

Precision Agriculture as the way to reducing Water pollution

Karel Charvát
Heřman Šnevajs
Vincent Ockelet
Michal Kepka

WirelessInfo
Czech Center of Science and Society - CCSS

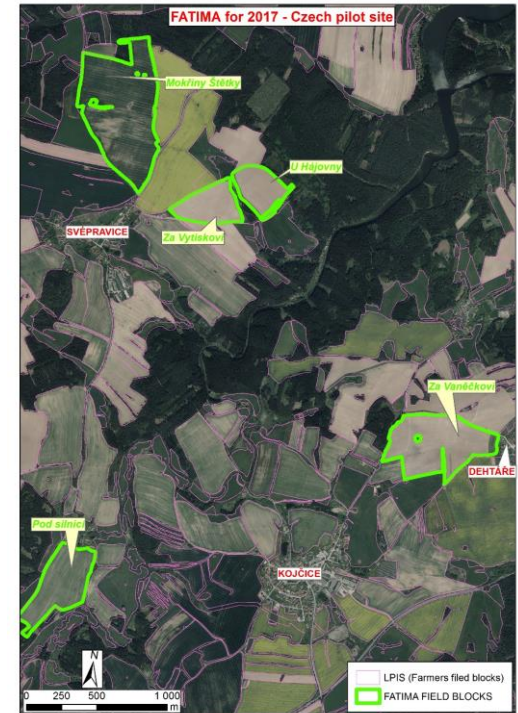
BIOeast FORESIGHT CONFERENCE, 27 September 2021



Initial ideas - FATIMA



- demonstrate FATIMA approaches in rainfed agricultural conditions (Czech Rep.)
- implement VRT for application of mineral fertilizers in within-field different yield potential zones in order to reduce nitrogen inputs, increase crop yields and reduce N leaching to waters.





SMARTAGRIHUB

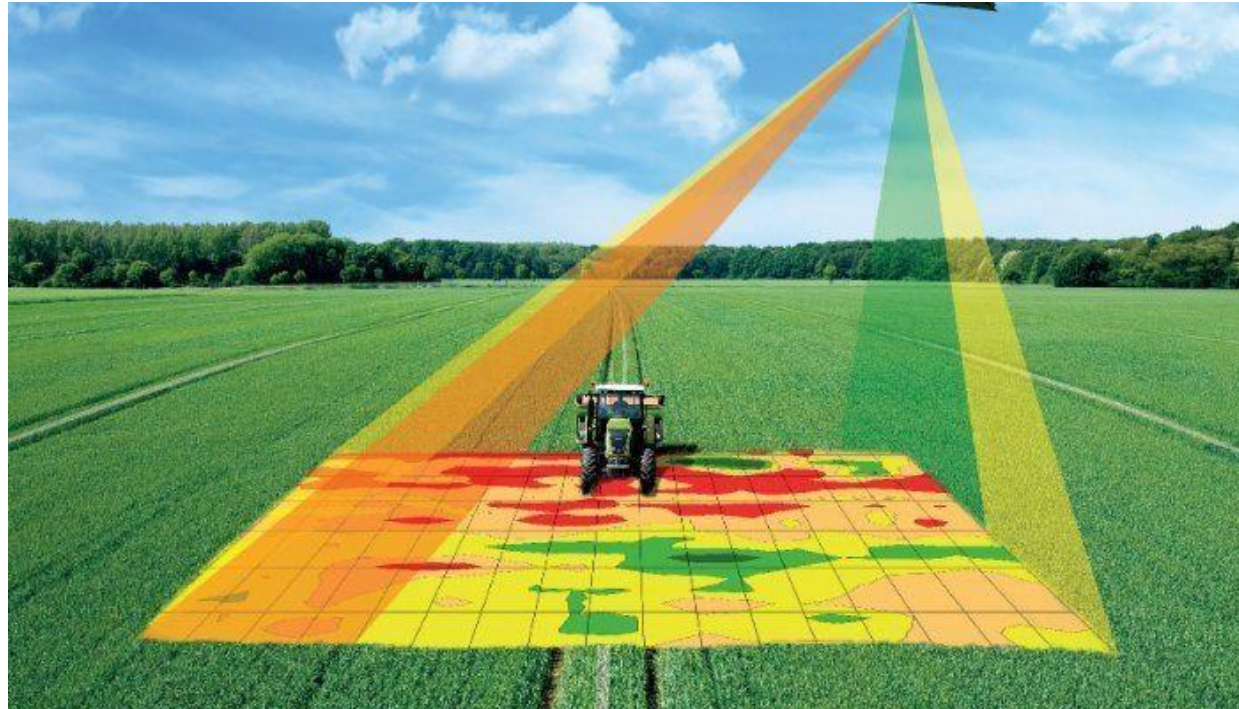
POÍDME UDĚLAT ČESKÉ ZEMĚDĚLSTVÍ
Rychlejší, udržitelné a
konkurenceschopné

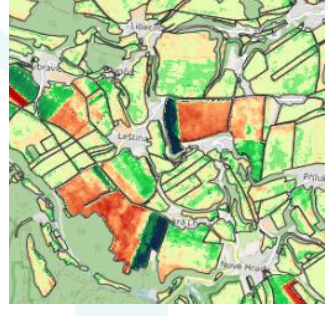
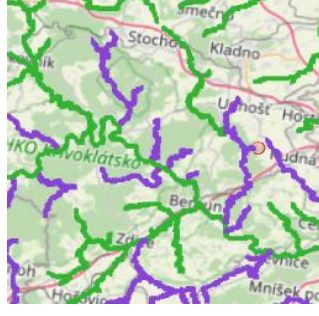
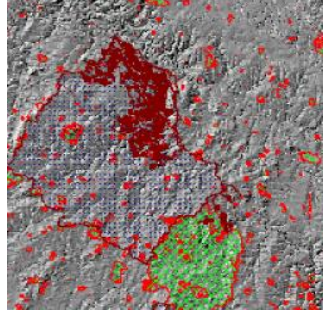
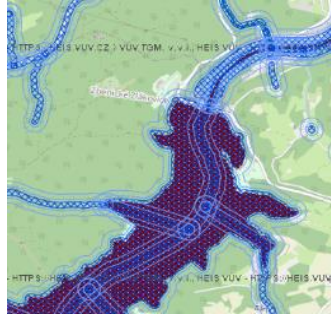
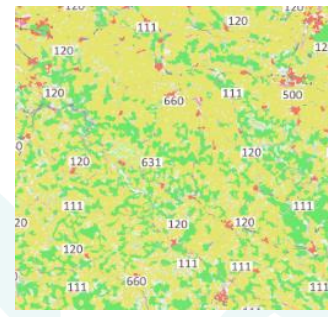
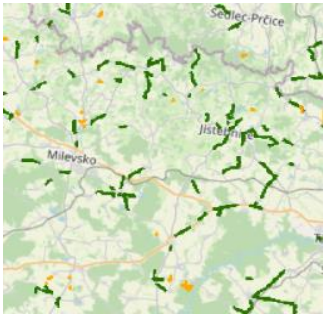
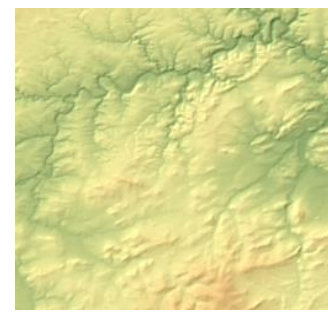
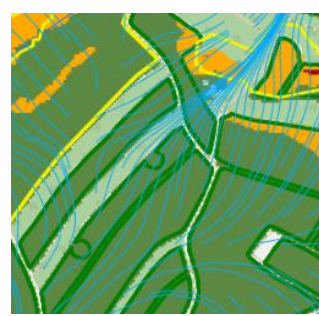
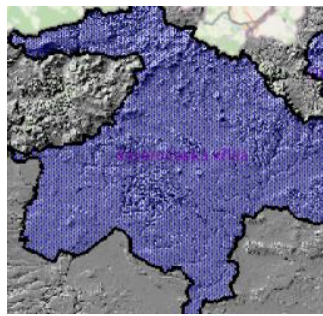
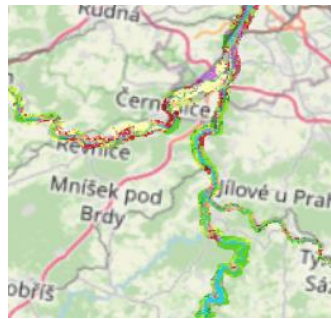
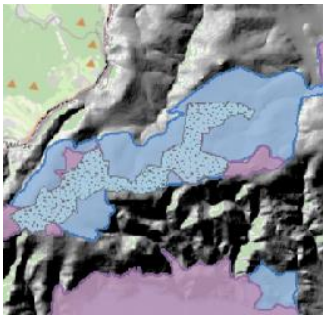


Motivation



- SUSTAINABILITY
 - ECOLOGICAL BENEFITS
 - STRICT REGULATIONS
- PRODUCTIVITY
 - ECONOMICAL BENEFITS
 - INCREASING DEMAND





Background



- Nitrogen plays a vital role in biochemical and physiological functions of plants.
- Too little nitrogen treatment affects crop output, whereas too much nitrogen has detrimental effects on plants.
- Incorrect application of nitrogen or inappropriate application methods can lead to losses through volatilisation, leaching or denitrification, and cause pollution.

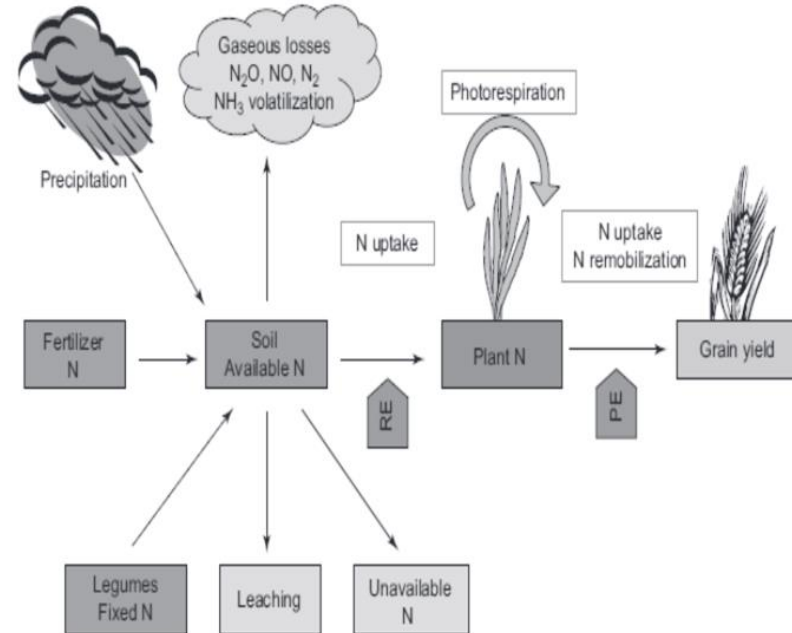


Figure 1 : Nitrogen in plants and environment (Good et al., 2004)

The project: Timing Nitrogen Application



The idea is to determine precisely the right time and the right quantity for nitrogen application in accordance with the phenological stage and the needs of the crop. The concrete objectives are :

- Define precise phenology stages and methods of reporting in the field with remote sensing and GIS knowledges.
- Analyse availability of Sentinel 2 and Sentinel 1 data and select one or several indices to determine crop status and provide their comparison.
- Define a method to easily monitor the state of vegetation dynamics, phenology and biomass quantity, based on time series of selected indices from Sentinel 2 and Sentinel 1.
- Define methods to easily visualise the time series data, to allow non-experts to easily compare and understand the data.

The aim of this project is to help farmers in ways :



Winter wheat nitrogen fertilization in general

It is important to apply nitrogen around the beginning of stem extension (Zadoks 23-30, figure 1 and 2), when the crop enters its very rapid growth phase. The maximum effect on growth is not given by a single application, but by a split application.

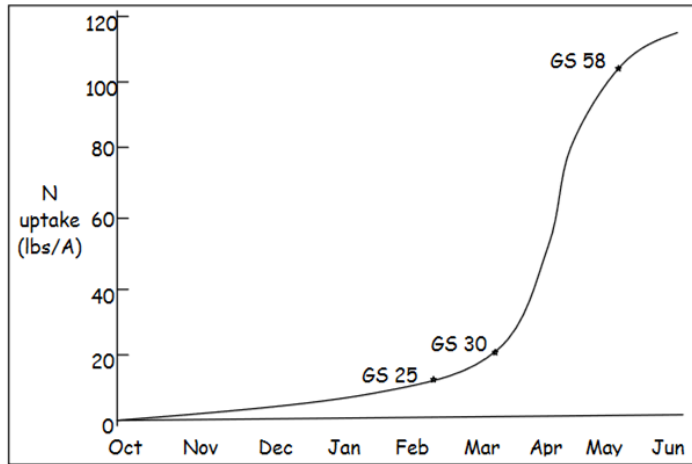


Figure 1 : Nitrogen uptake by winter wheat (Basden, T., Abaye, A., & Taylor, R. (2021). Chapter 5. Crop Production.)

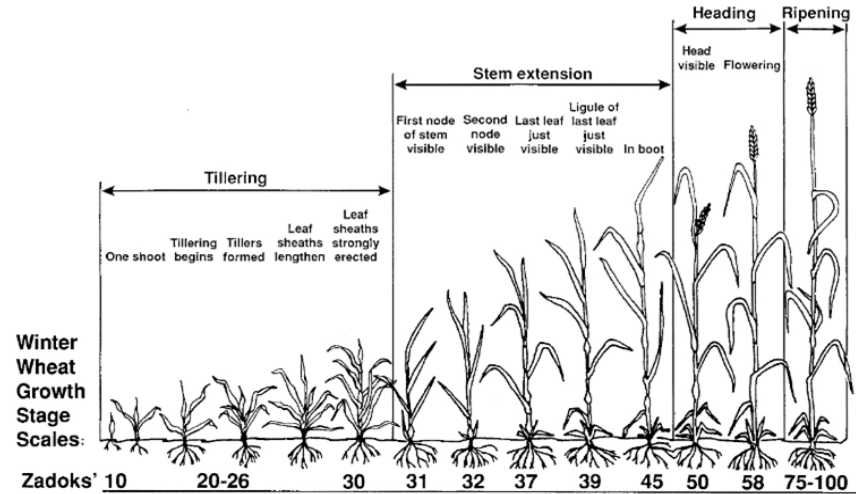




Figure 2 : Winter wheat growth stage scale (Basden, T., Abaye, A., & Taylor, R. (2021). Chapter 5. Crop Production.)

The technology and innovation



- Use of remote sensing and GIS
- Combination of radar and multispectral satellite
- Use of different Indexes (EVI, RVI4S1, LAI, NDMI)
- Mathematical methods
- Visual Analysis tool

Monitoring of the status and dynamics of crop phenology and prediction of the optimal time and amount for nitrogen application.

Sentinel 1 	Sentinel 2 	Combination of Sentinel 1 and 2
<ul style="list-style-type: none">- Ability to penetrate clouds- Work without illumination- Harder to comprehend	<ul style="list-style-type: none">- Easily approachable- Suitable for vegetation monitoring- Depends on cloudless skies	<ul style="list-style-type: none">- Higher accuracy for delineating land cover- Better results in cloud-prone regions.

SMARTAGRIHUB FIE solution



Browser address bar: https://groundwater.smartagro.lv/fie/index.html?hs_panel=layermanager&hs_x=2607590.5921581946&hs_y=7650319.94

Layermanager

Filter:

Baselayers

- Open street map
- Street map**

Map content

Vegetation indexes and satellite imagery

- Optical satellite basemap
- Infrared satellite map (Vilcini)
16.02.2019
- NDVI index (Vilcini)**
16.02.2019
- MSAVI2 index (Vilcini)**
16.02.2019
- Yield productivity zones

Map View:

Search: _____

SMART AGRI HUBS

Map labels: Meteostacija, Regulētais lauks - tēplaka, Regulētais lauks, Kontrolētais lauks

Scale: 500 m

The screenshot displays a web-based GIS application. On the left, a 'Layermanager' sidebar allows users to toggle between different map layers. The 'Baselayers' section includes 'Open street map' and 'Street map', with 'Street map' selected. The 'Map content' section is expanded to show 'Vegetation indexes and satellite imagery', where 'NDVI index (Vilcini)' and 'MSAVI2 index (Vilcini)' are both checked and set to the date '16.02.2019'. The main map area shows a satellite-style view of agricultural fields with blue outlines. Several locations are marked with black location pins: 'Meteostacija', 'Regulētais lauks - tēplaka', 'Regulētais lauks', and 'Kontrolētais lauks'. A search bar is at the top, and a scale bar for 500 meters is at the bottom left. The SMART AGRI HUBS logo is in the top right corner.

Thank you for your attention



Karel Charvát

charvat@wirelessinfo.cz

