Comparing remote and proximal platforms for crop N sensing in winter wheat

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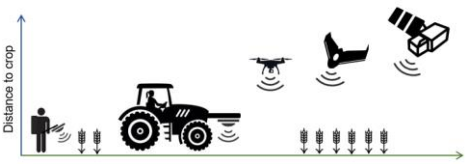
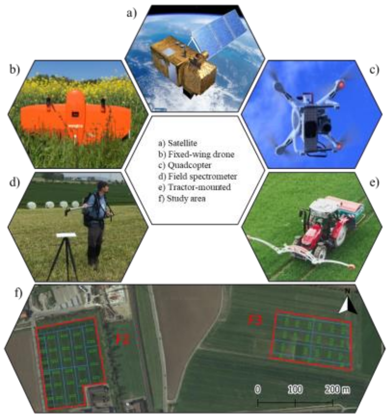
Background

- Proximal and remote sensing information on crop N status is valuable for improving N use efficiency at different scales [1].
- The choice of the optical sensor platform is often dictated by availability, costs and project-specific objectives.
- To support the decision, it is relevant to know how the sensor information from optical platforms is comparable e.g. for variable rate N application.

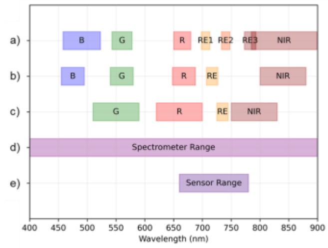


Methods and study area

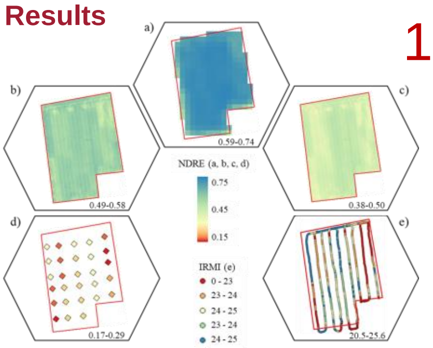
- Comparison of five different optical sensor platforms used in a practical case study.
- Indicator for crop N-status: correlation between measured N_{up} in the crop and predicted from spectral data.
- The data were collected in NE Switzerland in 2019 in two fields cropped with winter wheat at two growing stages.



	Platform	Optical sensor	Distance to crop	Spatial resolution	Spectral properties
a)	**Sentinel-2 satellite**	Multispectral Instrument	786 km	10–60 m/px	13 bands 443–2190 nm
b)	**WingtraOne fixed-wing UAV**	MicaSense, RedEdge	70–120 m	5–10 cm/px	5 bands 475–840 nm
c)	**DJI Phantom 4 quadcopter UAV**	Parrot, Sequoia	50–100 m	5-10 cm/px	4 bands 550–790 nm
d)	**Hand-held from operator**	ASD FieldSpec4®	0.5–1 m	~cm	Multiple bands 350–2500 nm
e)	**Tractor**	Isaria®, Fritzmeier	0.5–1 m	~cm	Multiple bands 660–780 nm



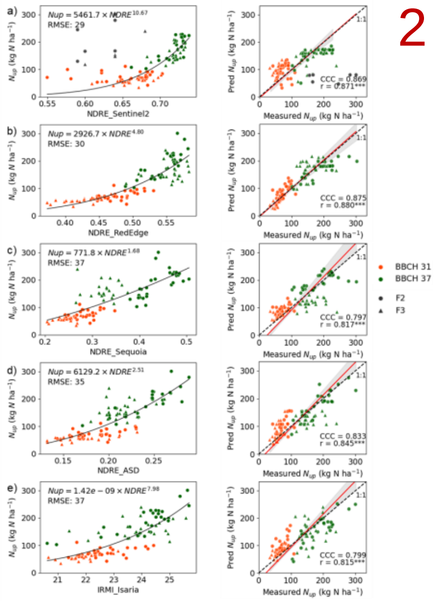
Results

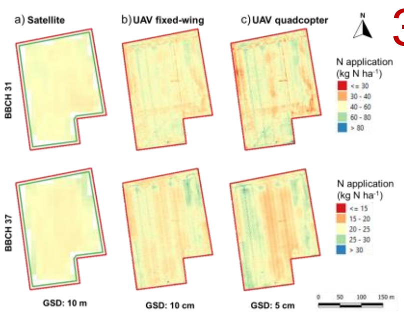


	NDRE				IRMI
	Sentinel-2	**MicaSense**	**Sequoia**	**ASD**	**Isaria**
Min	0.59	0.49	0.38	0.17	20.53
Max	0.74	0.58	0.50	0.29	25.63
Med	0.72	0.56	0.43	0.25	24.37
CV (%)	6.59	4.32	7.96	11.85	4.86

1. Normalized Difference Red-Edge (NDRE) index and Isaria Reflectance Measurement Index (IRMI) maps of a field at BBCH 37 (15-05-2019) for the five different spectral devices and the respective ranges of variation.

2. Power regression of N_{up} on the spectral indices NDRE and IRMI (n = 104) (left panels). Passing-Bablok regression between measured and predicted N_{up} (right panels).





		N application (kg N ha-1)		
		Sentinel-2	**MicaSense**	**Sequoia**
BBCH 31	**Min**	56	35	20
	Max	65	122	123
	Med	60	60	60
	CV (%)	3	10	14
BBCH 37	**Min**	24	17	18
	Max	27	47	43
	Med	25	25	25
	CV (%)	3	8	9

3. N map calculated from NDRE for three sensors [2]. The two rows report two different split applications at BBCH 31 (ref. value 60 kg N ha^{-1}) and at BBCH 37 (ref. value 25 kg N ha^{-1}) and the respective ranges.

Highlights

1. **Spectral information** among five different optical sensor platforms **is comparable**, despite different properties (e.g. type, spatial and radiometric resolution and distance to crop).
2. **For all optical sensors** the **correlation** (CCC and r) between measured and predicted N_{up} was in the **range 0.80 – 0.88**. The **RMSE** for the power regression **ranged from 29 to 37 kg N ha^{-1}**.
3. **The resulting N-status map** had a wider range of distribution of N application (kg N ha^{-1}) for the two UAV platforms compared to the satellite platform, in this case study.

References
[1] Gnyp, M., Panitzki, M., Reusch, S., Bareth, G., 2016. Comparison between tractor-based and UAV-based spectrometer measurements in winter wheat. 13th Int. Conf. Precis. Agric. 1–10.
[2] Argento, F., Anken, T., Abt, F., Vogelsanger, E., Walter, A., Liebisch, F., 2020. Sitespecific nitrogen management in winter wheat supported by low-altitude remote sensing and soil data. Precis. Agric.