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Exploring the use of high resolution drone data in monitoring a strip cropping system

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Background

- Sensors on drones can provide high-resolution data on spatial and temporal variation in crop performance, without the time consuming and laborious and practices associated with field data sampling.
- Remote agronomy** can be defined as the use of remote sensing data to identify agronomically-interesting phenomena in the field.
- In the context of complex cropping systems such as stripcropping, the interest lies in recognizing desired inter-crop interactions and specific crop properties that facilitate these interactions.
- Thus, for complex cropping systems, it is valuable to **monitor fields at the system level**, rather than plant level. The use of remote agronomy to assist in this task has yet been little explored.



A vegetation map of the plots (left) was created by applying a Vegetation Index (VI). A VI highlights certain vegetation properties (e.g. greenness).

- Four vegetation properties** were extracted **per plot** :
1. Vegetation height (m)
 2. Vegetation cover (m²)
 3. Triangular Greenness Index (sensitive to chlorophyll)
 4. Yellowness Index (sensitive to chlorosis)

Objective

To explore the capacity of remote agronomy in assisting the management of complex cropping systems.

Case study: Vitalis stripcropping field in Voorst, the Netherlands.



Main research question:

How can high-resolution Red-Green-Blue (RGB) imagery assist in monitoring variability in vegetation properties and interactions in a strip cropping system at the inter-plot level?

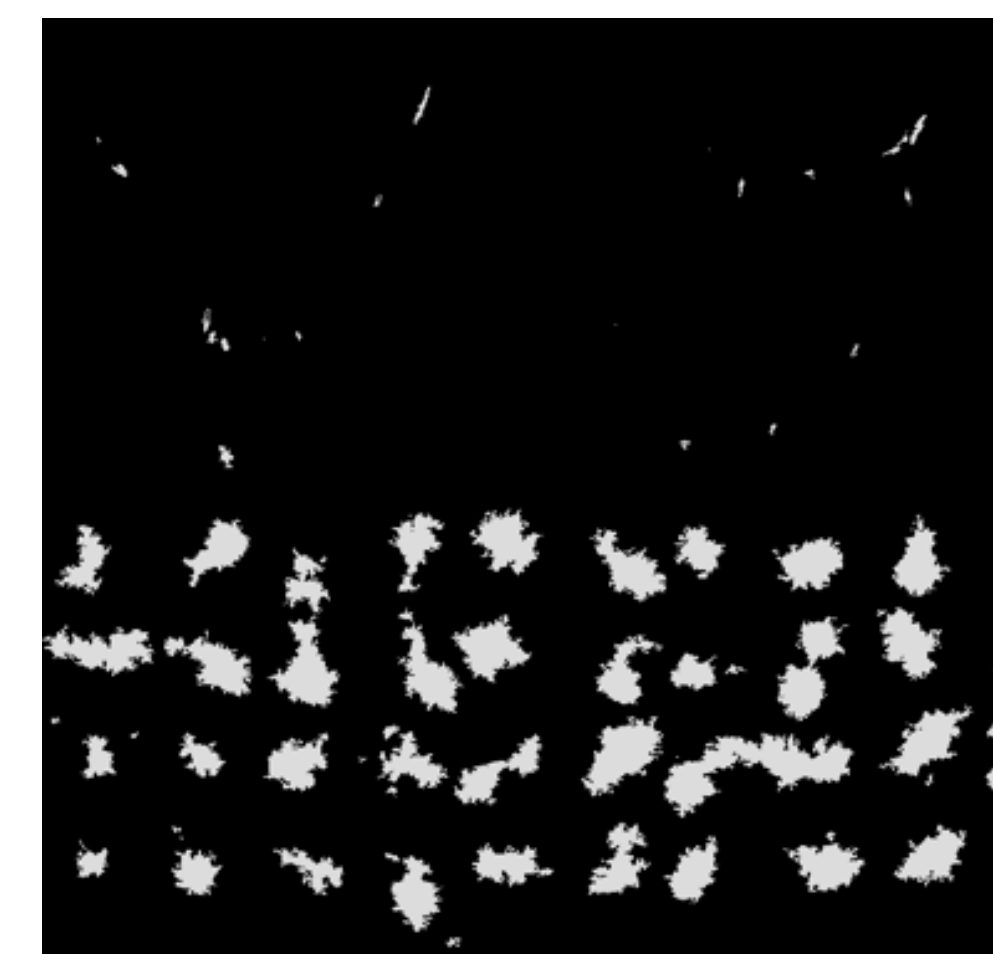
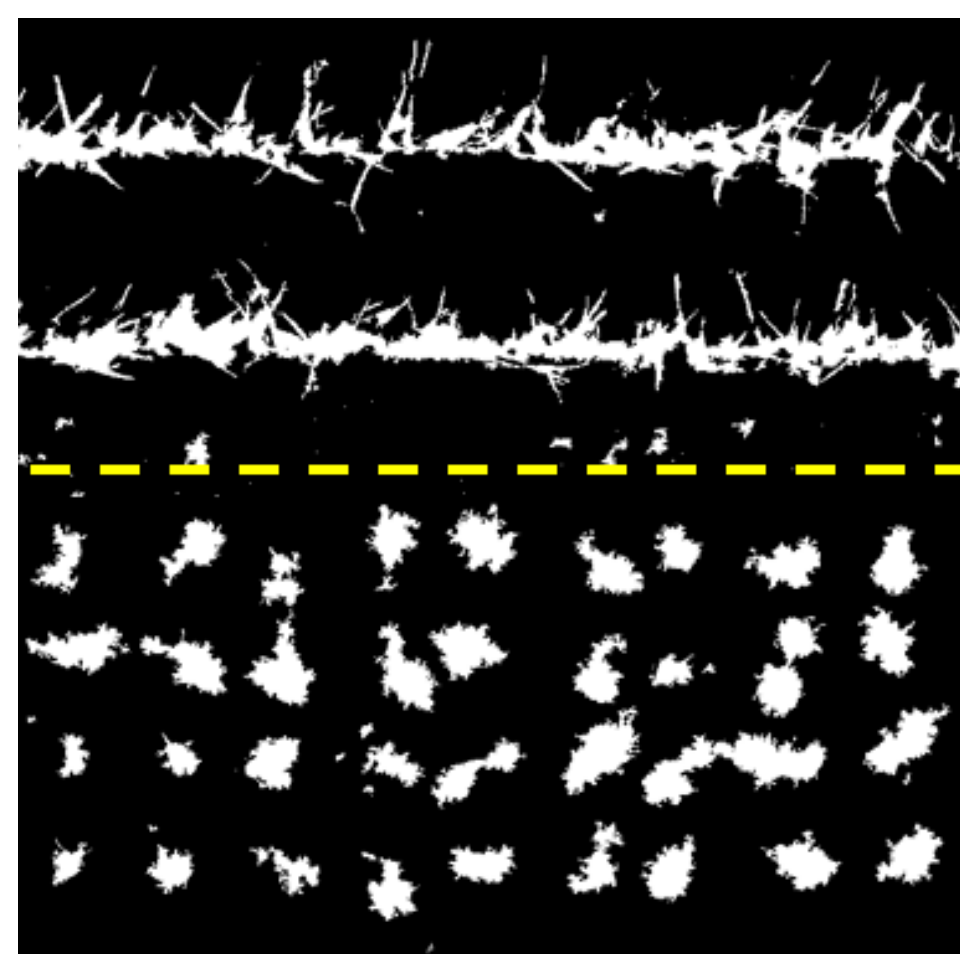
Methods

- 33 strips, with plots of 1.5m x 15.5m (experimental unit)
- Different cultivars of six crop species (pumpkin, cauliflower, fennel, lettuce, leek) were intercropped with each other and with grass-clover mixture

North											
Strip	Plot	1	2	3	4	5	6	7	8	9	
1	Front	Not rotated	2SEU4	Orange rotator	Not rotated	2SEU4	Orange rotator	Not rotated	2SEU4	Orange rotator	Back
2	Front	Aliso	Aliso	Aliso	Aliso	Aliso	Aliso	Aliso	Aliso	Aliso	Back
3	Front	2SEU4	Not rotated	Orange rotator	2SEU4	Orange rotator	2SEU4	Not rotated	Orange rotator	Not rotated	Back
4	Front	Not rotated	2SEU4	Orange rotator	Not rotated	2SEU4	Orange rotator	Not rotated	2SEU4	Orange rotator	Back
5	Front	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	Back
6	Front	Not rotated	2SEU4	Orange rotator	Not rotated	2SEU4	Orange rotator	Not rotated	2SEU4	Orange rotator	Back
7	Front	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	Back
8	Front	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	Back
9	Front	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	Back
10	Front	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	Back
11	Front	CF797	CF797	CF797	CF797	CF797	CF797	CF797	CF797	CF797	Back
12	Front	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	Back
13	Front	Orion	Orion	Orion	Orion	Orion	Orion	Orion	Orion	Orion	Back
14	Front	Orion	Orion	Orion	Orion	Orion	Orion	Orion	Orion	Orion	Back
15	Front	ES0F010	ES0F010	ES0F010	ES0F010	ES0F010	ES0F010	ES0F010	ES0F010	ES0F010	Back
16	Front	2SEU4	Not rotated	Orange rotator	2SEU4	Orange rotator	2SEU4	Orange rotator	2SEU4	Orange rotator	Back
17	Front	ES0F010	ES0F010	ES0F010	ES0F010	ES0F010	ES0F010	ES0F010	ES0F010	ES0F010	Back
18	Front	CF797	CF797	CF797	CF797	CF797	CF797	CF797	CF797	CF797	Back
19	Front	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	Back
20	Front	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	Back
21	Front	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	Back
22	Front	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	Back
23	Front	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	Back
24	Front	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	Back
25	Front	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	Back
26	Front	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	Back
27	Front	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	Back
28	Front	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	PR2	Back
29	Front	CF797	CF797	CF797	CF797	CF797	CF797	CF797	CF797	CF797	Back
30	Front	CF797	CF797	CF797	CF797	CF797	CF797	CF797	CF797	CF797	Back
31	Front	CF797	CF797	CF797	CF797	CF797	CF797	CF797	CF797	CF797	Back
32	Front	2SEU4	Orange rotator	2SEU4	Orange rotator	2SEU4	Orange rotator	2SEU4	Orange rotator	2SEU4	Back
33	Front	CF797	CF797	CF797	CF797	CF797	CF797	CF797	CF797	CF797	Back
South											

- Images of one flight (11th August 2021) stitched together to produce an **orthomosaic** (2D image) and **Digital Surface Model** (DSM)
- High resolution of 0.18cm/pixel

Results



Complex cropping system = more complex analysis (top left figure)

- Analysis has to be done **per strip** to capture the spectral signatures of all crops.
- If not applied, certain crops (e.g. leek) are identified as soil pixels.

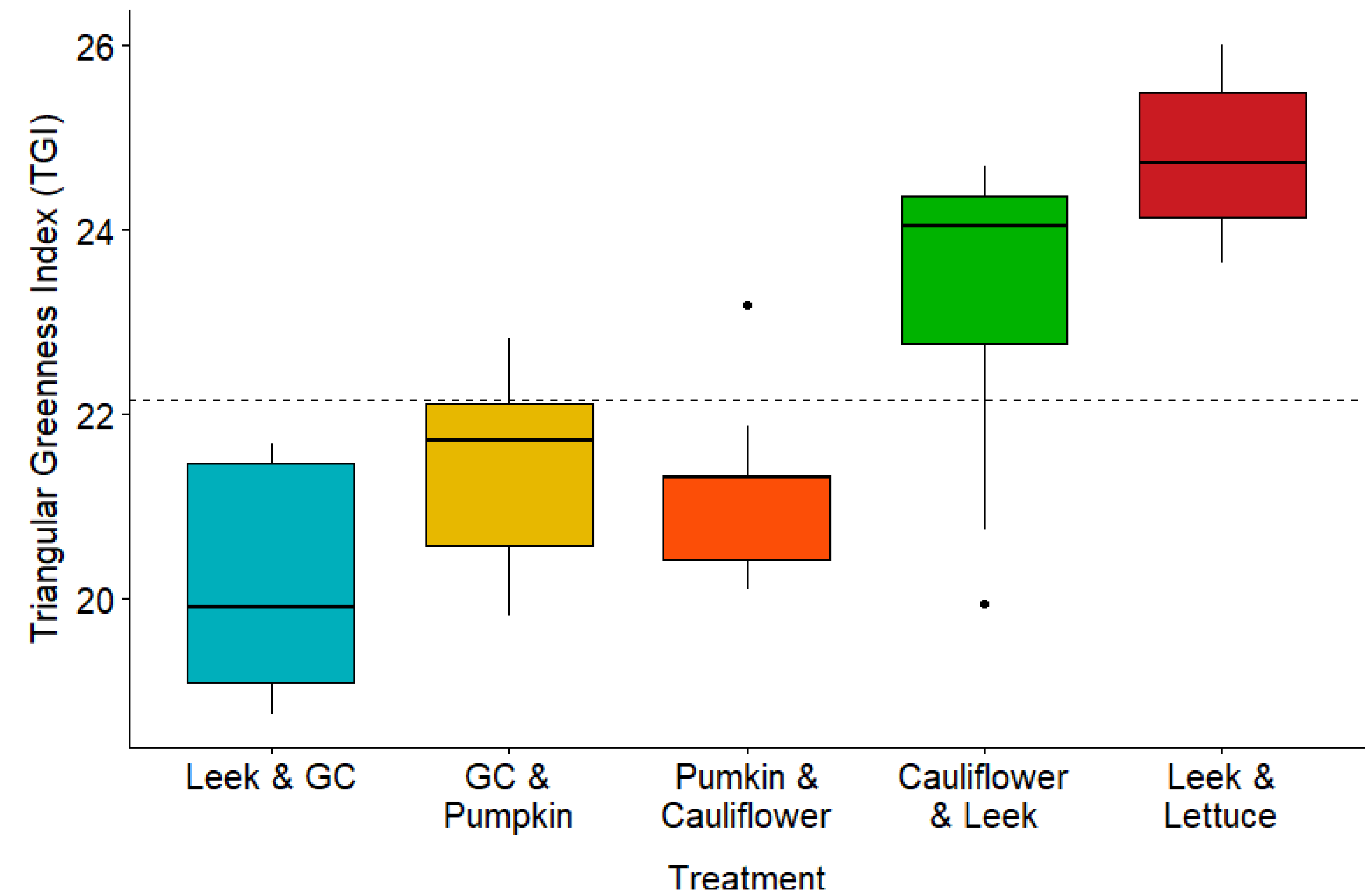
Limitations of remote agronomy (top right figure)

- Differences in illumination can sometimes result in less accurate identification of vegetation pixels.

Extraction of vegetation properties (example below)

- Triangular Greenness Index (indication of crop health) differed significantly per intercropping treatment for fennel.

Triangular Greenness Index (TGI) of fennel per treatment



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