic matter content,
- nitrogen,
- potassium,
- phosphorous,
- pH,
- *w* – soil moisture content,
- particle size
- and mineral composition of the soil;
- WHC.



Intelligent Systems in Technology of Precision Agriculture and Biosafety
Vladimir M. Koleshko, Anatolij V. Gulay, Elena V. Polynkova, Viacheslav A. Gulay and Yauhen A. Varabei

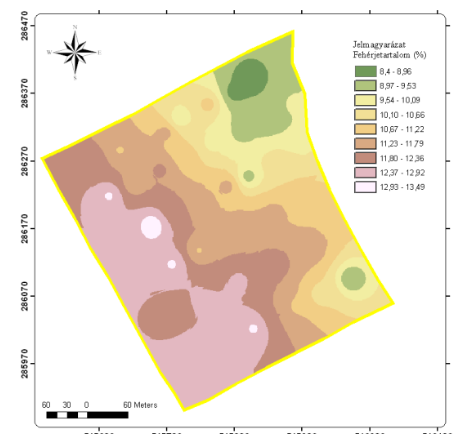
ON-LINE MEASURING THE GRAIN PHYSICAL AND CHEMICAL PROPERTIES (PROTEIN CONTENT)

Agrocom ACT

Dell Axim x50V PDA

CSI Wireless DGPS Max

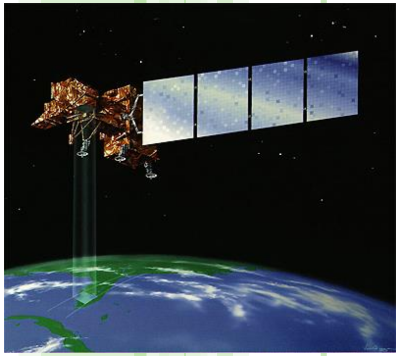
Zeltex On-Combine Grain Analyzer System



DATA COLLECTION METHODS – REMOTE SENSING

DETECTION OF REFLECTANCE OF SOLAR RADIATION

Satellite



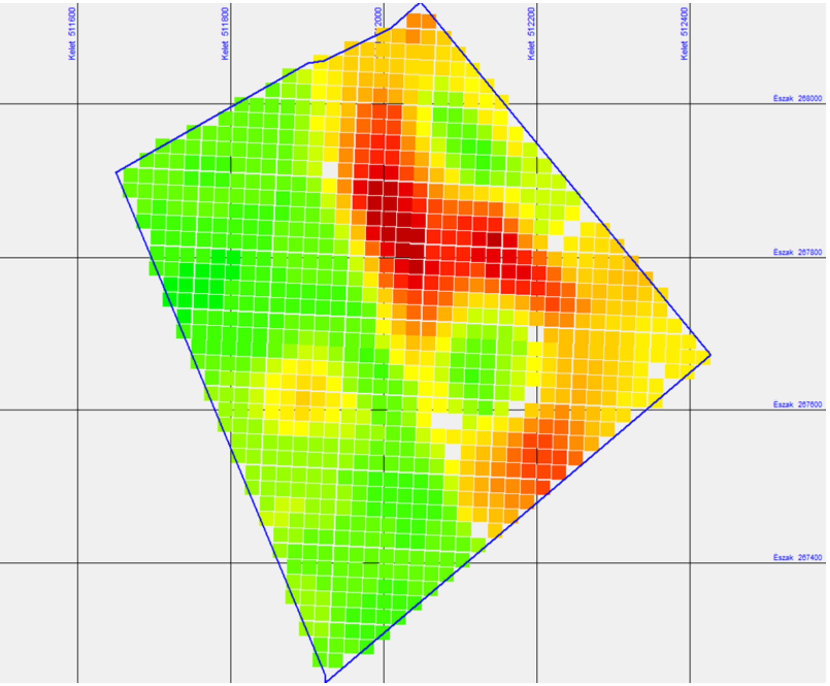
Airborne

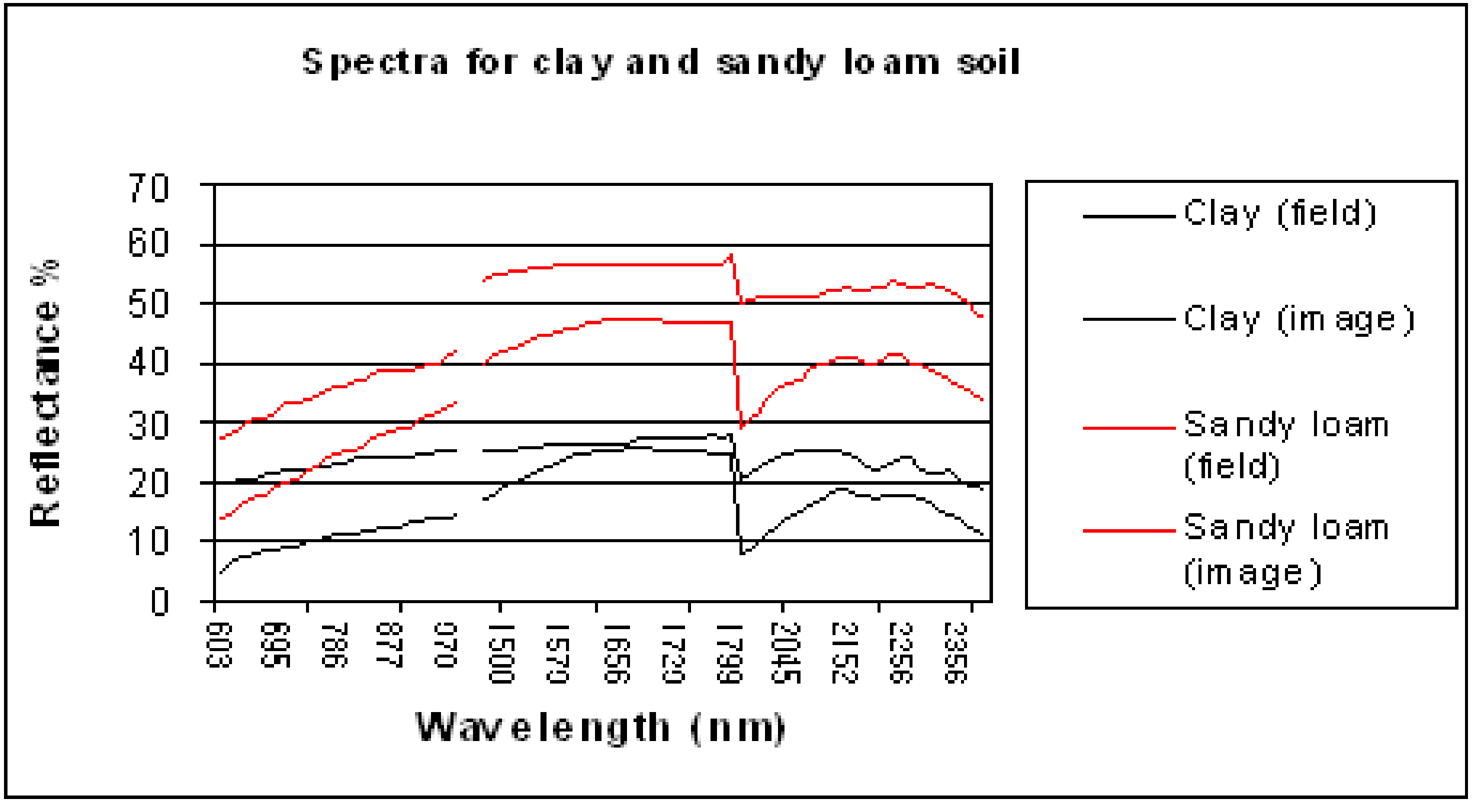
Airplane

UAVs - drones

Near-surface

USING TALKINGFIELDS DATABASE FOR CALCULATION THE RELATIVE BIOMASS SITE-SPECIFIC YIELD LOSS (20X20 M)




Spectra for clay and sandy loam soil
Reflectance %
70
60
50
40
30
20
10
0
603
695
786
877
1500
1570
1656
1720
1799
2045
2152
2256
2356
Wavelength (nm)
Clay (field)
Clay (image)
Sandy loam (field)
Sandy loam (image)

Detection of soil erosion

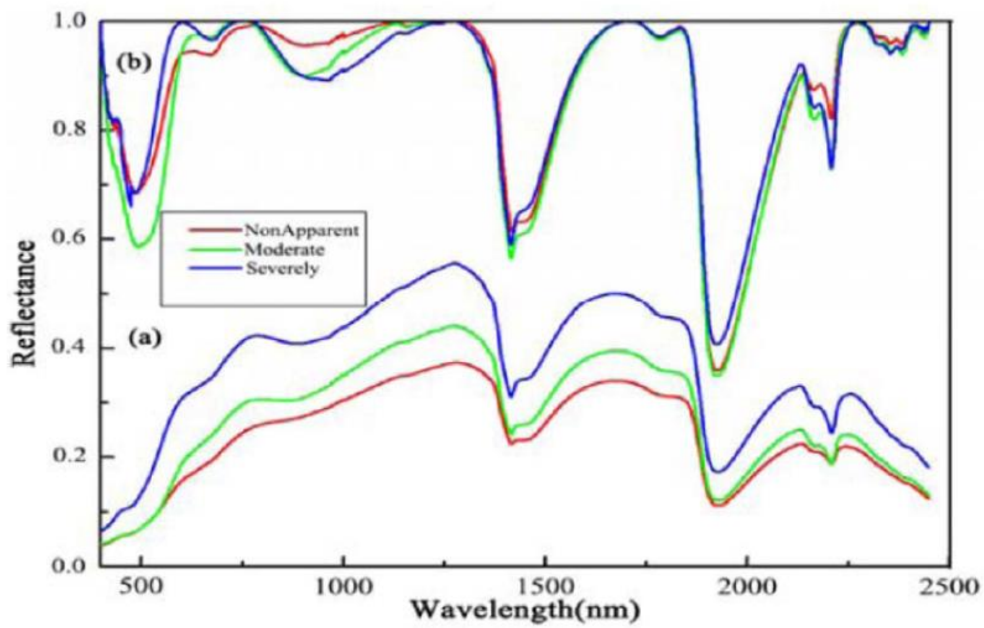
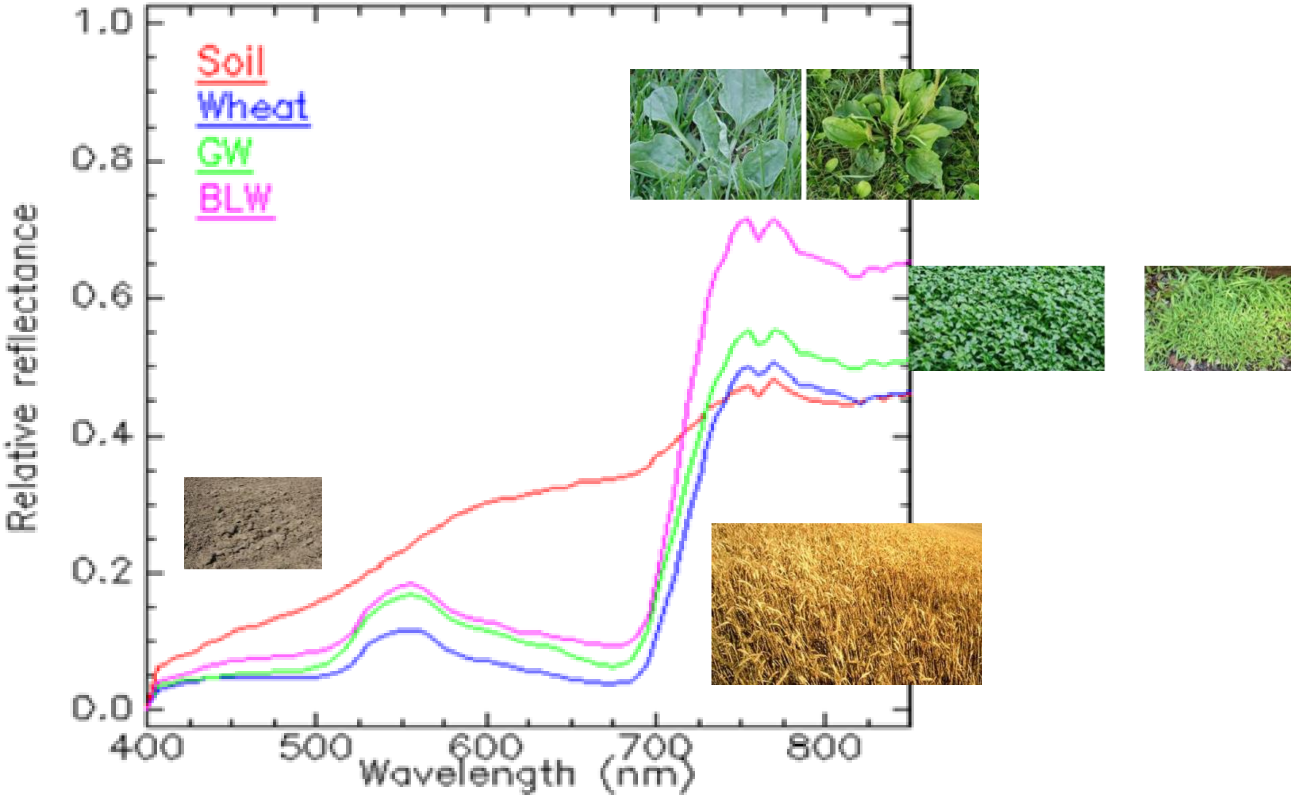


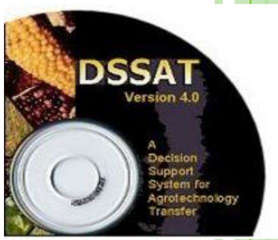
Figure 2 Reflectance spectral curves of different eroded soils (a) The average reflectance spectra; (b) The continuum removal spectral curves.

HYPERSPECTRAL DETECTION OF SOIL, WHEAT AND WEEDS

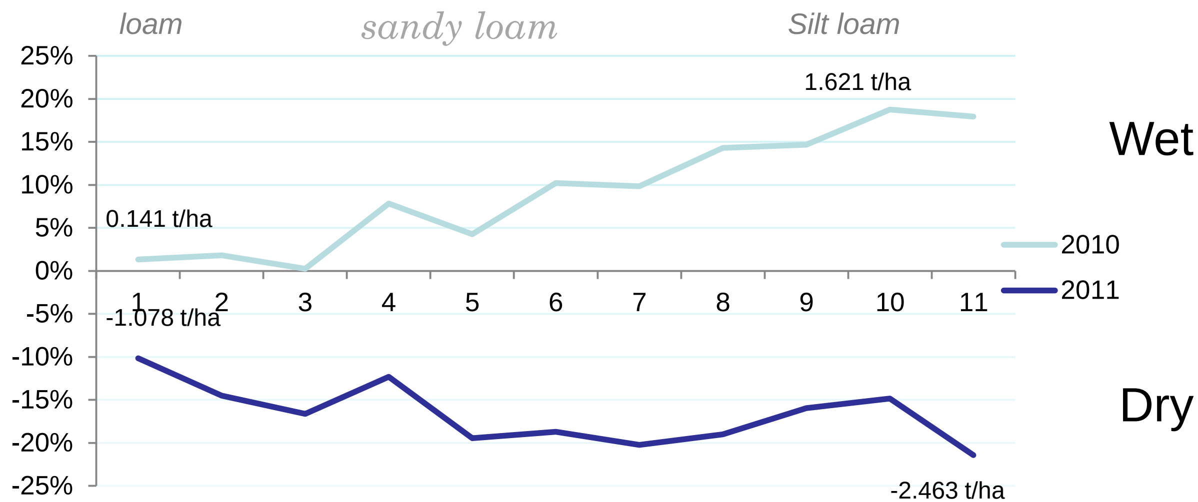


RELATIVE REFLECTANCE OF WHEAT OR CHICKPEA (CROP), GRASS WEEDS (GW), BROAD LEAF WEEDS (BLW) VS WAVELENGTH (SHAPIRA ET AL., 2010)

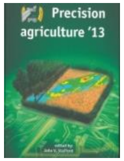
IMPROVING THE ACCURACY OF DSSAT MODEL



THE DIFFERENCE BETWEEN THE SIMULATED AND MEASURED MAIZE YIELD UNDER DRY AND WET CONDITIONS



Nyéki A. É.
PhD Thesis
2016



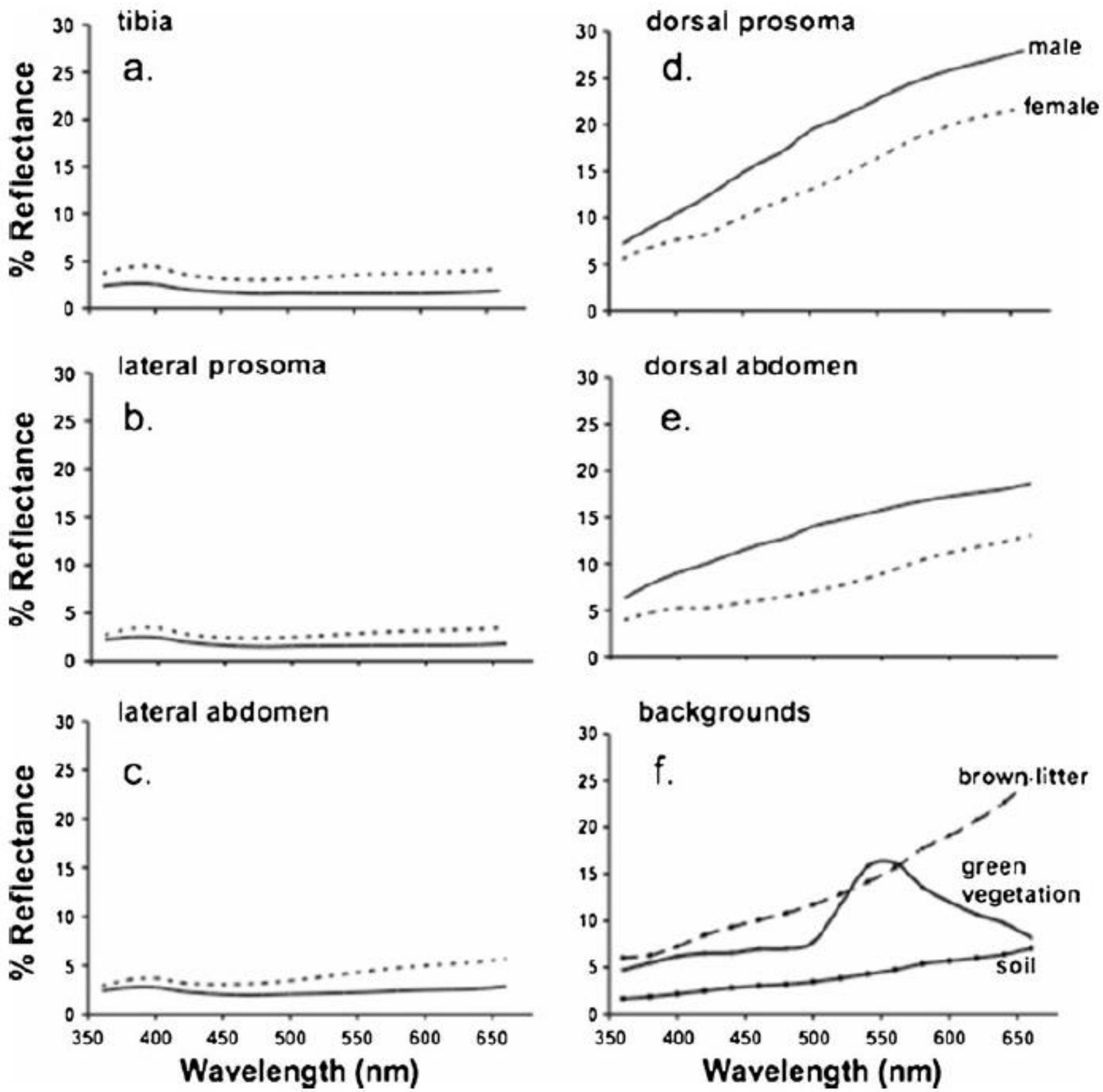
Nyéki, A., Milics, G., Kovács, A.J., Neményi, M. (2013): Improving yield advisory for precision agriculture with special regards to soil compaction in maize production. **9th EUROPEAN CONF. ON PRECISION AGRICULTURE**

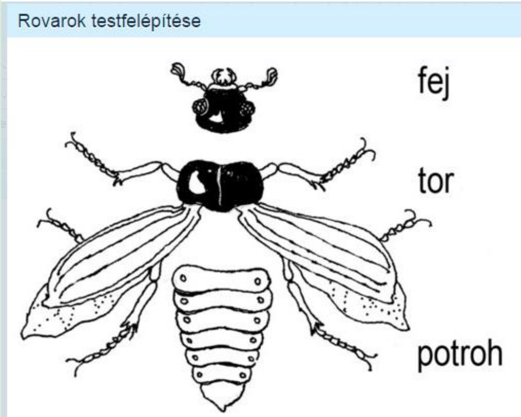
Nyéki, A., Milics, G., Kovács, A.J., Neményi, M. (2016): Effects of Soil Compaction on Cereal Yield: A Review. **CEREAL RESEARCH COMMUNICATIONS.**

REFLECTANCE SPECTRA OF BODY PARTS OF INSECTS

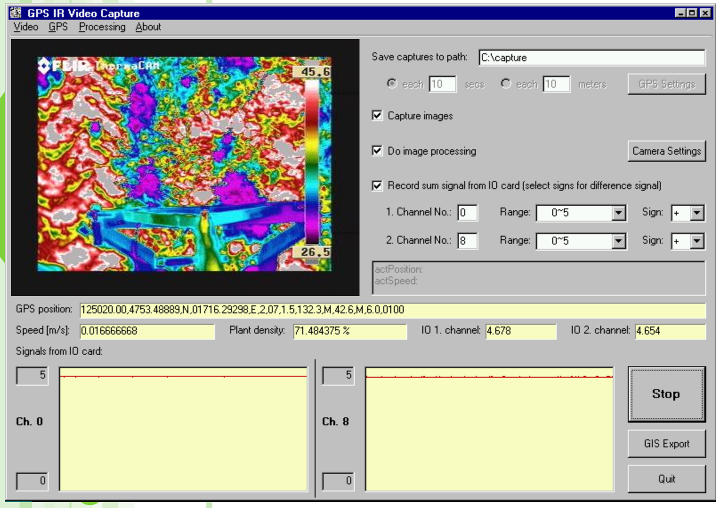
Behav Ecol Sociobiol (2011) 65:1237–1247 1241

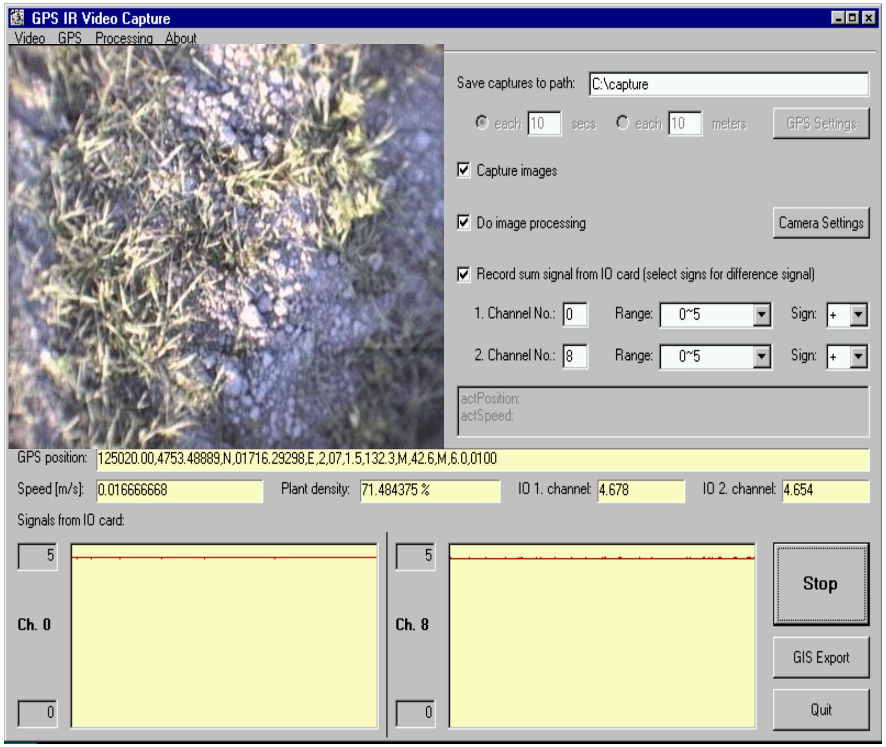
Fig. 2 **a–f** Reflectance spectra comparing males (*solid line*) to females (*dashed line*) for each body part measured with forest leaf litter backgrounds



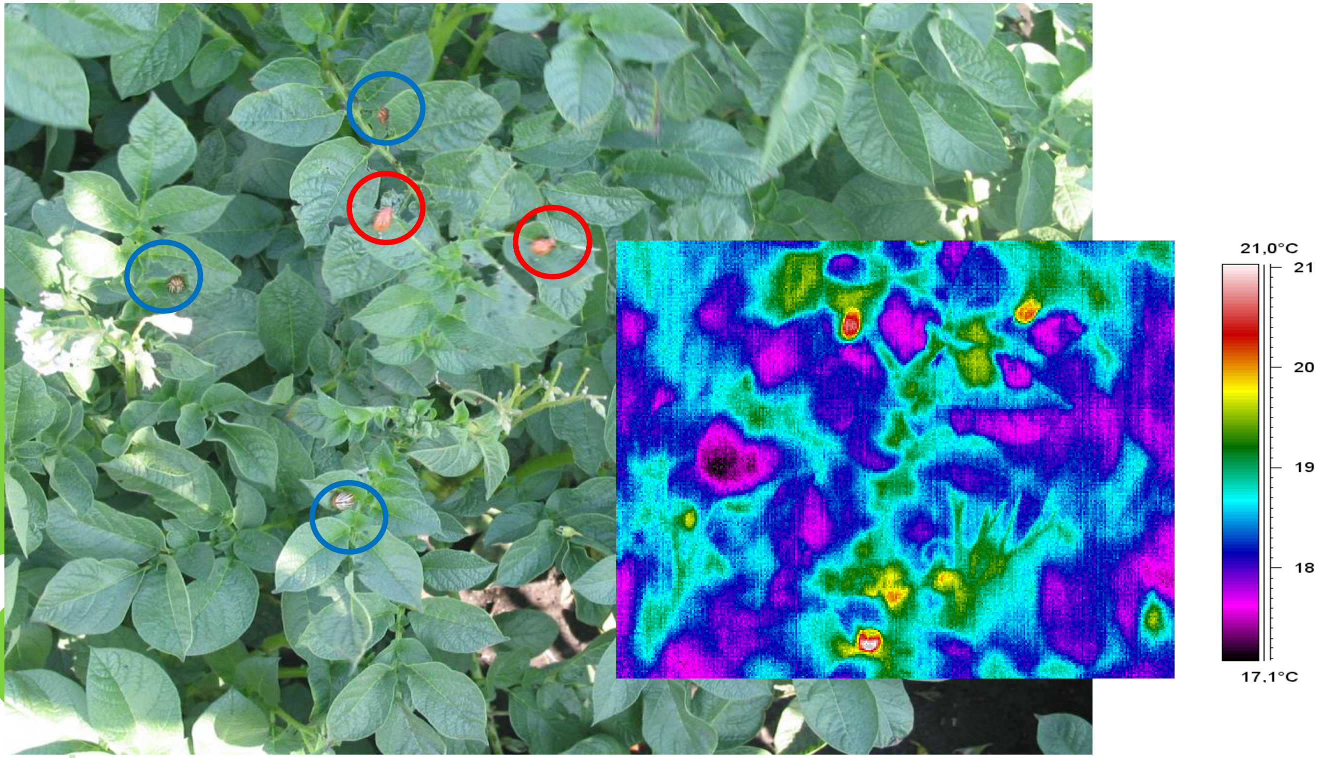


WEED MAPPING BY THERMO AND CCD CAMERA

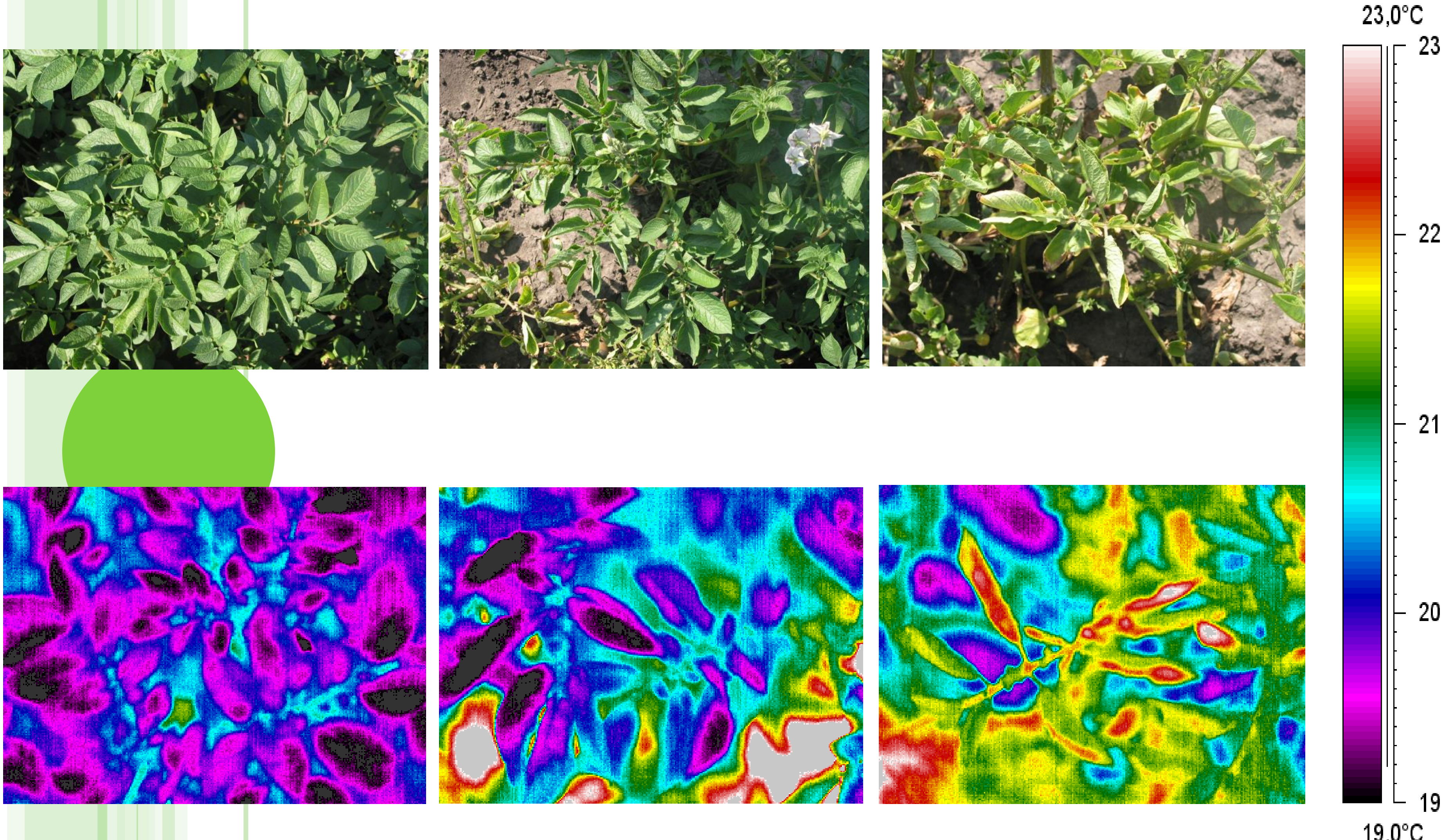




IMAGO AND LARVAE DETECTION



PERCEPTION OF THE DEGREE OF INSECT DAMAGE



Healthy

Medium and strong symptoms

APPLIED CLIMATE MODELS (IPCC:A1B)

"Multi-model climate change global simulation" predictions

Database for decision support systems.

Model	Country	Institute	Spatial and temporary resolution
C4I-HadCM3 (until 2075)	Ireland	Community Climate Changes Consortium for Ireland	190*190*3600
DMI-ARPEGE	Denmark	Danish Meteorological Institute	174*190*3652
KNMI-ECHAM5	Holland	The Royal Netherlands Meteorological Institute	170*190*3652
ETZH-HadCM3Q	Switzerland	Swiss Institute for Technology	170*190*3600
MPI-ECHAM5	Germany	Max-Planck-Institute for Meteorology	170*190*3652
SMHI-BCM	Sweden	Swedish Meteorological and Hydrologic Institute	170*190*3652

However, I would like to emphasize that we can put any kind of models in the DSSAT. The requirements are as follows: IPCC scenario, and the daliy data

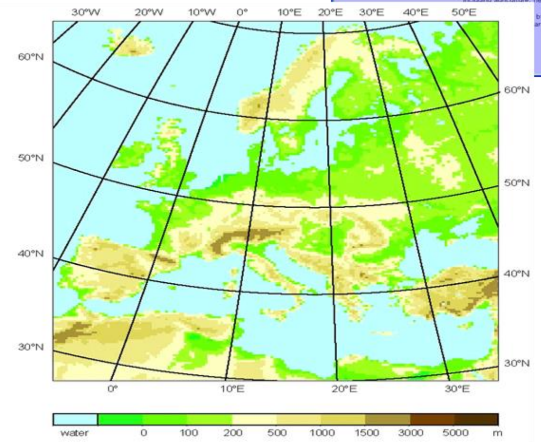
Climate models: Ensemble projekt (*A1B scenario package*)

5 models provide daily data until 2100.

Grid size: 25x25 km

Adapted input daily data:

1. ***Maximum temperatures,***
2. ***minimum temperatures,***
3. wind speed,
4. ***amount of precipitation,***
5. relative humidity,
6. potential evaporation,
7. sunshine duration and
8. ***surface radiation.***



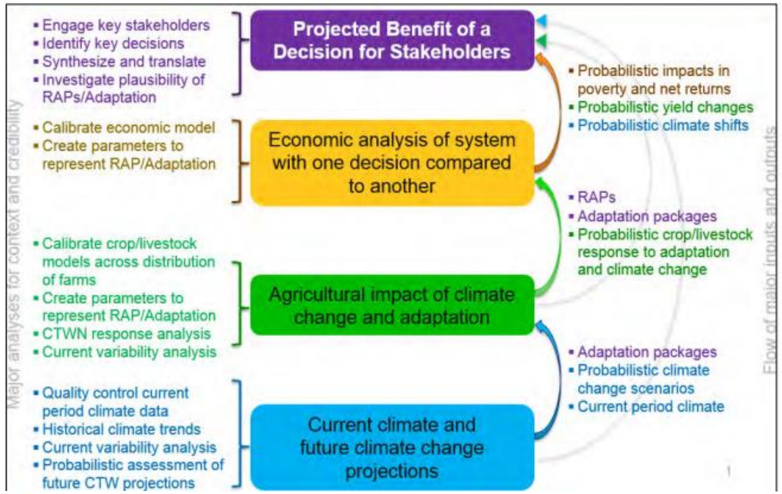
0.22° (25km) grid mesh (courtesy of Burkhardt Rockel)

Compactibility of decision support (plant physiological) models

AgMIP

The Agricultural Model Intercomparison and Improvement Project

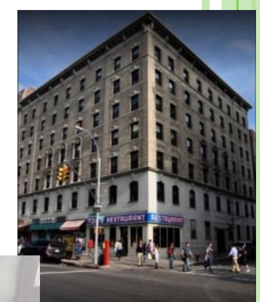
AgMIP: Protocols for AgMIP Regional Integrated Assessments Version 6.0



The AgMIP works out strategies in order to improve the accuracy of worldwide used DSS models. Thereby the results of these models can be compared. This is actually a process of unification.

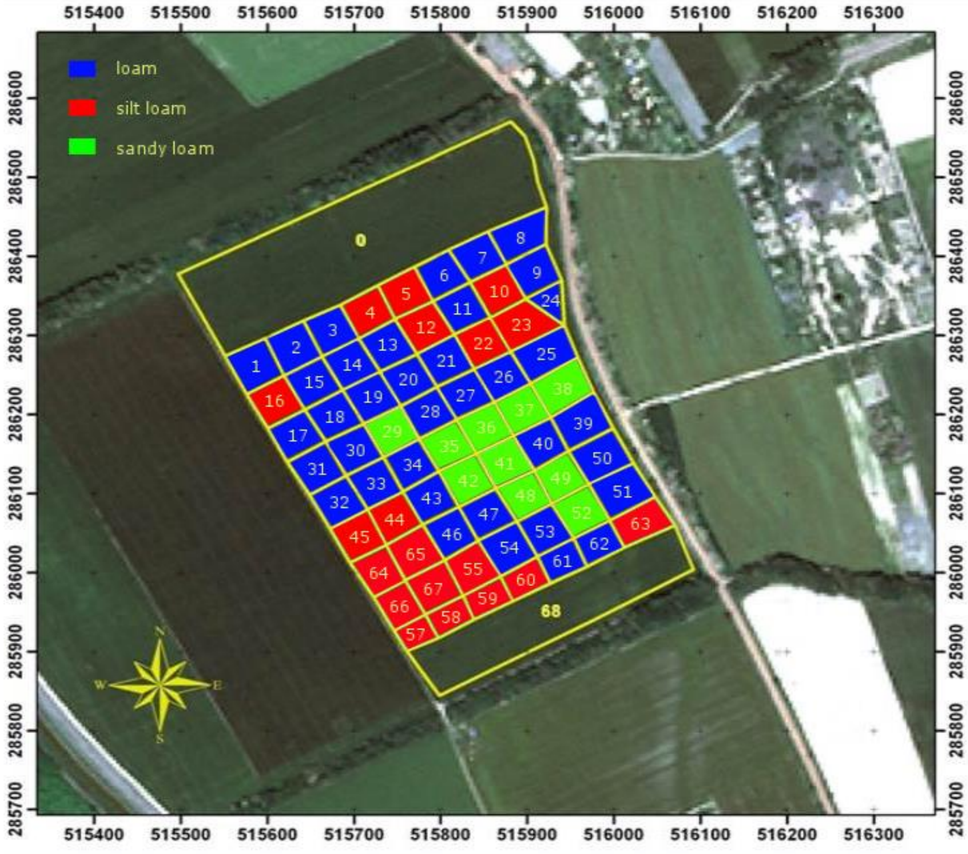
NASA

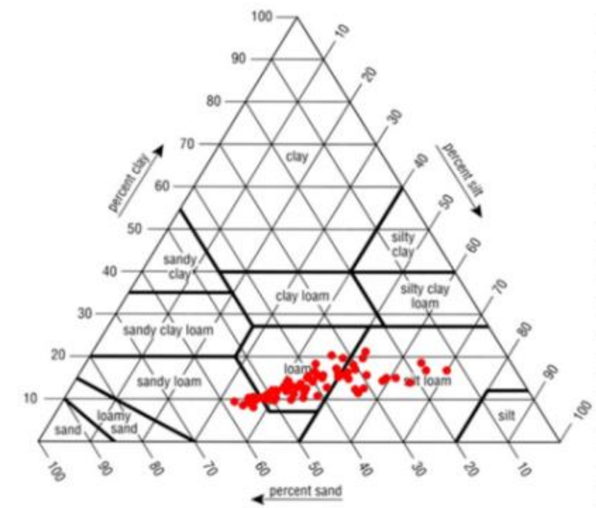
Goddard Institute of Space Studies (NY)



2014

2016

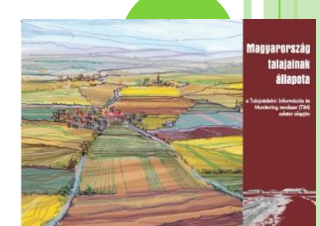




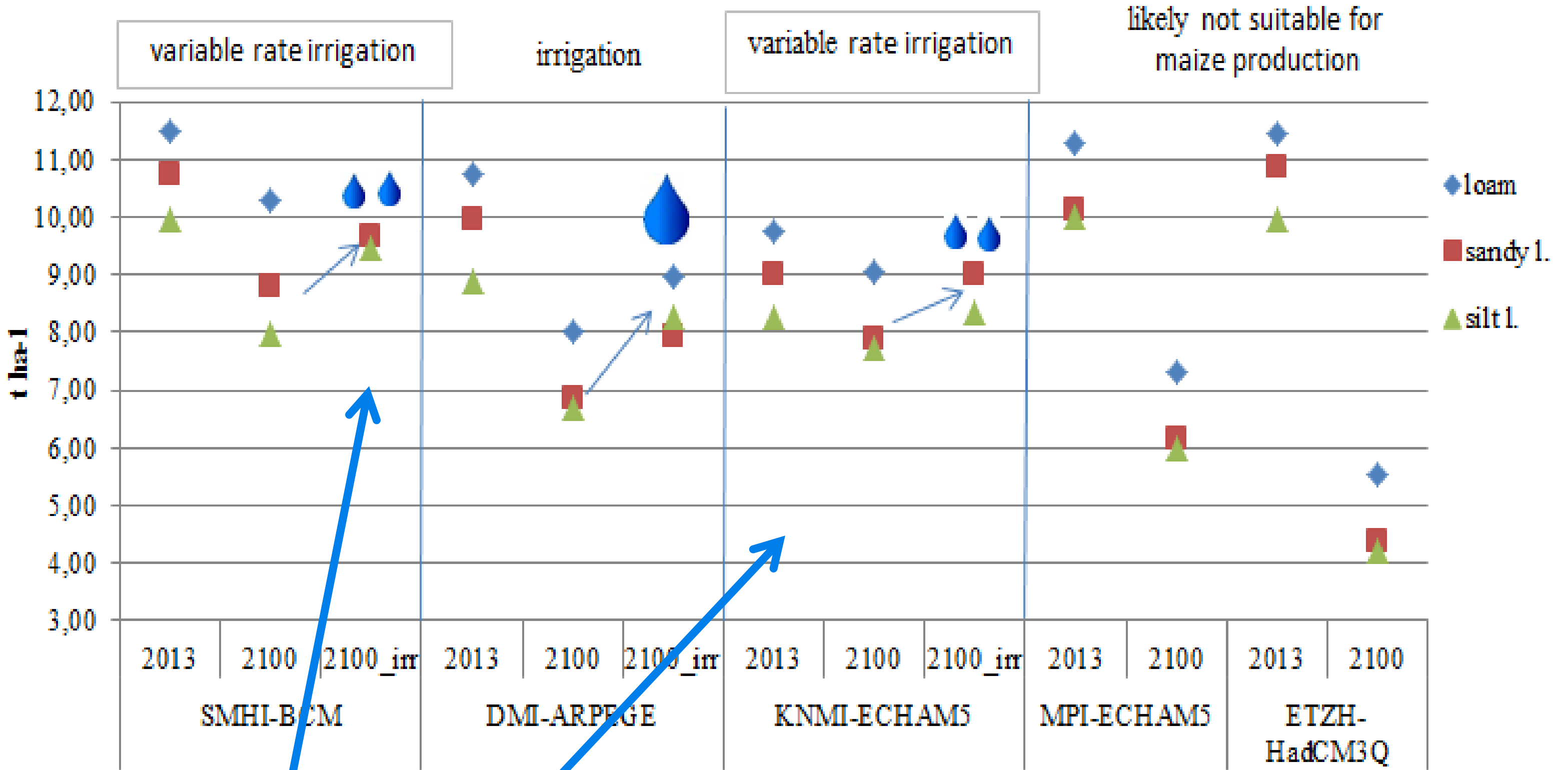
(GPS-BASED) SOIL SAMPLING POINTS

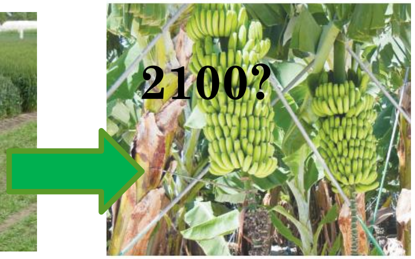
Stochastic distribution of the three soil types: loam, silt loam and sandy loam in the research field, Mosonmagyaróvár

HUNGARIAN SOIL INFORMATION AND MONITORING SYSTEM (SIMS)



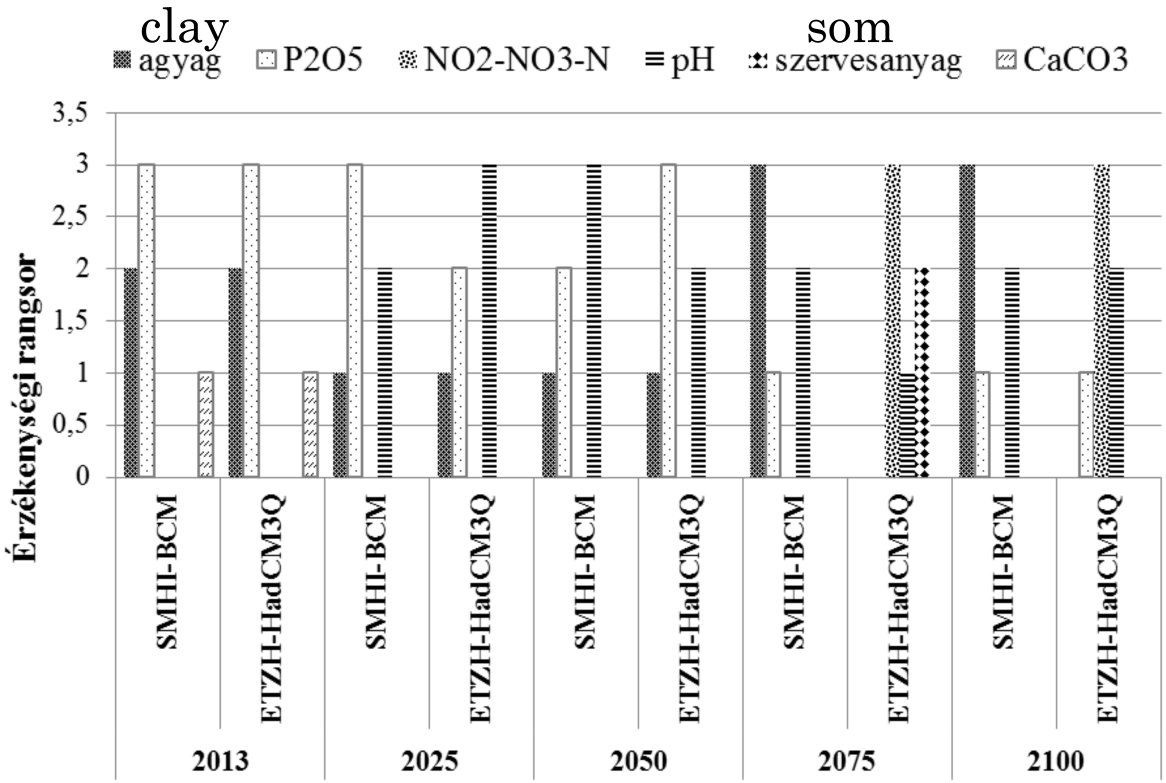
PREDICTED MAIZE YIELD IN MOSONMAGYARÓVÁR IN 2100 WITH VARIABLE RATE IRRIGATION (VRI) AT DIFFERENT SOIL TYPES





Kovács, A. J., Nyéki, A., Milics, G., Neményi, M. (2014) Climate change and sustainable precision crop production with regard to maize (Zea mays L.). 12th International Conference on Precision Agriculture. July 20-23, 2014; Sacramento, CA, USA.

TOTAL EFFECT INDEX RANKING WITH SENSITIVITY ANALYSIS (FOR SOIL PARAMETERS)



BGC
BioGeoChemical
model

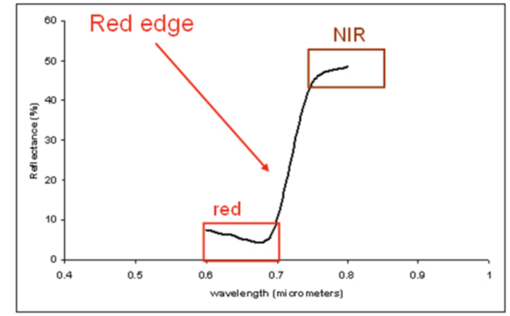
Nyéki, A., Kalmár, J., Milics, G., Kovács, A.J., Neményi, M. (2015): **Climate sensitivity analysis of maize yield on the basis of data of precision crop production. 10 th EUROPEAN CONF. ON PRECISION AGRICULTURE.**

Nyéki, A., Kalmár, J., Milics, G., Kovács, A.J., Neményi, M. (2016): Climate sensitivity analysis of maize yield on the basis of precision crop production. 13 **th INTERNATIONAL CONF. ON PRECISION AGRICULTURE.**

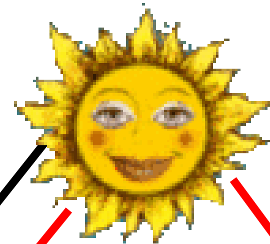
TOTAL EFFECT INDEX RANKING WITH SENSITIVITY ANALYSIS (CLIMATE PARAMETERS)

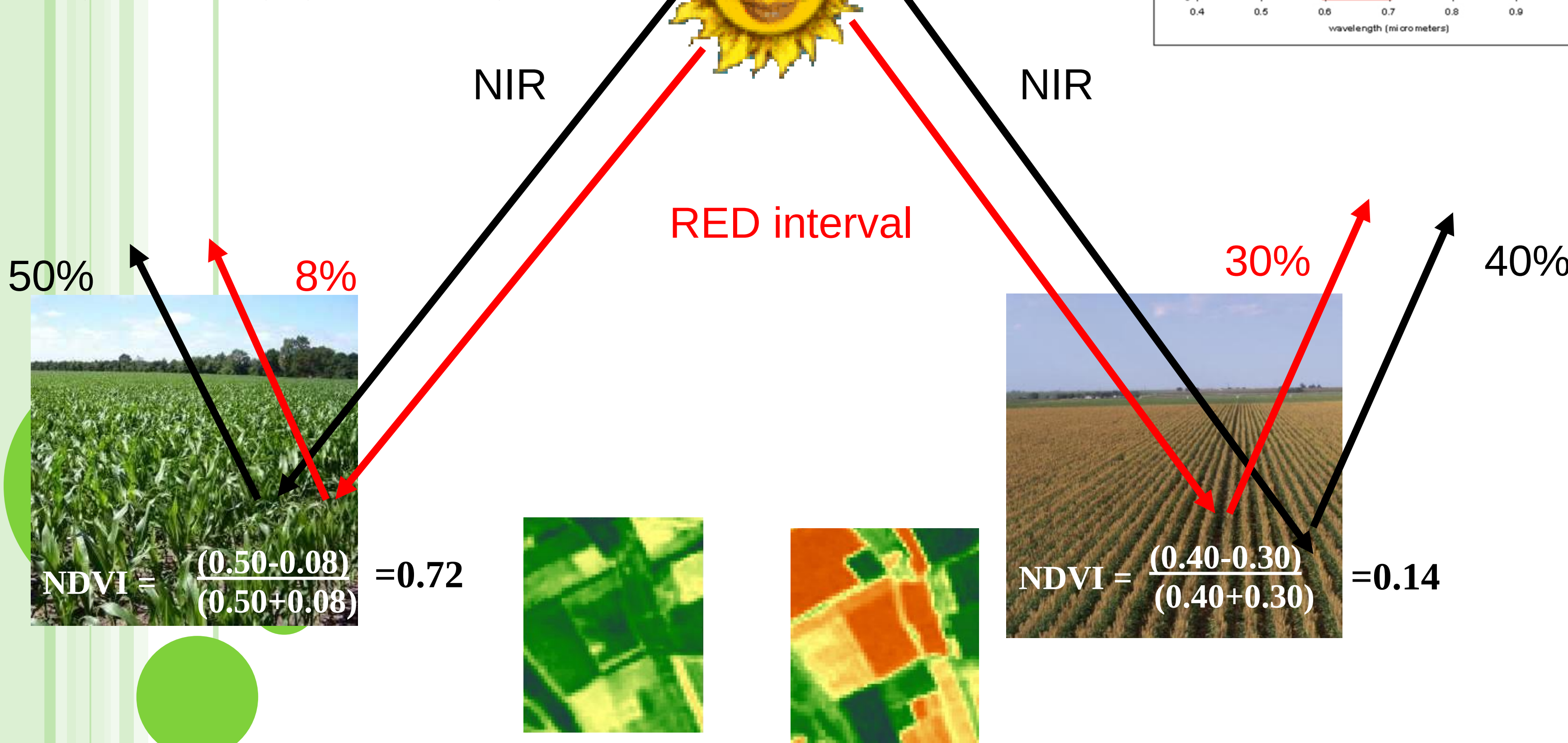
Climate scenarios	***CO_2 ppm***	***Precipitation***	***Maximum temperature***	***Minimum temperature***
MPI-ECHAM5	***-0,018960243***	***0,001574***	***-2,47269***	***0,596704***
ETZH-HadCM3Q	***-0,036826056***	***0,007045***	***1,491355***	***0,68335***
SMHI-BCM	***-0,001529906***	***0,000442***	***-0,36137***	***0,435233***
KNMI-ECHAM5	***-0,006911322***	***0,00787***	***-0,5114***	***-0,28296***
DMI-ARPEGE	***0,00539868***	***0,011239***	***-1,44363***	***2,161368***

NORMALIZED DIFFERENCE VEGETATION INDEX



NDVI: (NIR-VIS)/(NIR+VIS)



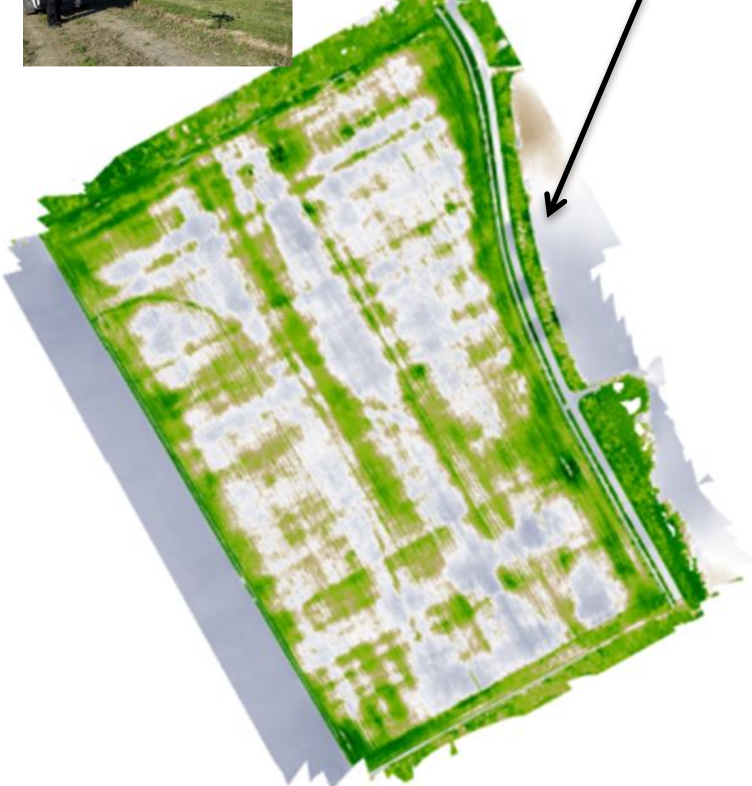


UAVs spatial resolution are tipically 5-15 cm

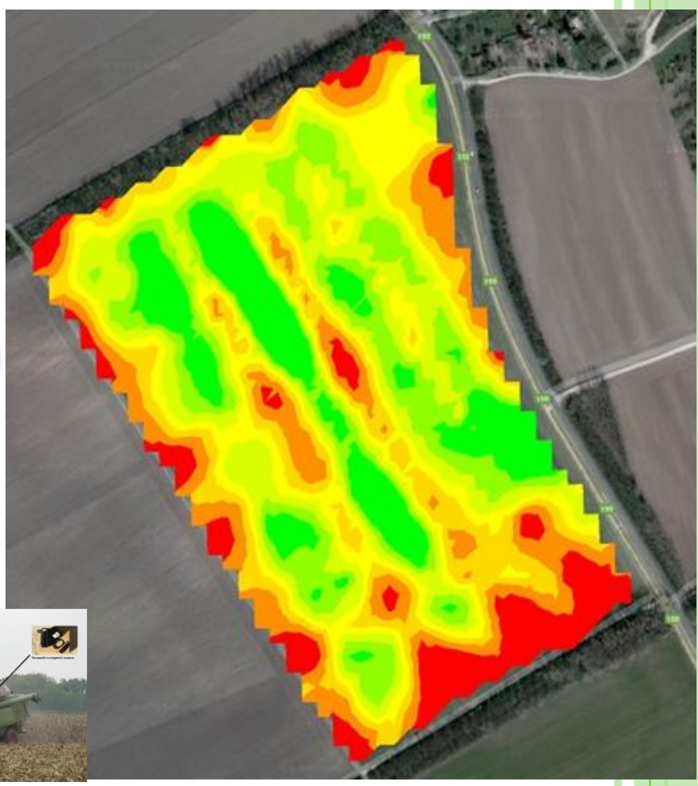
NDVI (Normalized Difference Vegetation Index)

Using NDVI for the enhance of yield prediction accuracy at decision support models (eg. DSSAT) during vegetation period e.g. suggestion topdressing, irrigation….etc.

2016 April: Winter Wheat NDVI



2016. July: yield map

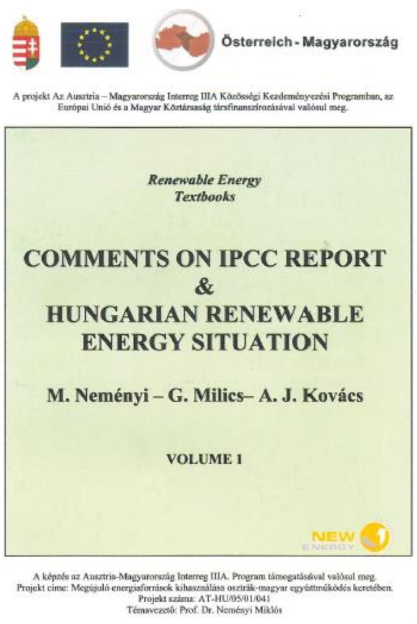


VAHAVA (Climate change – impact – response) national climate change project (2003-2006)

Prof. Dr. Dr. h.c. Csete László, The redactor of periodic „AGRO-21”

Prof. Dr. Dr. h.c. Láng István
MHAS
Head of project

Neményi, M. (2005): Agricultural engineering aspects of climate change. AGRO-21, 43. pp. 45-70.



Rajenda Pachauri: Head of I.P.C.C., receaved the 2007 Nobel prize

2008. April 8.

Former and recent PhD students of PA

A. Mouazen (Szíria)

Pecze Zs.

Mesterházi P.Á.

Maniak S. (NSZK)

Nagy V. (Szlovákia)

Mikéné-Hegedűs F.

Petróczki F.

Csiba M. (Szlovákia)

Milics G.

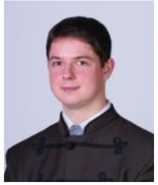
Virág I.

Nyéki A. É.

.

M. Farouk (Egyiptom) Post-doc. 2010/11

Smuk N. Predoc.



Dakos Á. PhD hallgató

Pörneczi A. PhD hallgató


Thank you for your attention!