ADDRESSING THE WITHIN-FIELD SPATIAL VARIABILITY IN CROP MANAGEMENT

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Site specific crop management

uses knowledge about in-field **variability** for **optimization** of returns on inputs (fertilizers, pesticides, …) while **preserving** environmental resources.

Benefits:

Economical

effective use of farm inputs

Environmental

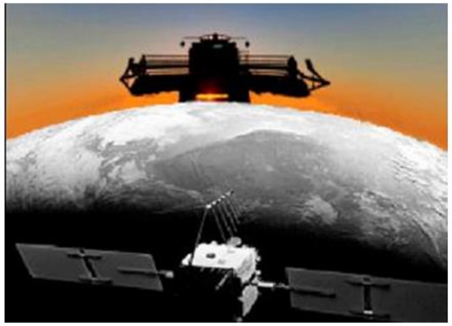
cropping intensity according to site specific condition

Other

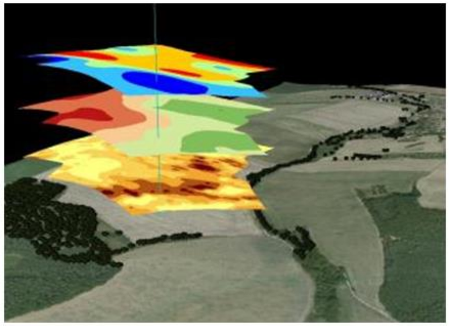
machinery management, traceability

Precision Agriculture Technologies

GNSS
Global Navigation Satellite Systems



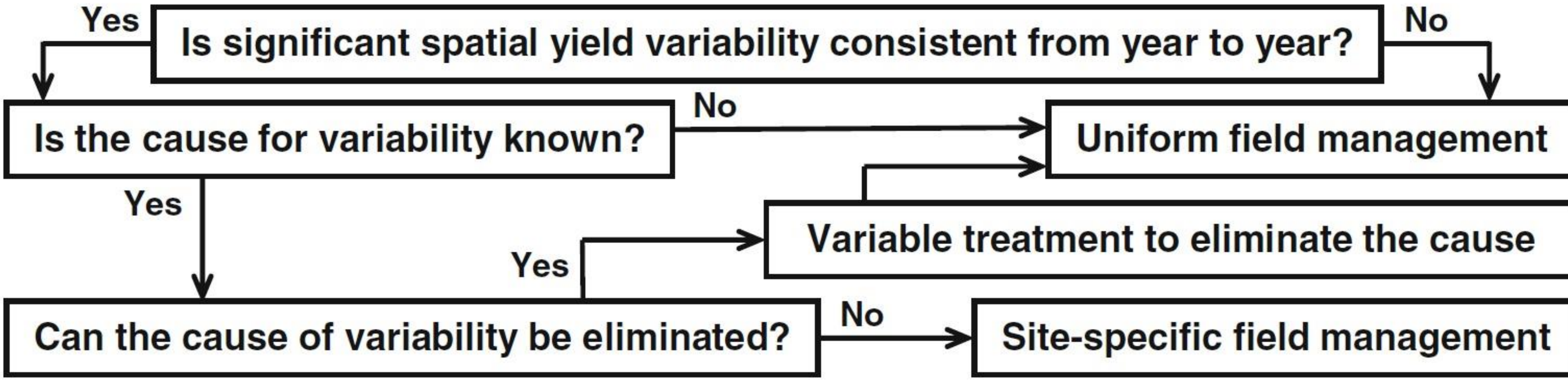
ICT
Information and Communication Technologies



GIS
Geographic Information Systems

VRA
Variable rate application components

Sensors
Sensor systems for mapping of soil and crop



Adamchuk, V.I., Ferguson, R.B., Herbert, G.W. 2010. Soil Heterogeneity and Crop Growth.
In Oerke, E.C., Gerhards, R., Menz, G., Sikora, R.A., Precision Crop Protection - the Challenge and Use of Heterogeneity.

Verification of sensor methods

Measurement of apparent electrical conductivity of soil

- on-the-go measurement using *Geonics EM38* (2004, 2007) and *GF Instruments CMD* (since 2009)
- electromagnetic induction (EMI) principle = non-contact, non-invasive (depth 0.7 - 1.5 m)
- a non metalic plastic sledge was constructed to draw the instrument behind the vehicle (tractor, quad-bike, off-road)

2009

2011

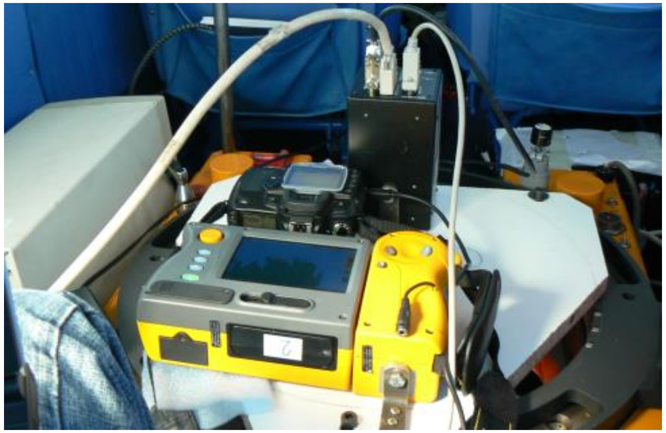
2012

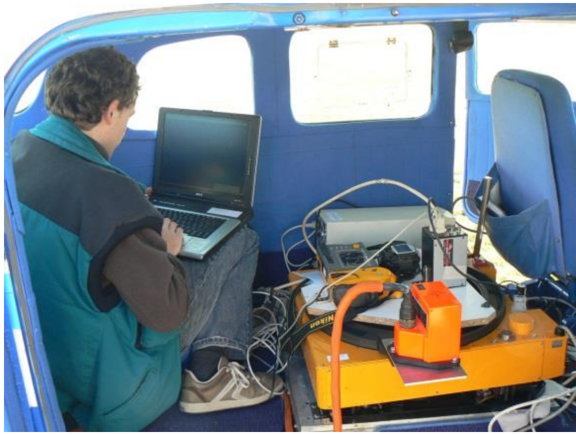
2013

Verification of sensor methods

Aerial imaging of bare soil

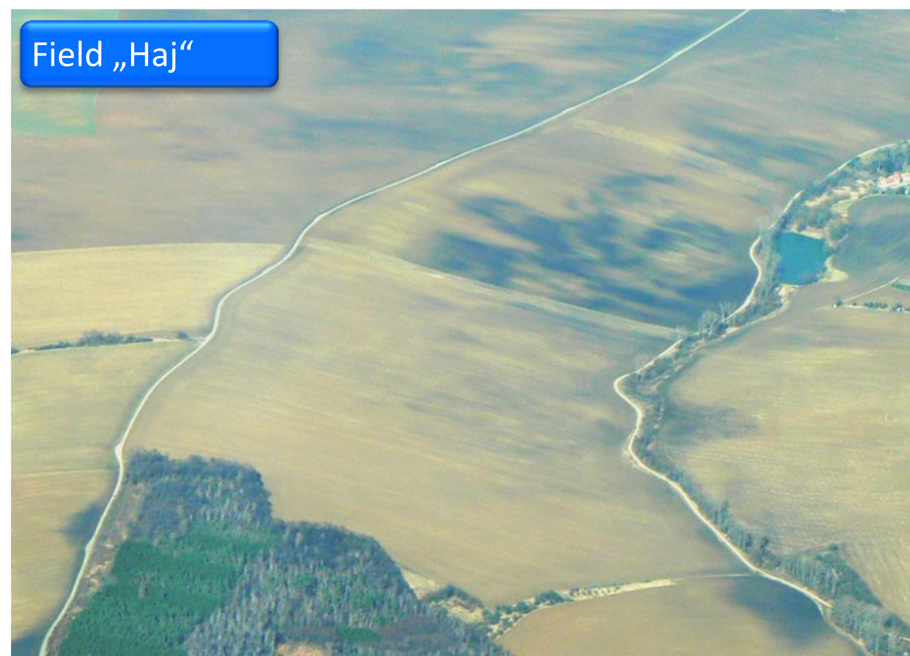
- measurement of spectral properties of soil surface (reflectance)
- carried out with Cessna TU206F in altitude of 2000 m
- instruments on board:
  - DSLR Nikon D80 (visible; 0.3 m / pixel)
  - multispectral camera DuncanTech MS3100 (G, R, NIR; 0.75 m / pixel)
  - thermocamera Fluke Ti55 (TIR, 3 m / pixel)



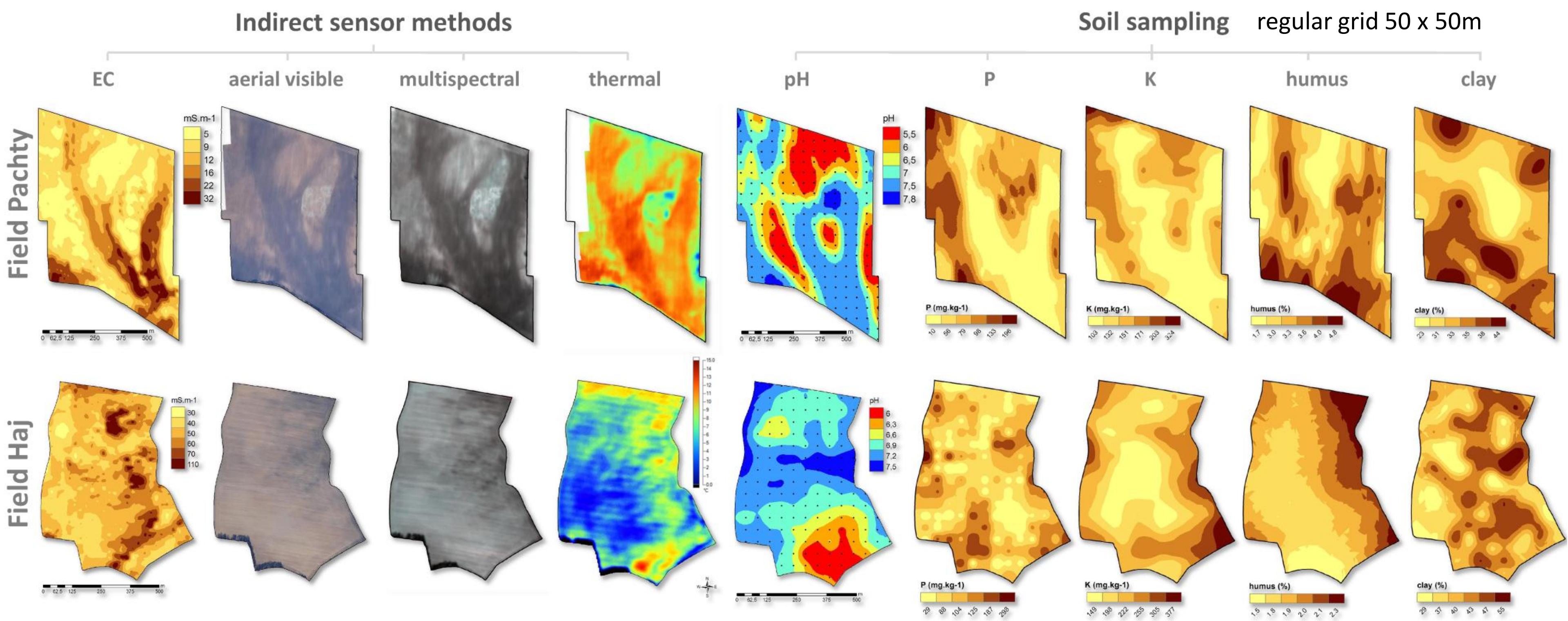


Experimental site

Field „Pachty“	Field „Háj“
52.5 ha	37.8 ha
Chernozem	Haplic Luvisol
Elev. 176 – 182 m	Elev. 280 – 342 m



Mapping of soil spatial variability



The coefficients of correlation

		pH	P	K	Humus	Clay
Field Pachty	VIS_c1	-0.371**	0.560**	0.501**	-0.428**	-0.506**
	MS_c1	-0.410**	0.653*	0.593**	-0.547**	-0.540**
	EC (mS.m^{-1})	0.565**	-0.575**	-0.500**	0.469**	0.433**
	Temp. (°C)	0.424**	-0.534**	-0.569**	0.276**	0.644**
Field Haj	VIS_c1	-0.391**	-0.082	-0.169*	-0.470**	-0.051
	MS_c1	-0.348**	-0.093	-0.229**	-0.439**	-0.068
	EC (mS.m^{-1})	-0.057	-0.258**	0.174*	0.061	0.373**
	Temp. (°C)	0.044	-0.159	0.136	0.194*	0.261*

Verification of sensor methods

Summary

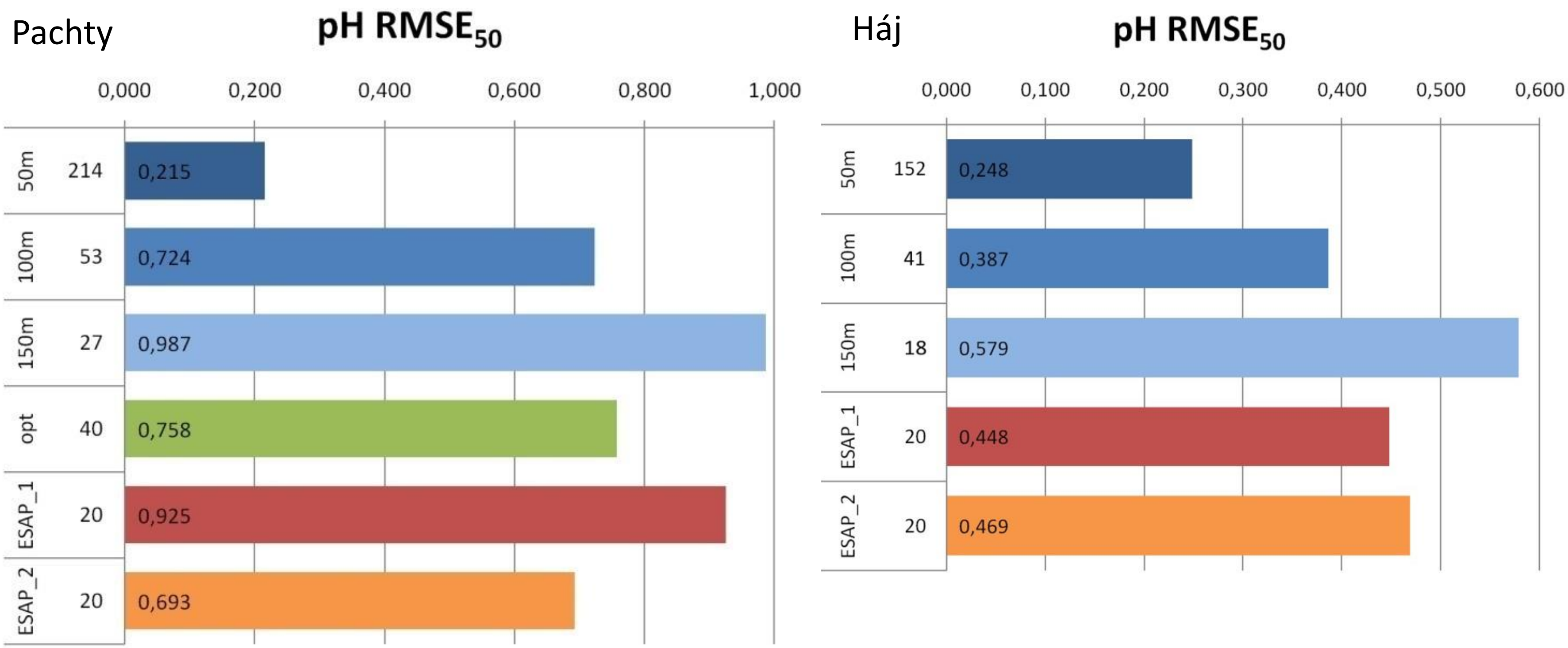
- EC and remote sensing showed similar potential for identification of soil spatial patterns (effect of soil factors: texture-moisture – organic matter)
- the level of correlation varied among the localities (higher variability = better statistical relationship)
- the interaction among soil factors **limits the identification of specific soil properties**, but allows to obtain an overview on heterogeneity of soil condition in field.

An example of interpretation of soil maps: Base fertilization of crops

Modification of traditional approach for base fertilization of field crops to follow the concept of site specific crop management.

1. optimization of soil sampling
2. more precise interpretation of soil maps
3. considering in-field variability of crop yield

I. Optimization of soil sampling



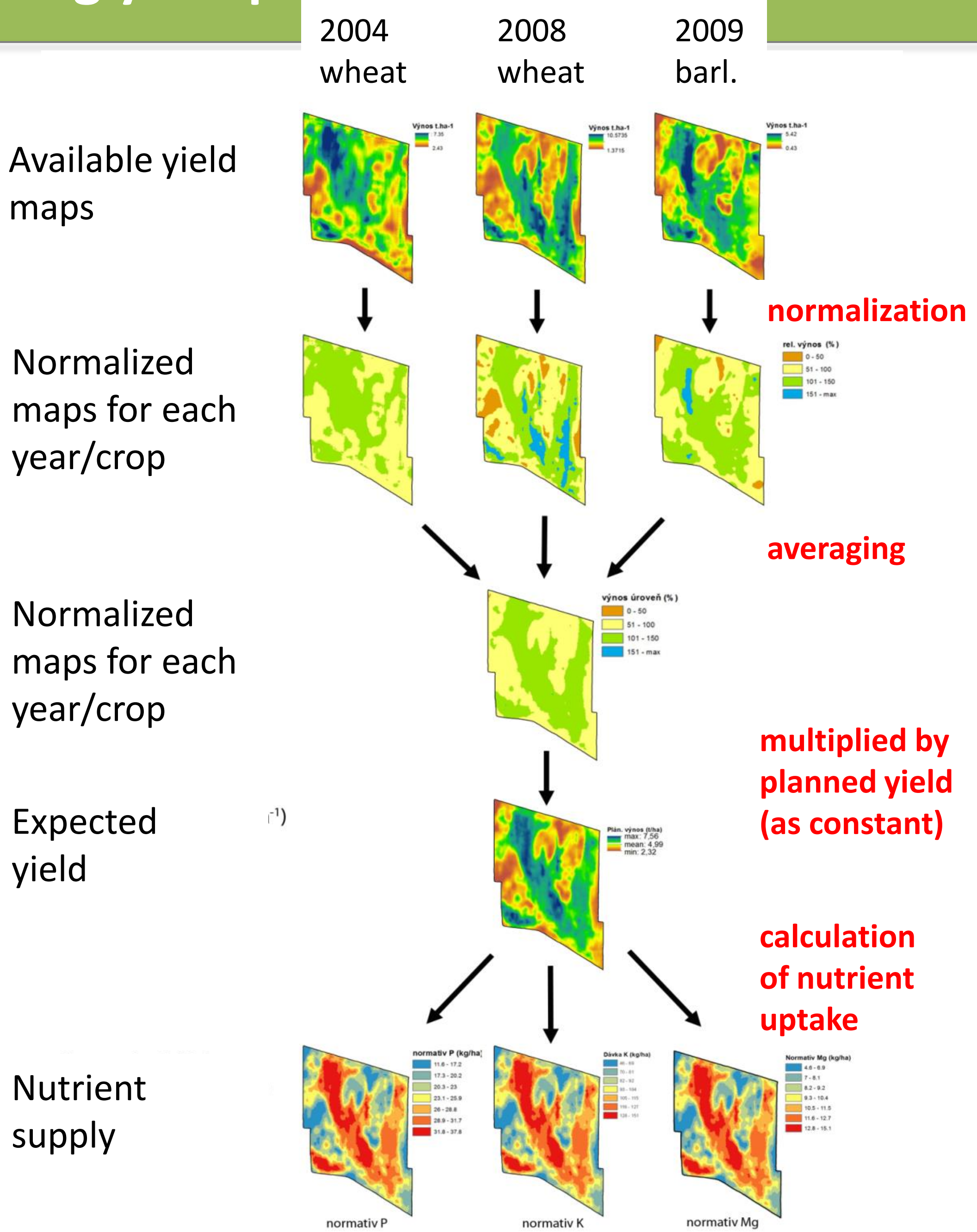
OPT – subjective optimization based on the EC data

ESAP_1, ESAP_2 – optimization using ESAP-RSSD algorithm (1 – based on the EC data, 2 – based on the RS data)

Results:

- reduction of samples by 50 - 60 % using ESAP-RSSD algorithm (comparing to the regular 100m grid)
- reduction of samples by 25 % with manual selection of points (OPT)

II. Integrating yield productivity map



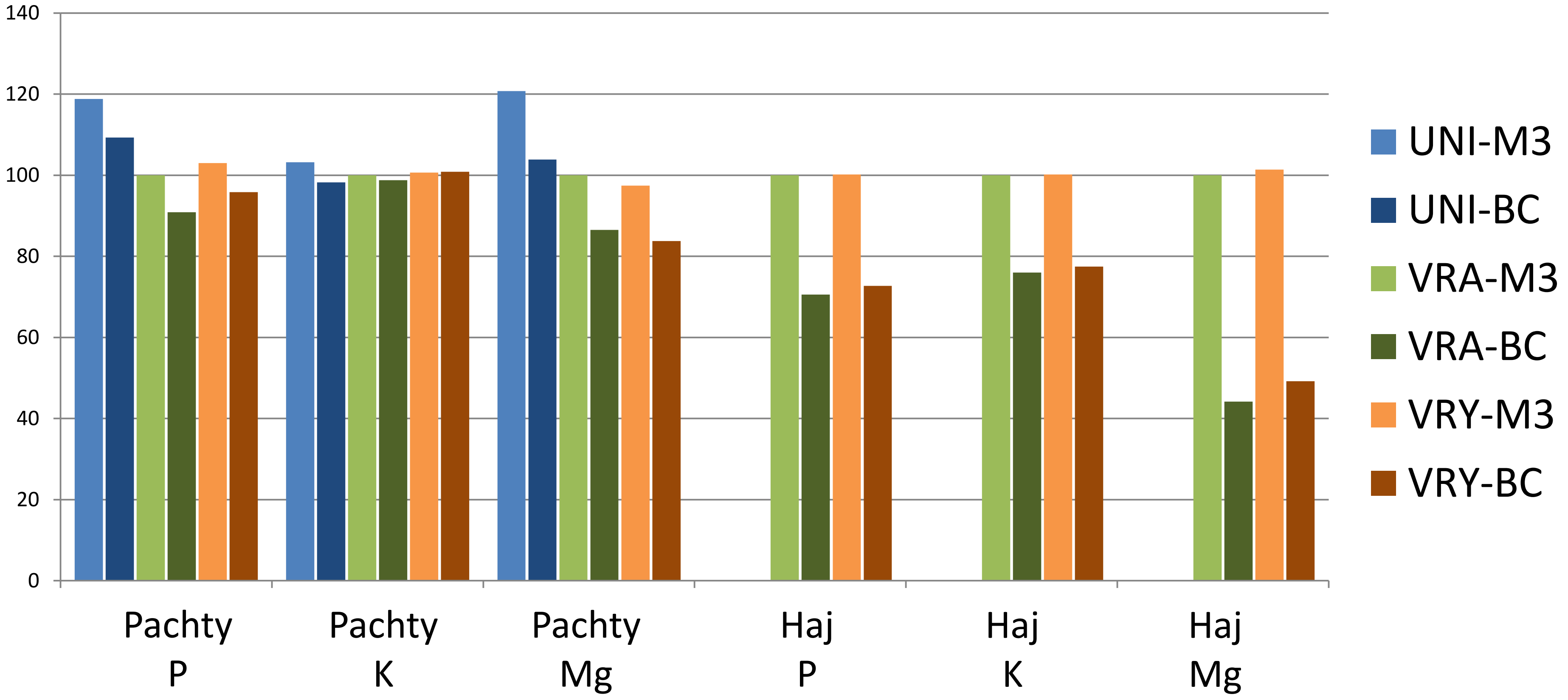
Comparison of variants

- six variants of interpretation of P, K and Mg soil maps were compared to verify the effect on the total fertilizers dose
- for both fields, the winter wheat was simulated as the main crop with the yield level 5 $t.ha^{-1}$ and nutrient uptake of 5 kg P, 20 kg K and 2.4 kg Mg per one tone of final yield.

Variant Code	Application	Interpretation	Planned Yield as
UNI-M3	uniform	Mehlich 3	constant
UNI-BC	uniform	Bal.coef.	constant
VRA-M3	VRA	Mehlich 3	constant
VRA-BC	VRA	Bal.coef.	constant
VRY-M3	VRA	Mehlich 3	zones
VRY-BC	VRA	Bal.coef.	zones

Comparison of variants

Percentage of application rates (VRA-M3 = 100%)



Comparison of variants

Summary

- Implementation of **balance coefficient** led to **decrease** of average nutrient dose compared to the interpretation using Mehlich 3 almost at all variants
- The differences between **uniform** (UNI) and variable rate application (**VRA**) had to be evaluated **separately** for both locations.
- At the Field Pachty uniform application had the same or higher average dose compared to the variable application. On the other hand the omission of fertilization was recommended at the Field Haj for uniform application, because of considering the soil texture differences within the field and masking the local extremes by average nutrient content for whole field.

= VRA doesn‘t mean saving of fertilizers in all cases!!!

- The integration of the yield productivity map (VRY) had in most cases **similar or higher doses** than VRA with constant yield per field (up to 5 % of doses).

Conclusions

- Sensor methods showed potential for identification of spatial variability in soil conditions, but the complexity of factors **limits a detailed estimation** of relevant soil parameters
- The study with 3-step modification of traditional approach showed that it is possible to get more precise VRA maps using current methodology, which is familiar for the farmers/agronomists
- Effect of modifications on the average application rate compared to the uniform treatment is field specific

  = quantification of the benefits needs further verification on different soil and farm conditions.

esf european social fund in the czech republic

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Thank you for your attention

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