



# Calibration and Evaluation of an UAV-based Multispectral Sensor to Winter Wheat Crop Characteristics

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## INTRODUCTION

UAV-based (unmanned aerial vehicle) multispectral-cameras have the potential to provide crop data, such as the green area index (GAI), with a spatial and temporal high resolution. However, first of all substantial efforts are needed to calibrate the UAV-based multispectral data with already established methods.

## MATERIAL & METHODS

**Data acquisition** 2016/17 & 2017/18 on winter wheat trials (variation in cultivar, N-fertilization & sowing density):

- Reference: Scan (LI-3100, LiCor®) of the green area of leaf, shoot & spike
- Spectral: UAV-based Sequoia-camera (Parrot™), wavelengths: Green, Red, Red Edge (RE) & Near Infrared (NIR)

**Calibration** via different approaches:

- Established vegetation indices:

$$GAI_{NDVI} = a + \exp(b \cdot NDVI)$$

$$GAI_{NIR/RE} = a + b \cdot NIR/RE$$

- New vegetation index (VIQUO):

$$GAI_{VIQUO} = a + b \cdot NIR/Green + b \cdot NIR/Red + c \cdot NIR/RE$$

- The best tested advance predictive model: Support vector machine with linear kernel (SVM)

**Evaluation** of the models:

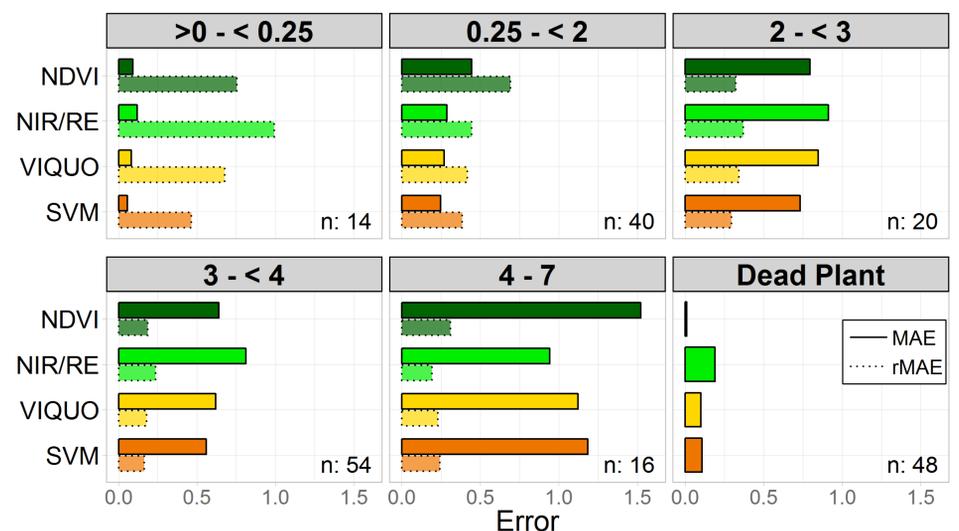
- Mean absolute error (MAE) in calibration and evaluation (Tab. 1) & MAE and relative MAE (rMAE) in different GAI classes (Fig. 1)
- Correlating green area duration through the whole season 2017/18 with the final dry matter (GAI curves: multispectral data from 14 flights, linearly interpolated) (Fig. 2)

## CONCLUSION

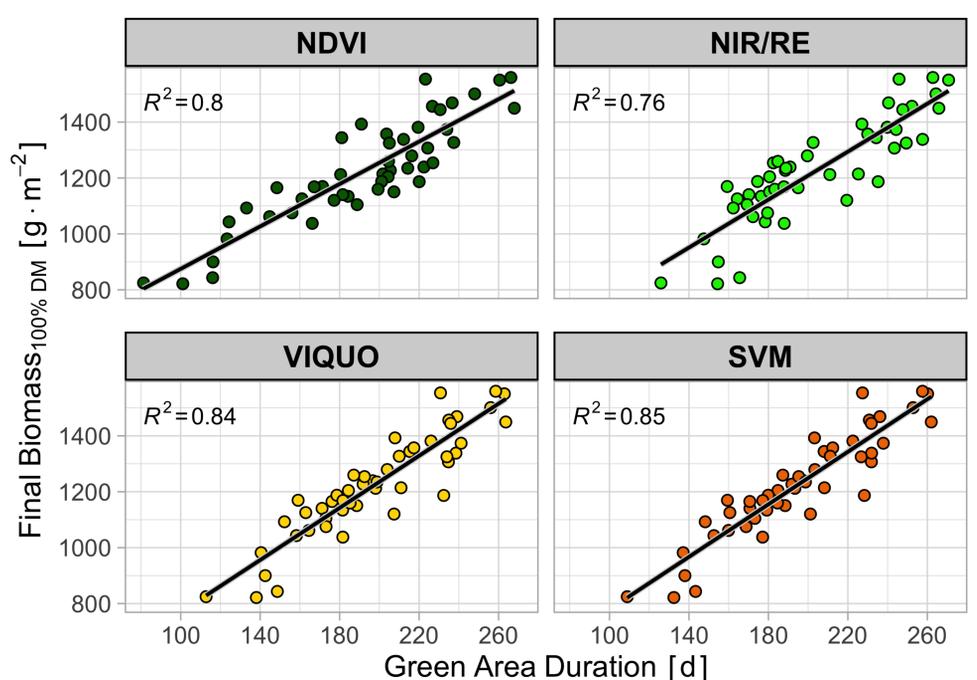
UAV-based multispectral data allows a reliable GAI-monitoring. The more sophisticated support vector machine provides a better GAI-prediction than the traditional vegetation indices, but the newly developed vegetation index VIQUO comes very close to its quality, with the advantages of easy calculation and communication.

**Table 1:** Mean absolute error (MAE [ $m^2 m^{-2}$ ]) as measurement of model performance for the prediction of GAI [ $m^2 m^{-2}$ ] in calibration and evaluation.

Model	MAE <sub>calibration</sub>	MAE <sub>evaluation</sub>
NDVI	0.42	0.49
NIR/RE	0.44	0.52
VIQUO	0.35	0.44
SVM	0.35	0.42



**Figure 1:** Mean absolute error (MAE [ $m^2 m^{-2}$ ]) & relative MAE (rMAE [-]) of the models for the evaluation dataset in different GAI classes (n: sample size).



**Figure 2:** Correlation between the calculated Green Area Duration through the whole season 2017/18 and the final dry matter on one of the sampled trials.

