

Grain Yield Prediction and Plant Height Measurement using UAV Imagery



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Video



Why UAVs?

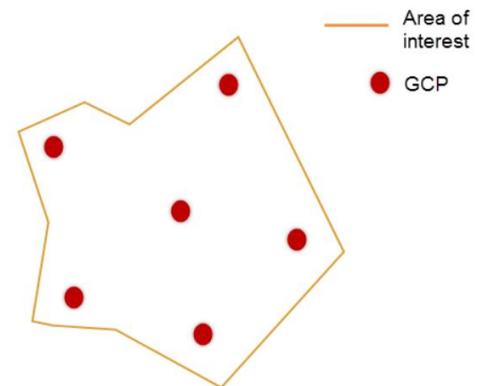


- Traditional phenotyping: time consuming, labor intensive, costly and low throughput, UAV imagery caught interest in this field.
- UAV images have shown a promising capability to predict Grain yield as an important trait in plant phenotyping.

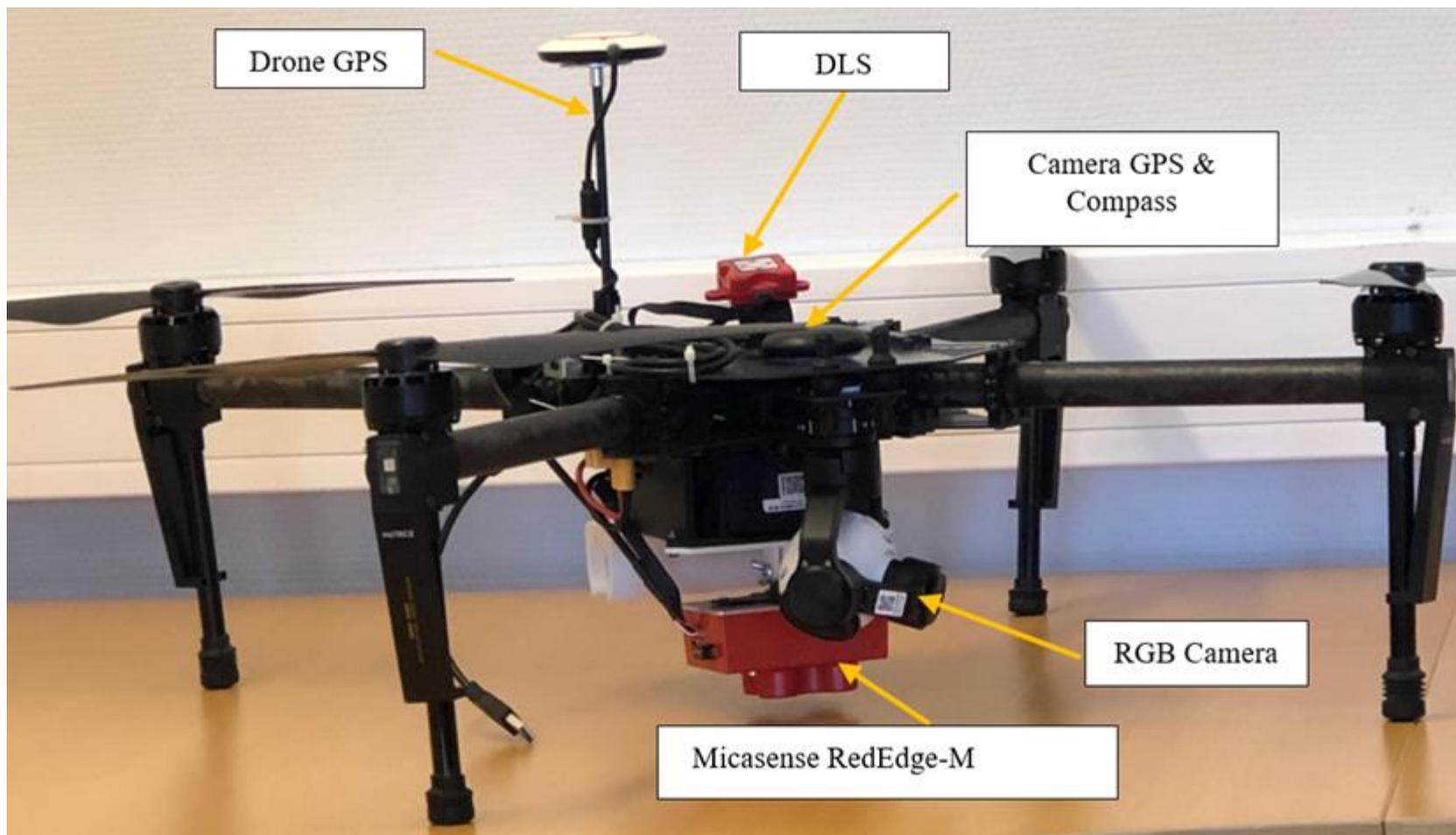
How to Start a Project:

Before Starting a Project

A minimum number of 5 GCPs per project.



Drone and Camera:



Field location and Making Routes in Altizure App:

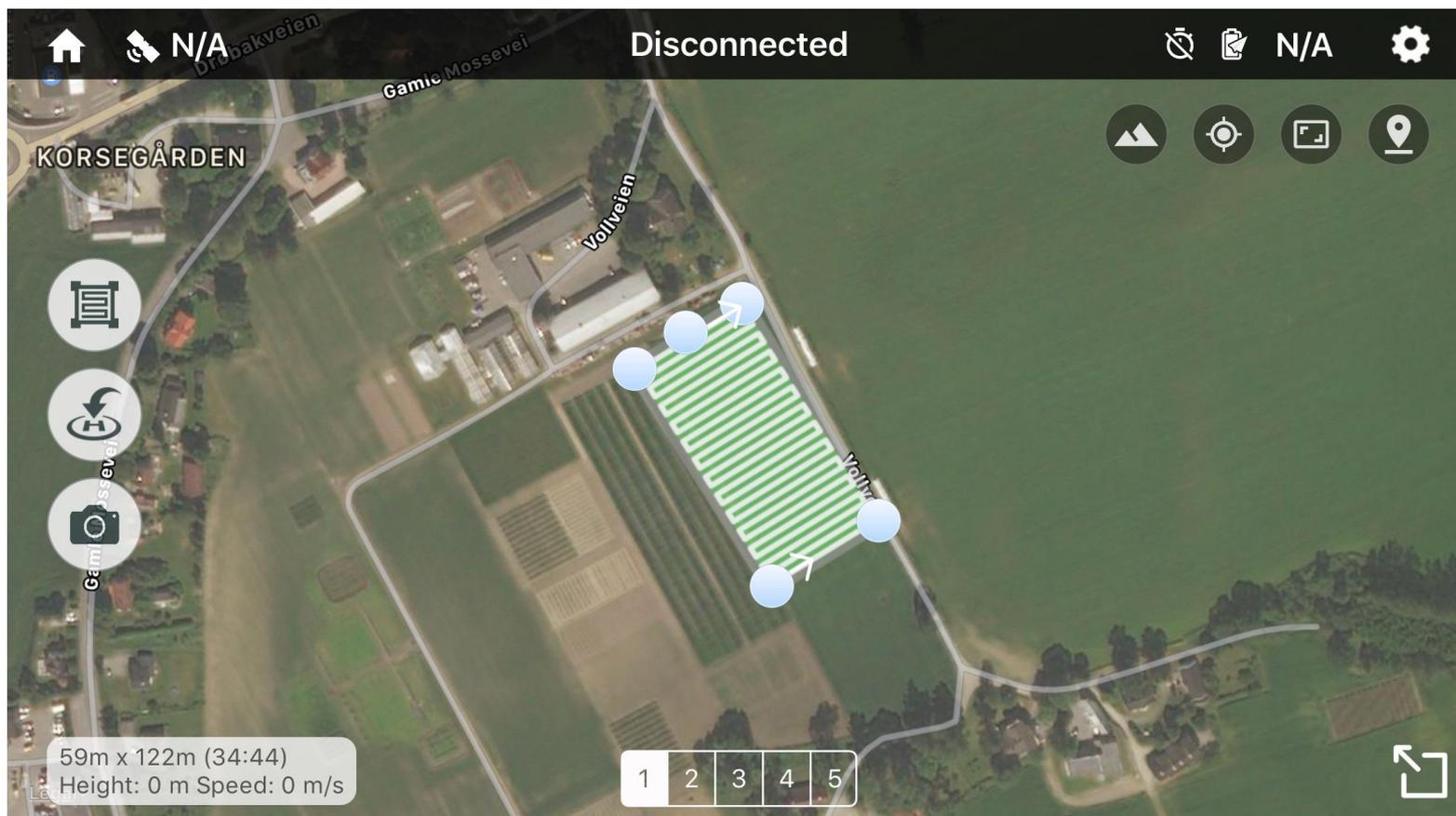
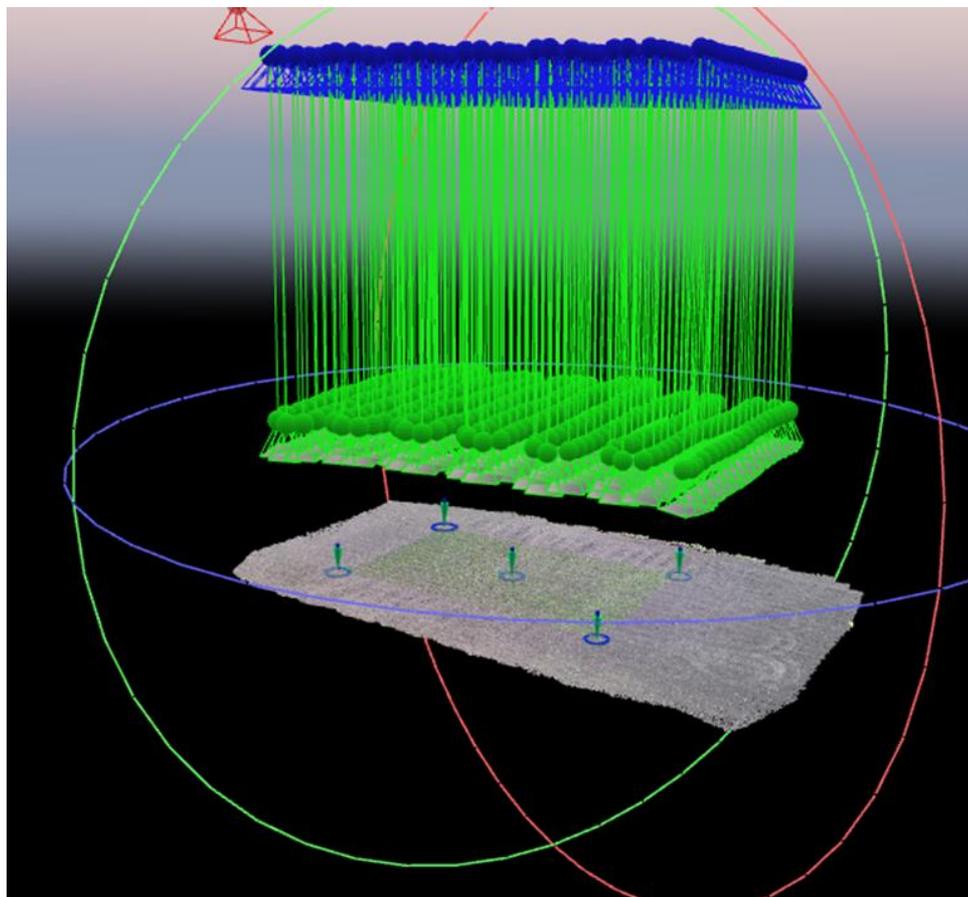
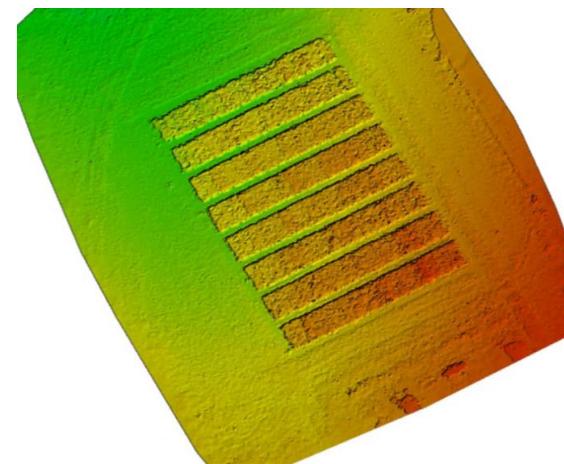
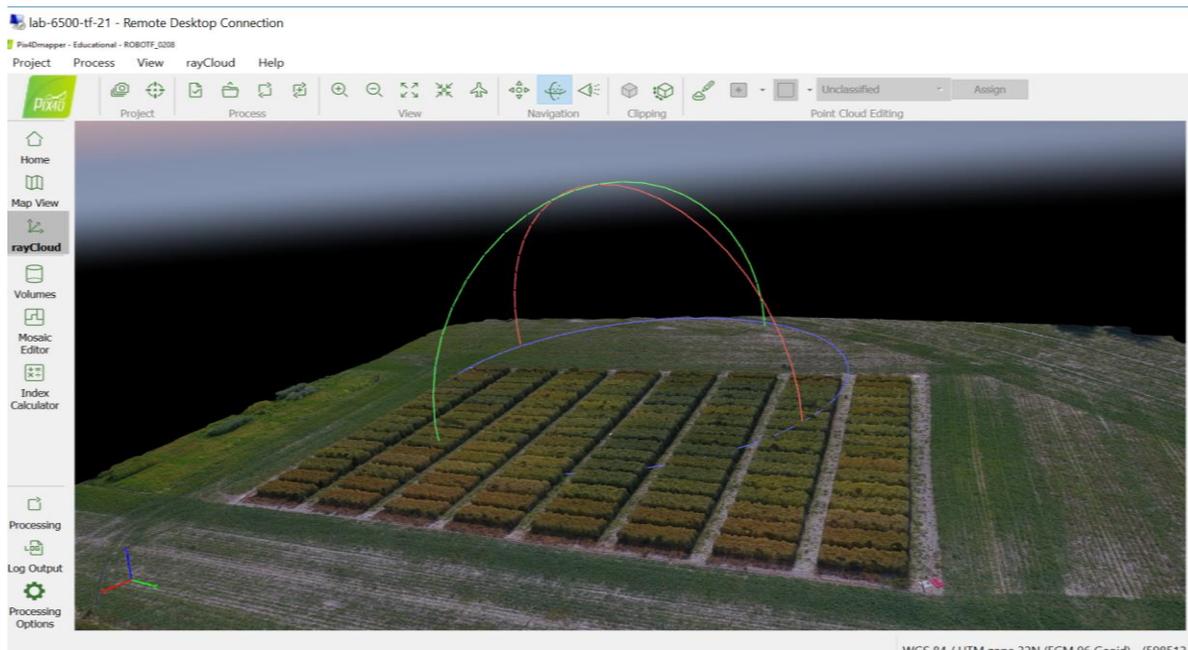


Image Analysis in Pix4D:



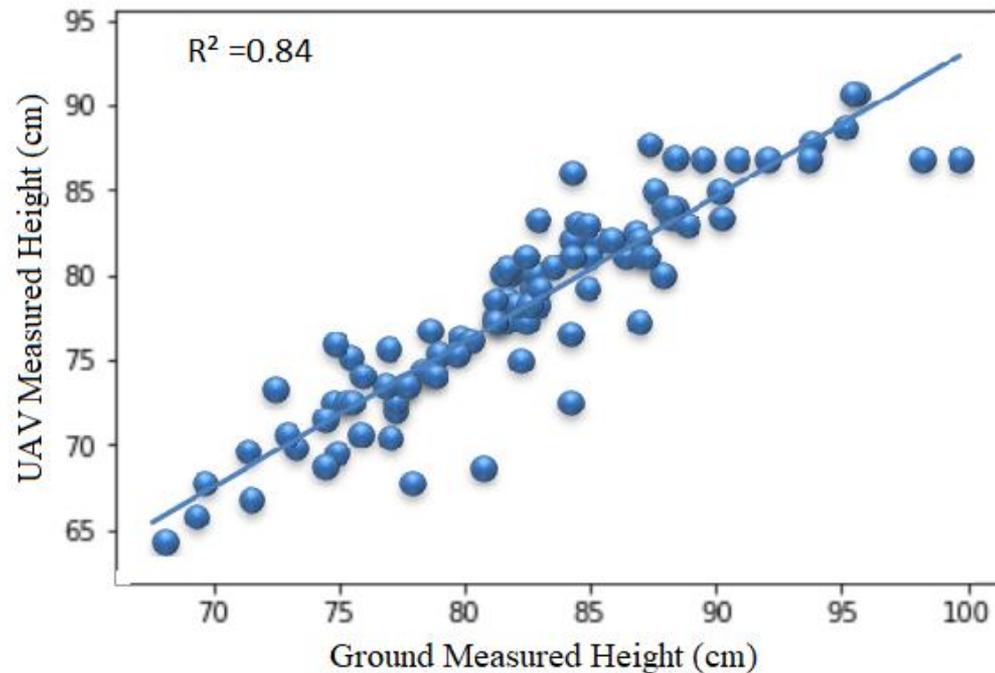
3D Model in Pix4D



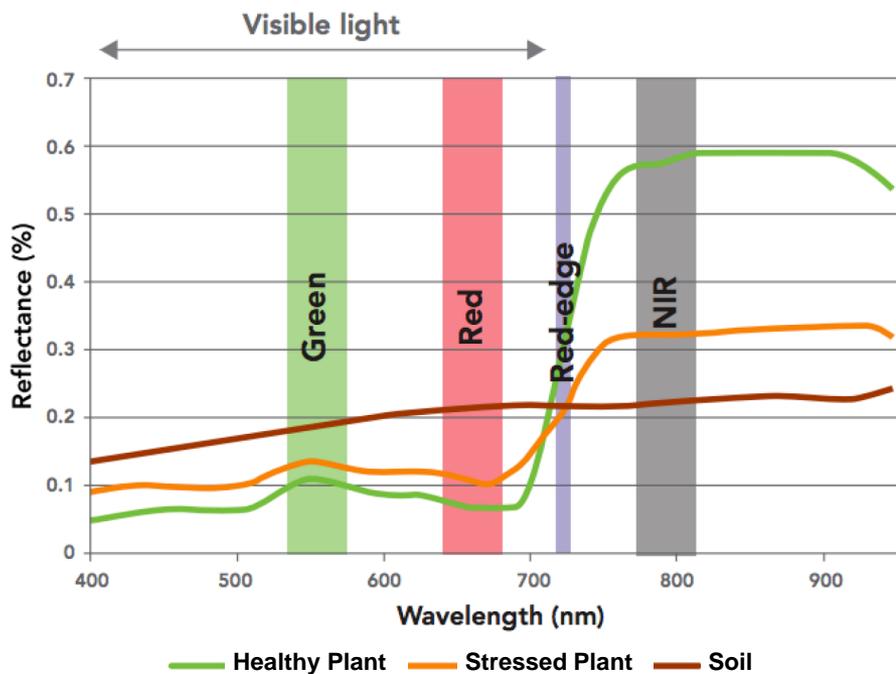
DSM

Plant Height estimation

- ✓ Generating of Digital Surface Model(DSM)
- ✓ Generating Digital Terrian Model (DTM)
- ✓ Plant Height = DSM-DTM



Vegetation indices



- Normalized Difference Vegetation Index (NDVI):

$$NDVI = \frac{NIR - Red}{NIR + Red}$$

- MERIS Terrestrial Chlorophyll Index (MTCI):

$$MTCI = \frac{NIR - Rededge}{Rededge - Red}$$



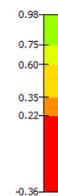
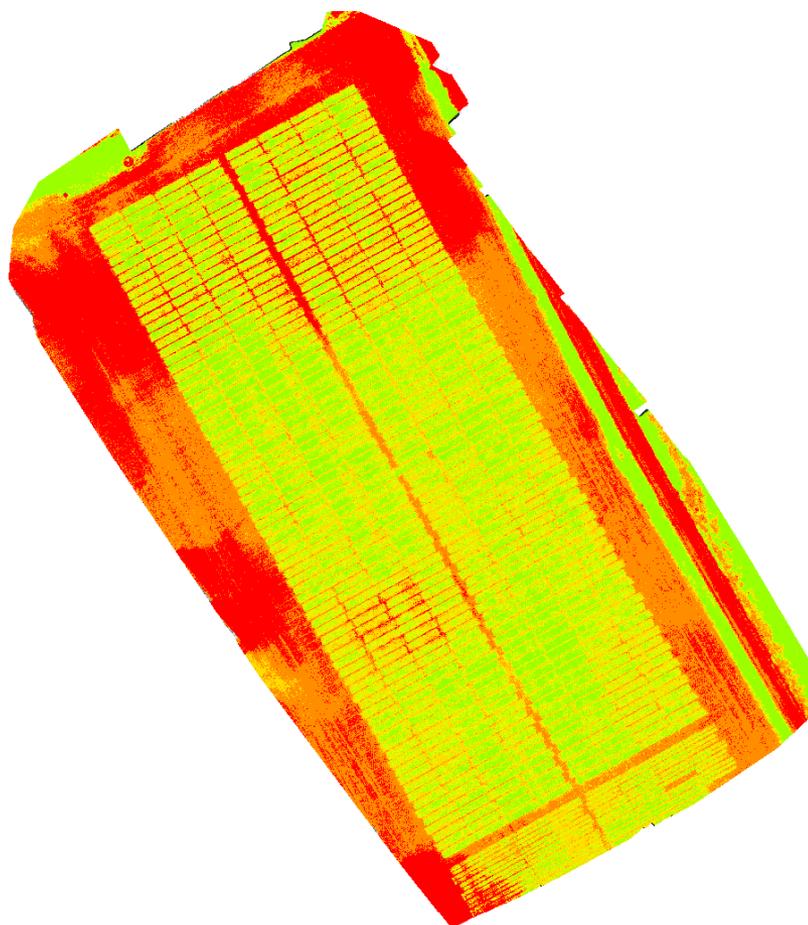
Micasense.com

- Enhanced vegetation index - EVI

$$EVI = 2.5 (NIR - RED) / (NIR + 6 RED - 7.5 BLUE + 1)$$

Indices Maps

NDVI



Index Calculator

▼ 1. Reflectance Map

Generate

Band	nm	Min	Avg	Max	St
blue	475	0.01	0.07	0.41	
green	560	0.01	0.17	1.77	
red	668	0.01	0.16	4.42	
nir	840	0.08	0.42	1.77	
red_edge	717	0.03	0.23	0.91	

▼ 2. Regions

Whole Ma Draw Clear Regions...

▼ 3. Index Map

Name Formula

ndvi = (nir - red) / (nir + red)

Edit... Indices... Generate

Band	Min	Avg	Max	Stde
band1	-0.72	0.47	0.98	0.2

▼ 4. Color Maps and Prescription

Number of Classes 5 Equal Area

Min/Max -0.36 - 0.98 Clamped

Color	Min	Max	Area [ha]
Green	0.75	0.98	0.20
Yellow-Green	0.60	0.75	0.20
Yellow	0.35	0.60	0.20
Orange	0.22	0.35	0.20
Red	-0.36	0.22	0.20

RdYlGn Invert

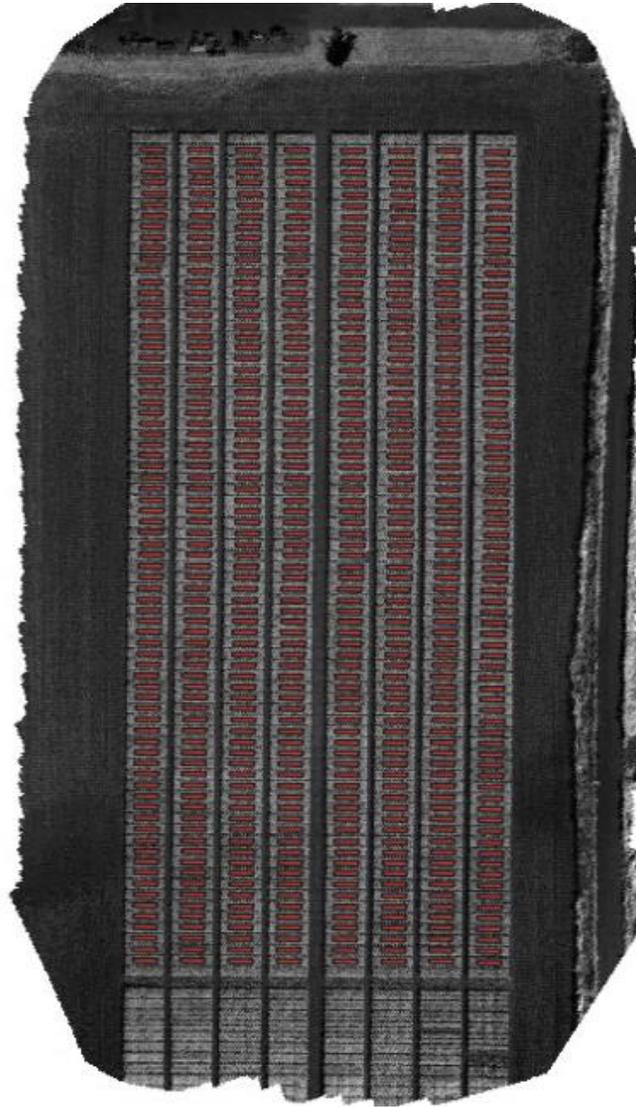
▼ 5. Export

Index Values and Rates as Polygon Shapefiles (SHP) with Grid Size

Colored Index Map (GeoTIFF) and GeoJPG (JPG):

Upload Reflectance Map to MicaSense Atlas:

Plot Extraction in QGIS



Results

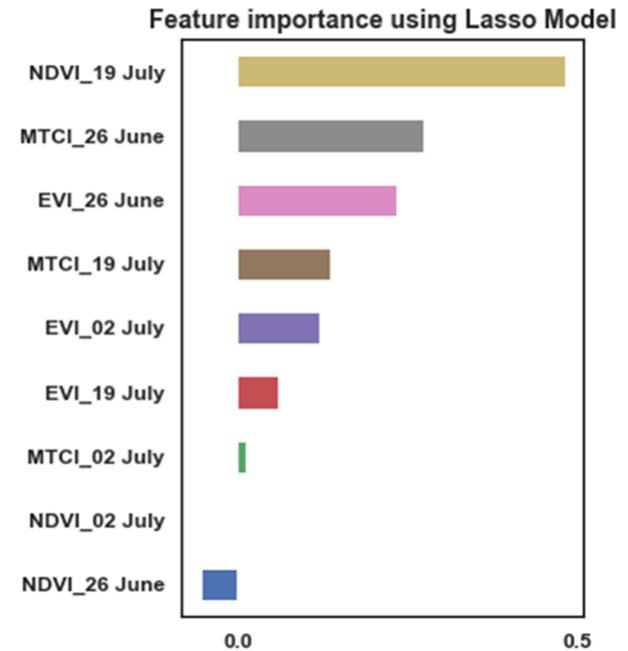


Pearson correlation between traits (DM: days to maturity)

Results

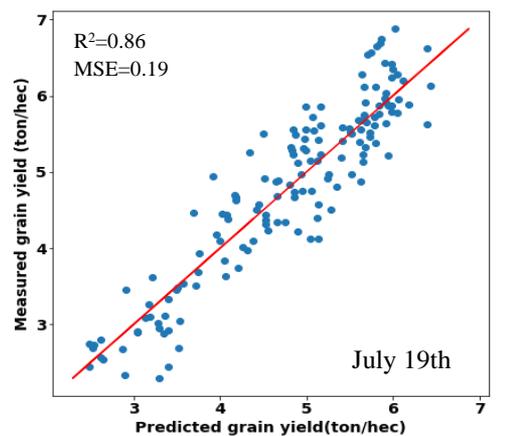
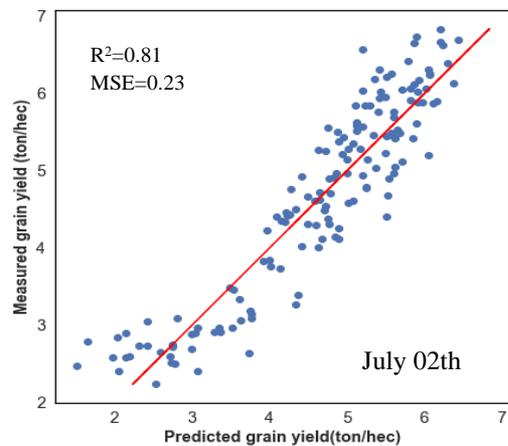
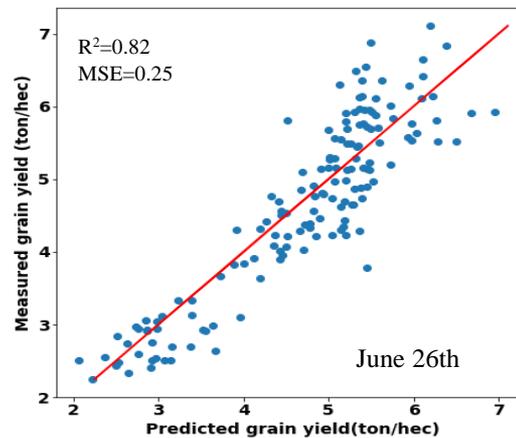
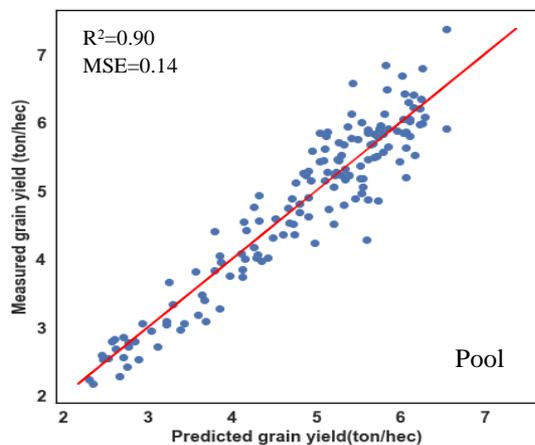


Date	Selected indices	Importance
26.06.2018 (47 days after sowing)	NDVI	0.54
	MTCI	0.5
	EVI	0.14
02.07.2018 (54 days after sowing)	NDVI	0.71
	MTCI	0.42
	EVI	0.008
19.07.2018 (70 days after sowing)	NDVI	1
	MTCI	0.11

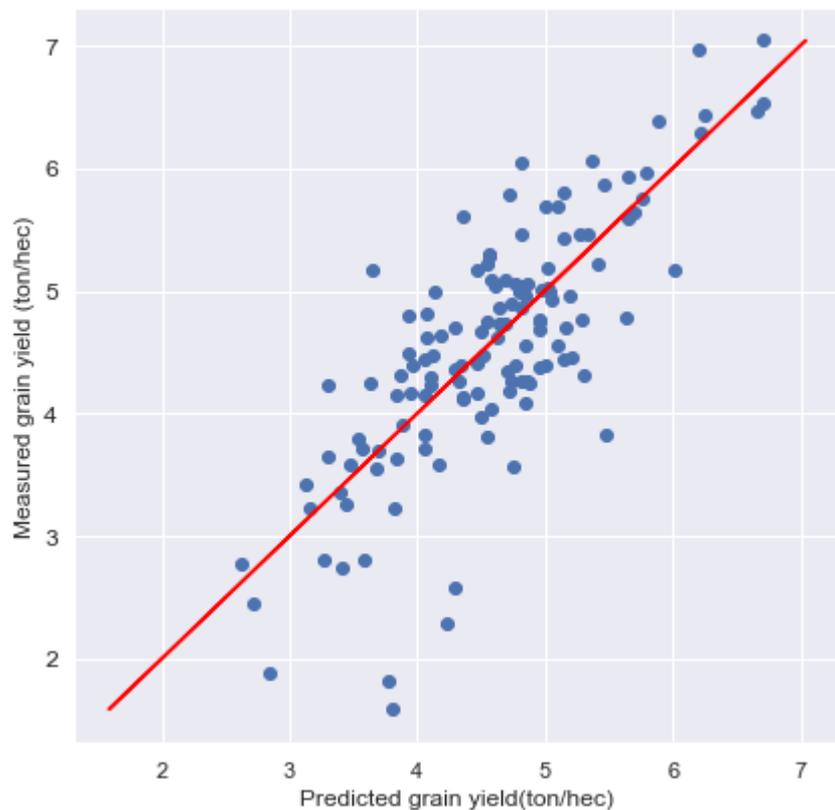


The feature importance of the pool data

Measured grain yield against predicted value

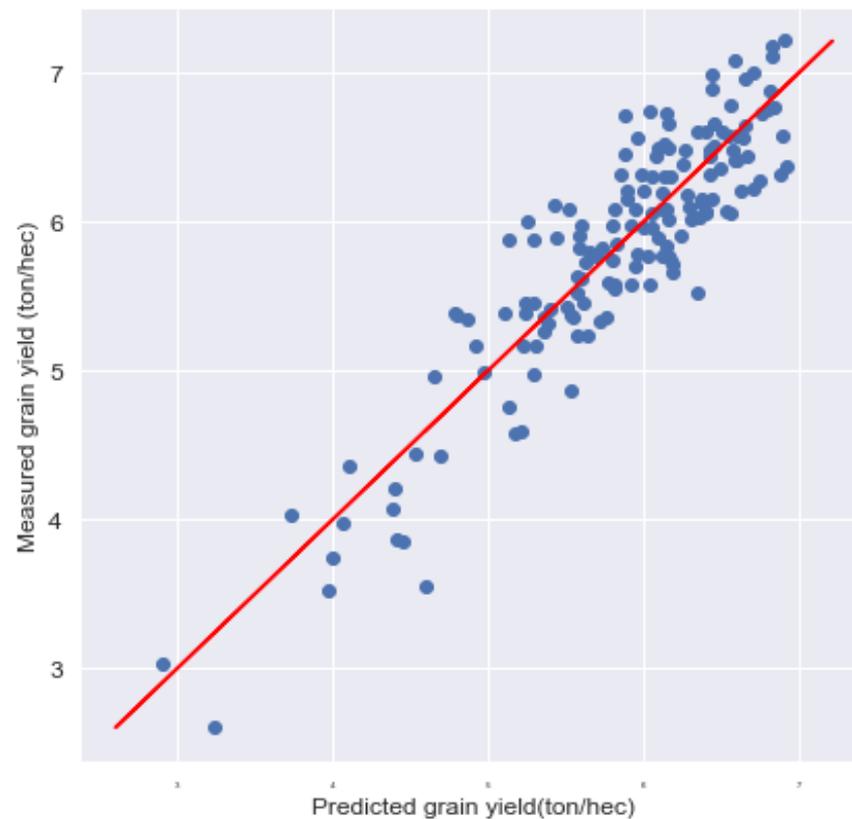


MABASIS 2018



R^2 train: 0.61, test: 0.62
 MSE train: 0.38, test: 0.38

MABASIS 2019



R^2 train: 0.81, test: 0.82
 MSE train: 0.13, test: 0.12