Sensitivity of vegetation indices derived from Sentinel-2 data to change in biophysical characteristics

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APOLLO PLATFORM

GeoMLA Belgrade, 21-24. 6. 2016.

CONTEXT

- Research is done within the scope of APOLLO project (H2020)
- APOLLO – Advisory platform for small farms based on Earth Observation (EO)
- Information useful for agriculture management practice is derived from Copernicus Sentinel satellites' free and open data

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CROP CONDITION MONITORING

- Monitoring of crop condition/ development means monitoring of temporal and spatial changes of biophysical parameters of crops
- Using Sentinel-2 optical data (high spatial, spectral and temporal resolution)
- "Crop health" measurement – Estimation of Chl and N content
- Estimation of Leaf Area Index (LAI)
- Estimation of biomass

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BIOPHYSICAL PARAMETERS

- Crop chlorophyll content may be used as a proxy for gross primary production and nitrogen content (Gitelson et al., 2014). Chl is indicator of N status. Close relationship between N content and crop yield.

- LAI (green LAI)- useful for estimating agronomic variables and crop vegetation status, biomass estimation, variable in vegetative evapotranspiration calculation, etc. (Delegido et al., 2011; Nguy-Robertson et al., 2014; Casa et al., 2012)

- Biomass is used for yield prediction

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BIOPHYSICAL PARAMETERS

Models:

- Estimation of biophysical parameters from Vegetation Indices (VI) – transfer functions

Tasks:

- To define optimal VI(s)
- To define optimal and universal transfer functions for operational generation of biophysical parameters

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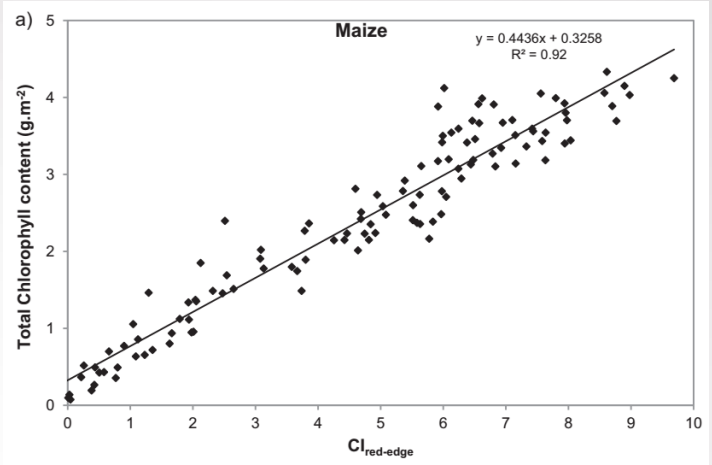
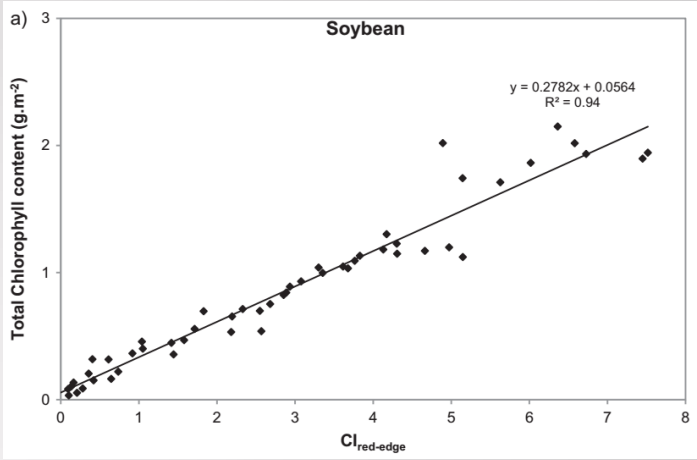
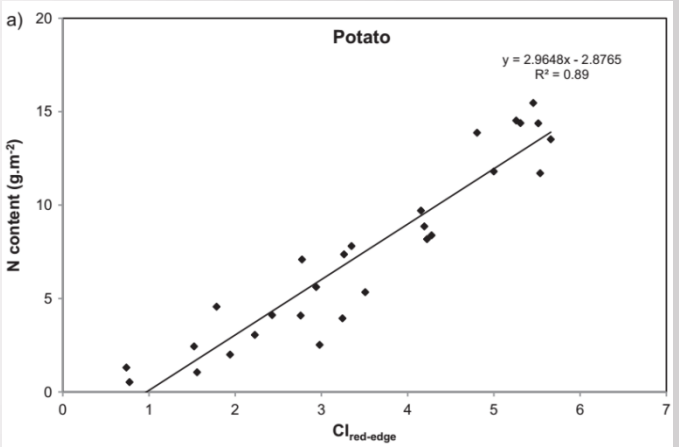
BIOPHYSICAL PARAMETERS

Chl and N estimation



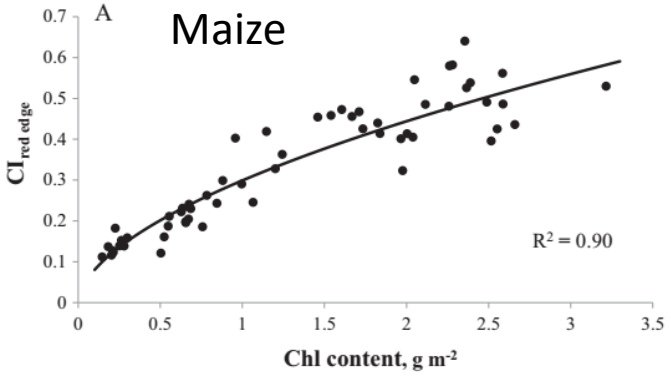


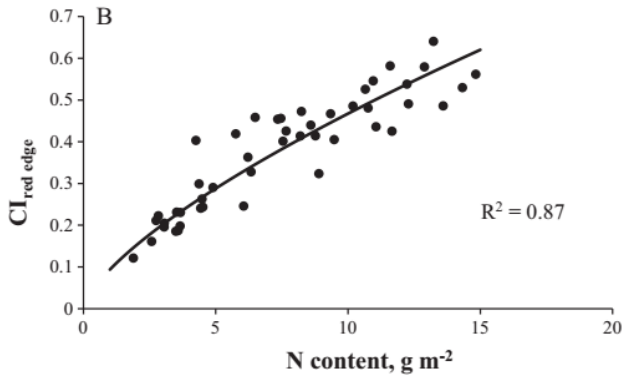
Clevers and Gitelson, 2013



Cl(green) and Cl(red-edge) VIs are estimators of the N/Chl status (Schlemmer et al., 2013)

Schlemmer et al., 2013





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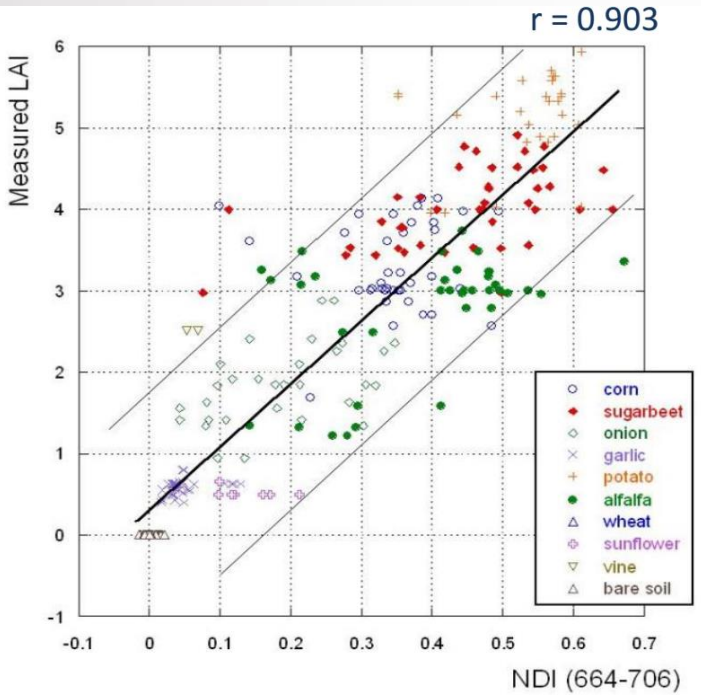
BIOPHYSICAL PARAMETERS

LAI estimation - crop specific or universal solution?

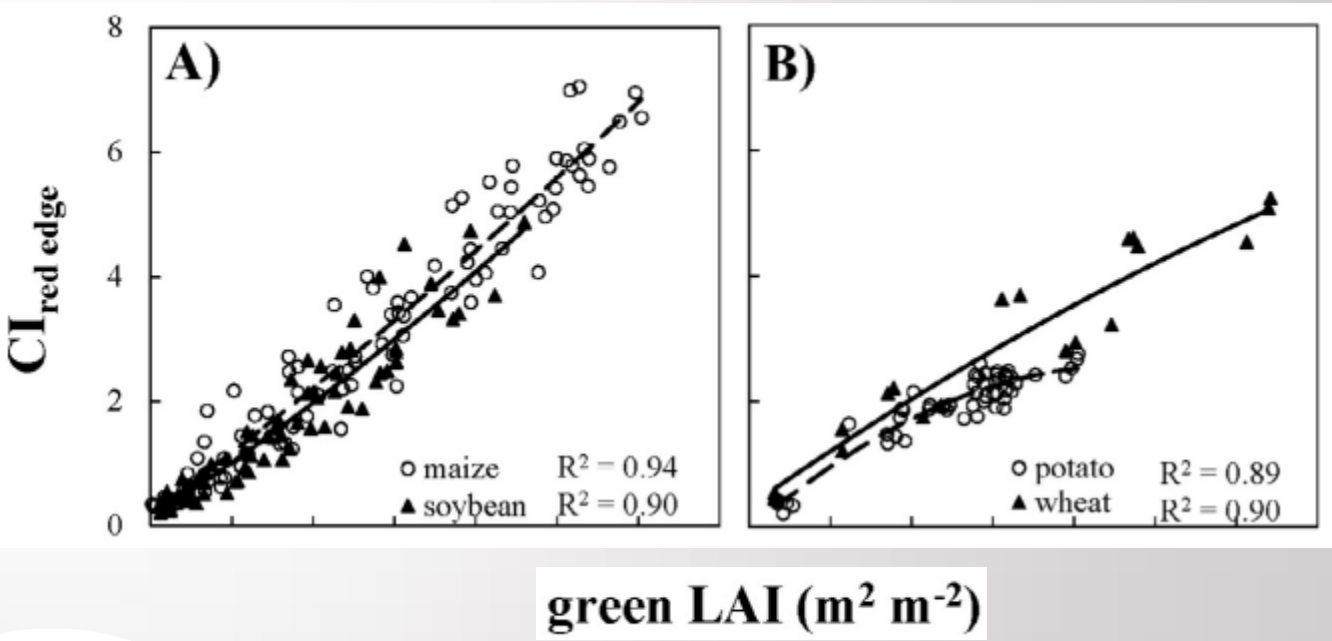
Delegido et al., 2011

With CHRIS bands 664 (**B4**) nm (red) and 706 (**B5**) nm (red-edge) we obtained:

$$LAI = 8.452\left(\frac{R_{706} - R_{664}}{R_{706} + R_{664}}\right)$$



Nguy-Robertson et al., 2014



Robust over a wide variety of crop types. **No saturation at higher LAI.**

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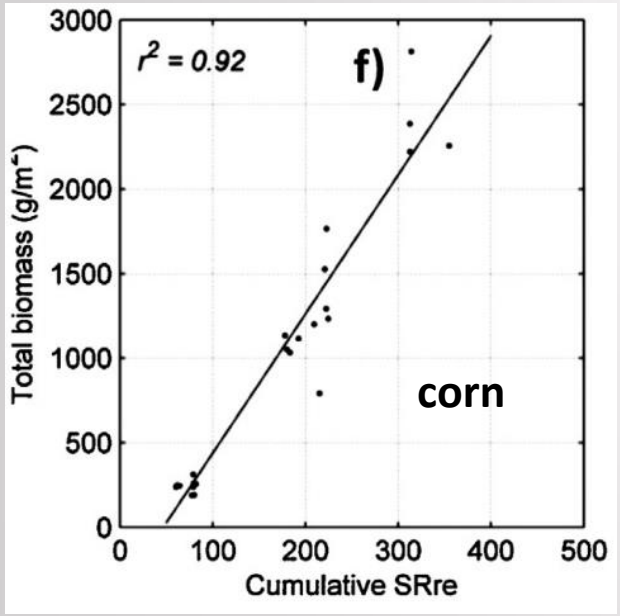
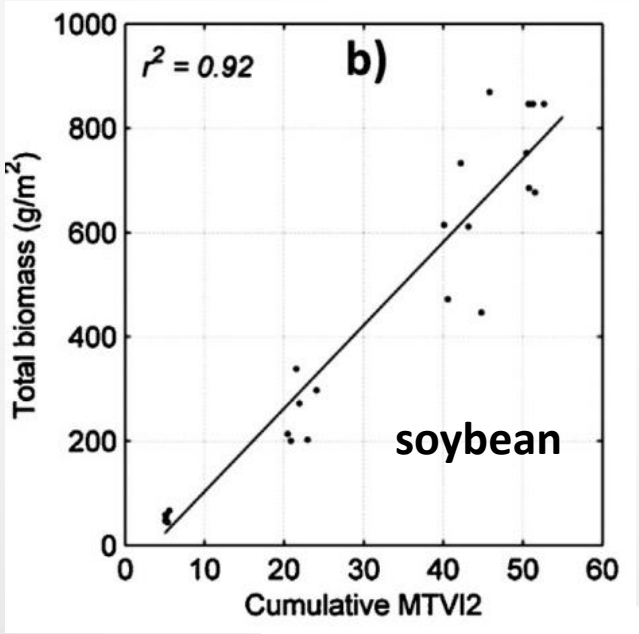
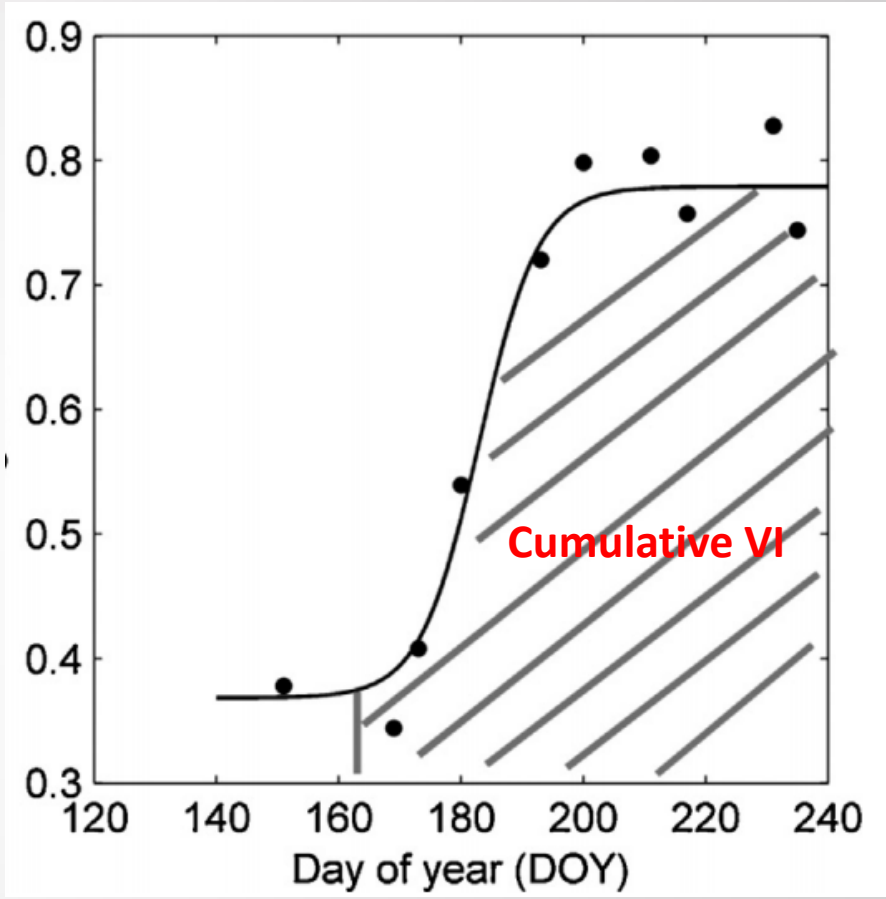
BIOPHYSICAL PARAMETERS

Biomass estimation

Cumulative VIs have been used as a proxy for absorbed photosynthetically active radiation which is proportional to total biomass (Kross et al., 2015)







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APOLLO PLATFORM

EXPERIMENTAL WORK

The idea: to study the behavior of S-2 data and derived VIs during crop development period of wheat and barley

Sentinel-2 data collection and pre-processing:

- Sentinel-2 L1C (TOA reflectance) data from 5 dates from January – June: 1-1-2016, 18-3-2016, 7-4-2016, 27-4-2016, 27-5-2016
- Level 2A (BOA reflectance) generated using sen2cor

Field data collection:

- 16 parcels (11 under wheat and 5 under barley)
- In situ data collection on 28-5-2016

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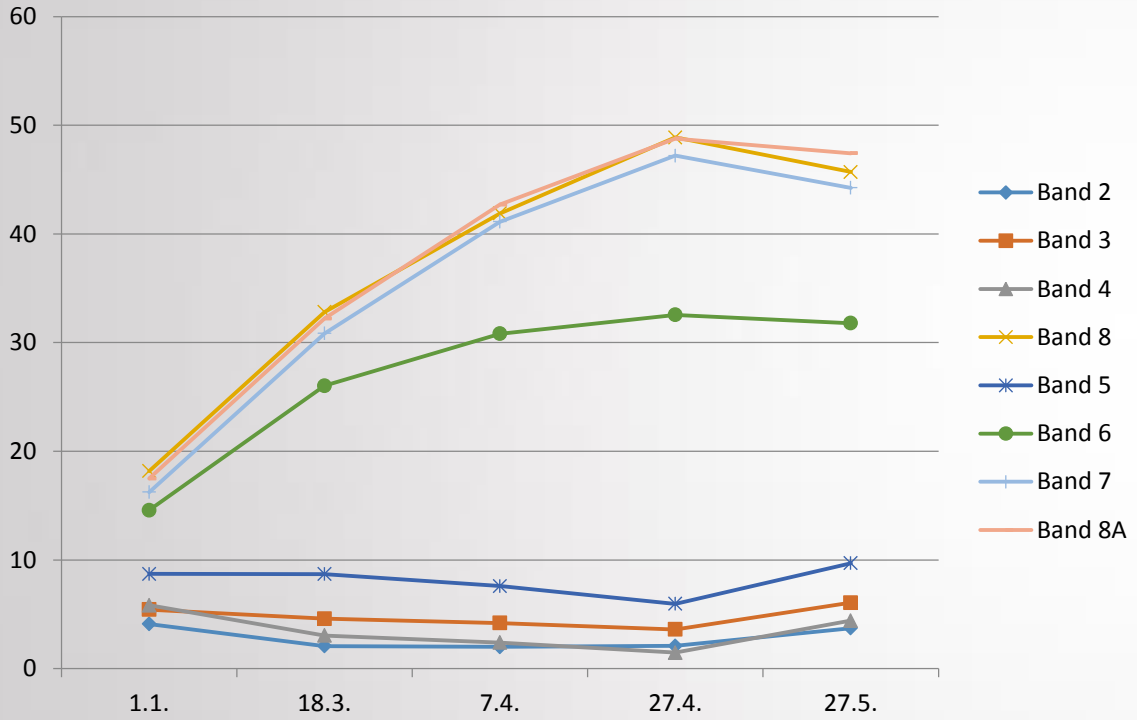
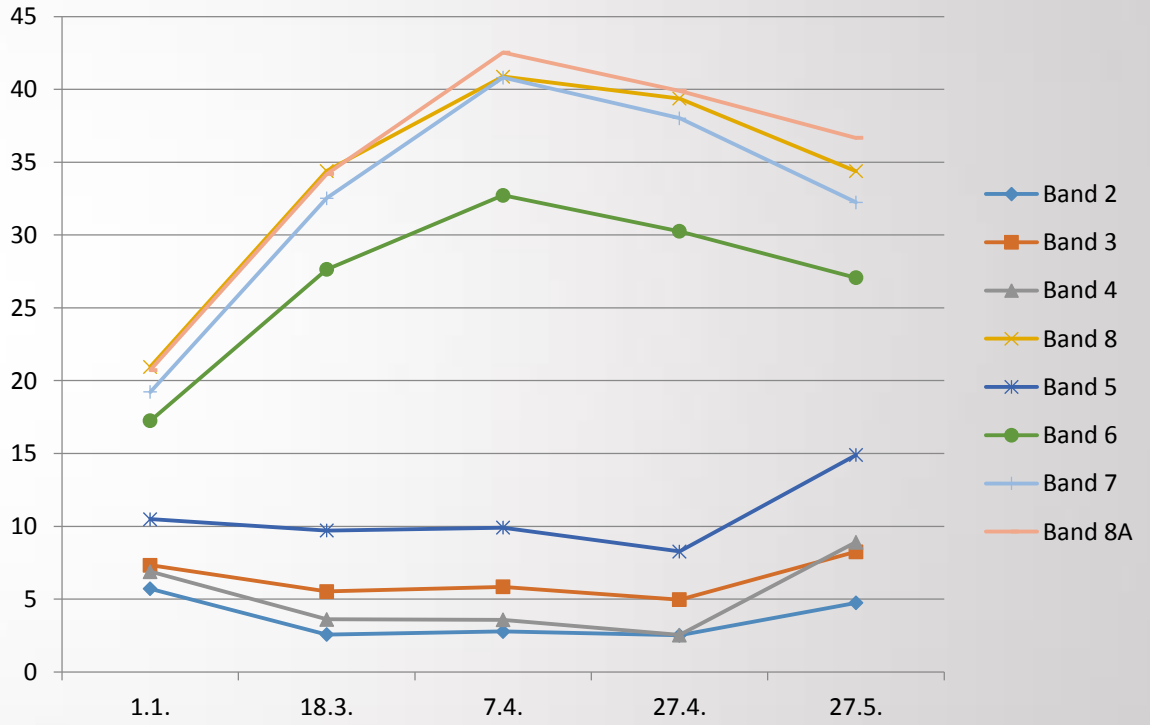
EXPERIMENTAL WORK

SPECTRAL SIGNATURES (TOA refl.)OF WHEAT AND BARLEY AT CANOPY LEVEL



WHEAT



BARLEY

Similar behavior until 7-4-2016

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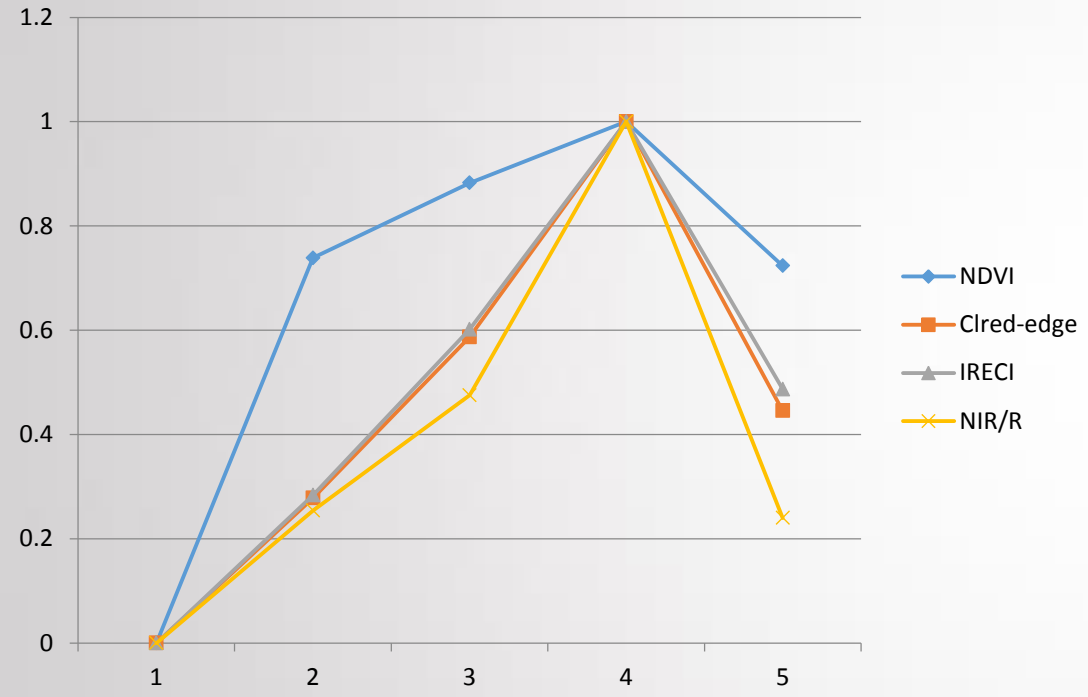
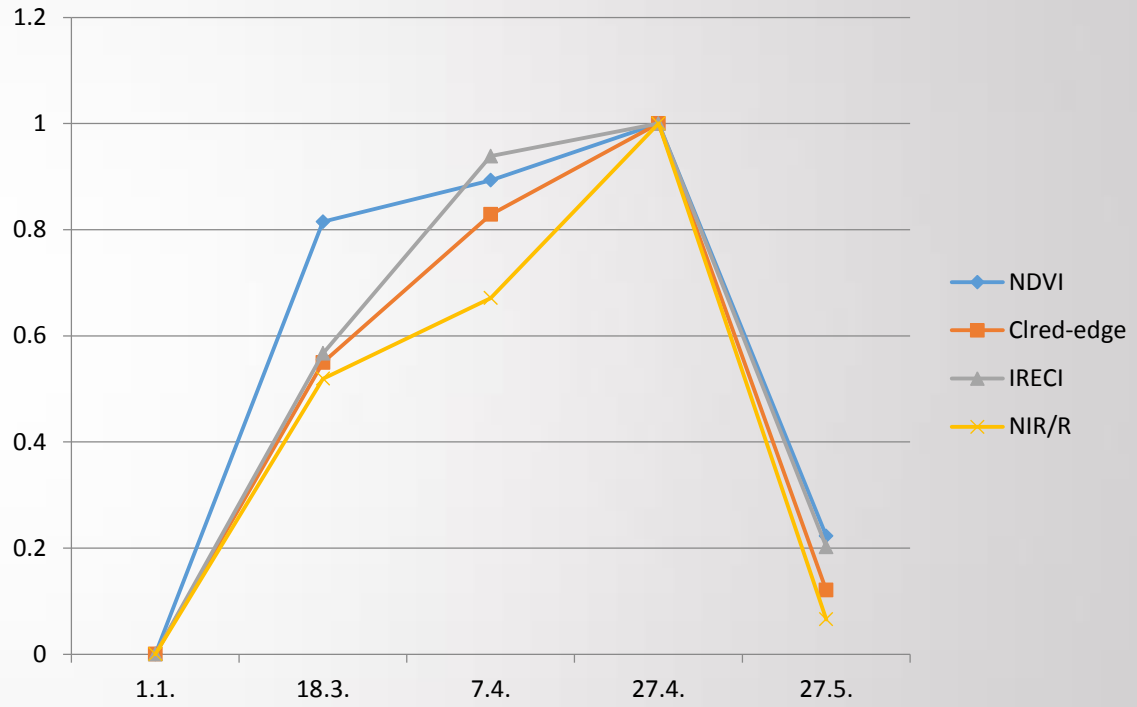
EXPERIMENTAL WORK

SENSITIVITY OF VI TO CROP CANOPY DEVELOPMENT



WHEAT



BARLEY

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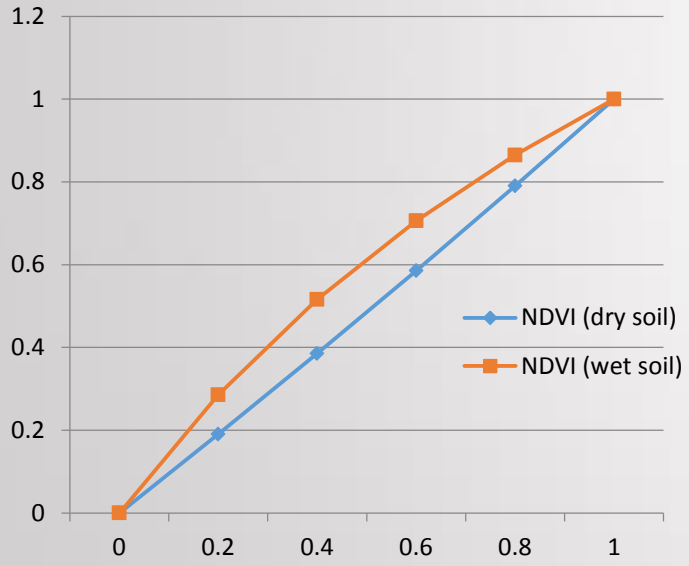
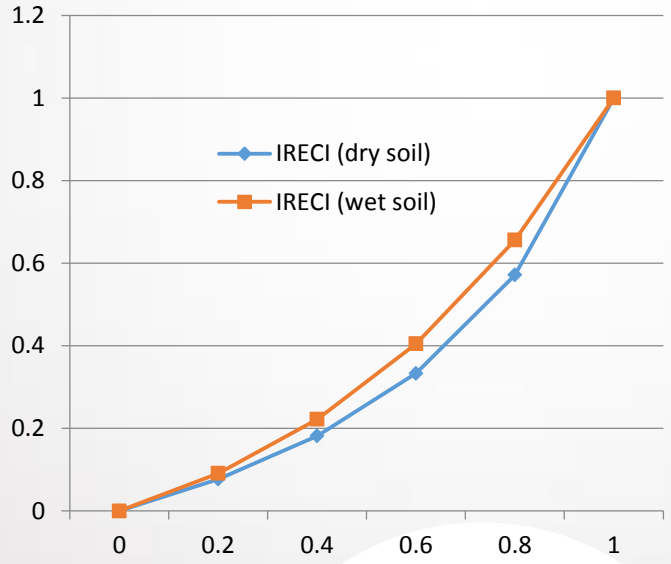
APOLLO PLATFORM

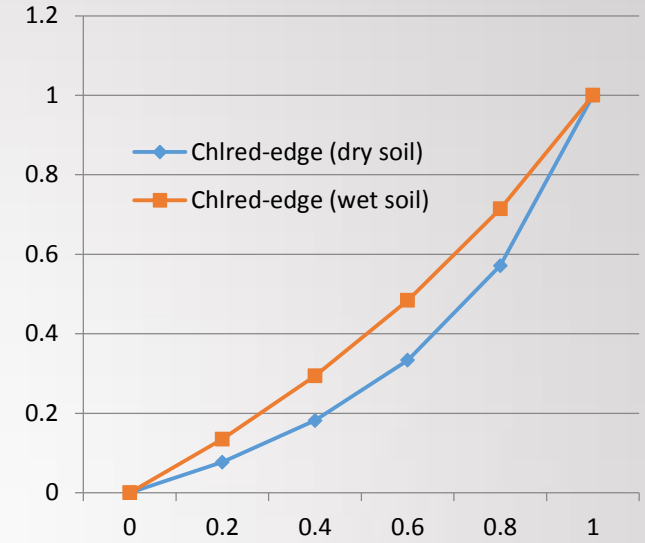
EXPERIMENTAL WORK

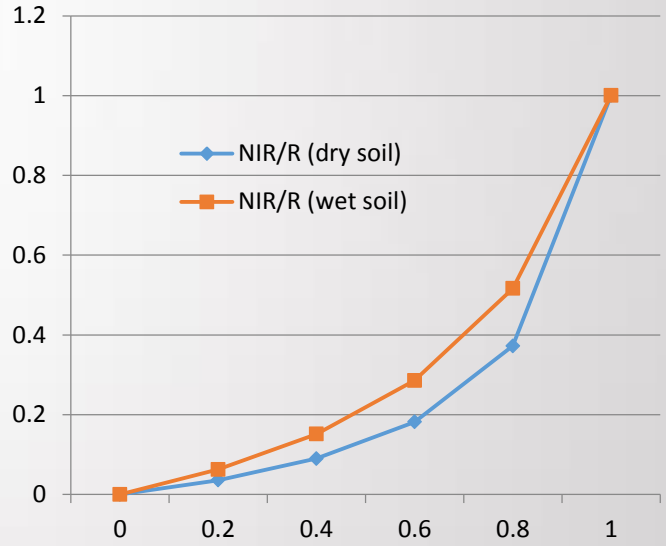
INFLUENCE OF SOIL BACKGROUND

Spectral mixture = soil reflectance x soil share +plant reflectance x canopy share









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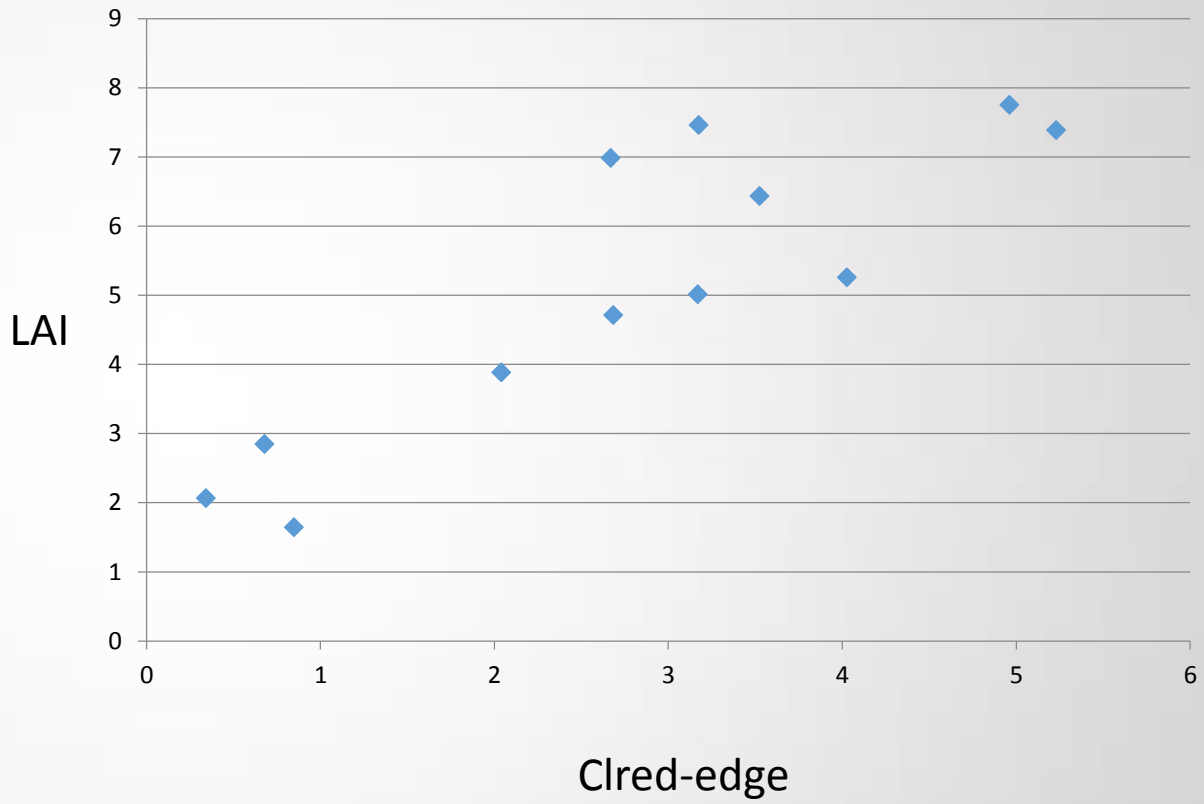
EXPERIMENTAL WORK

ESTIMATION OF LAI

LAI estimated on 12 sampling points (combined wheat and barley) on 28-29.5.2016.

Compared with IRECI and Clred-edge
Linear relationship with both VIs

The better performing VI was Clred-edge
R^2= 0.77 (for IRECI R^2= 0.68)



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CONCLUSIONS

- Models for operational generation of biophysical parameters from VIs should be crop specific
- Further testing of the models proposed by the literature with fine calibration by using significant amount of in situ data
- S-2 and in situ data noise minimization in calibration phase. Identification of S-2 data noise in operational phase
- High quality in situ data is essential – the biggest challenge. The requirement: LAI and biomass measured, Chl and N can be estimated from physical models (PROSAIL)

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