Drone sensing

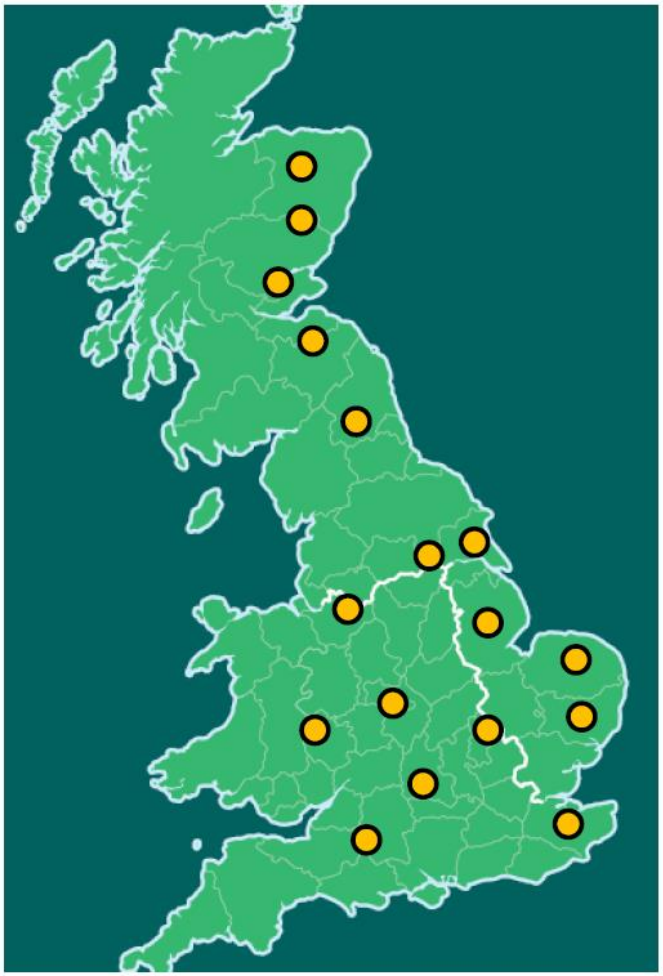
A new perspective on cereal disease management ?

David Whattoff - Agricultural Development Manager

SOYL

SOYL Precision Ag

- National coverage
- Provide application plans to 1,000,000 ha per year
- PA services based on
  - Nutrient grid sampling
  - EC soil surveys
  - Nitrogen management
  - UAV imagery
- Field scale R & D program



Precision Agriculture

The right amount,

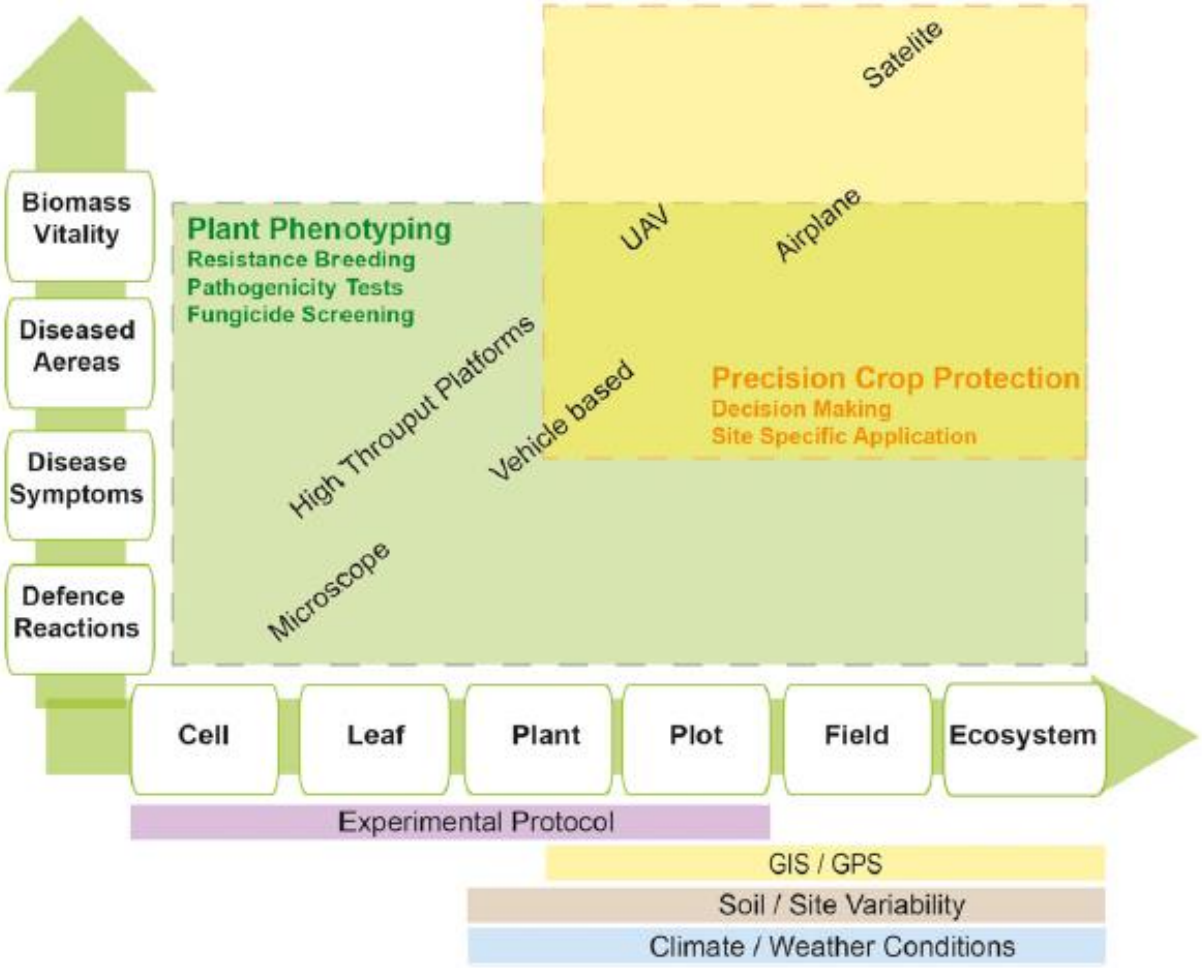
in the right place,

at the right time,

in the right way

- Decision making
- Input optimisation
- Yield improvement
- Record keeping
- Sustainably
- Traceability

Overview of current sensor technology



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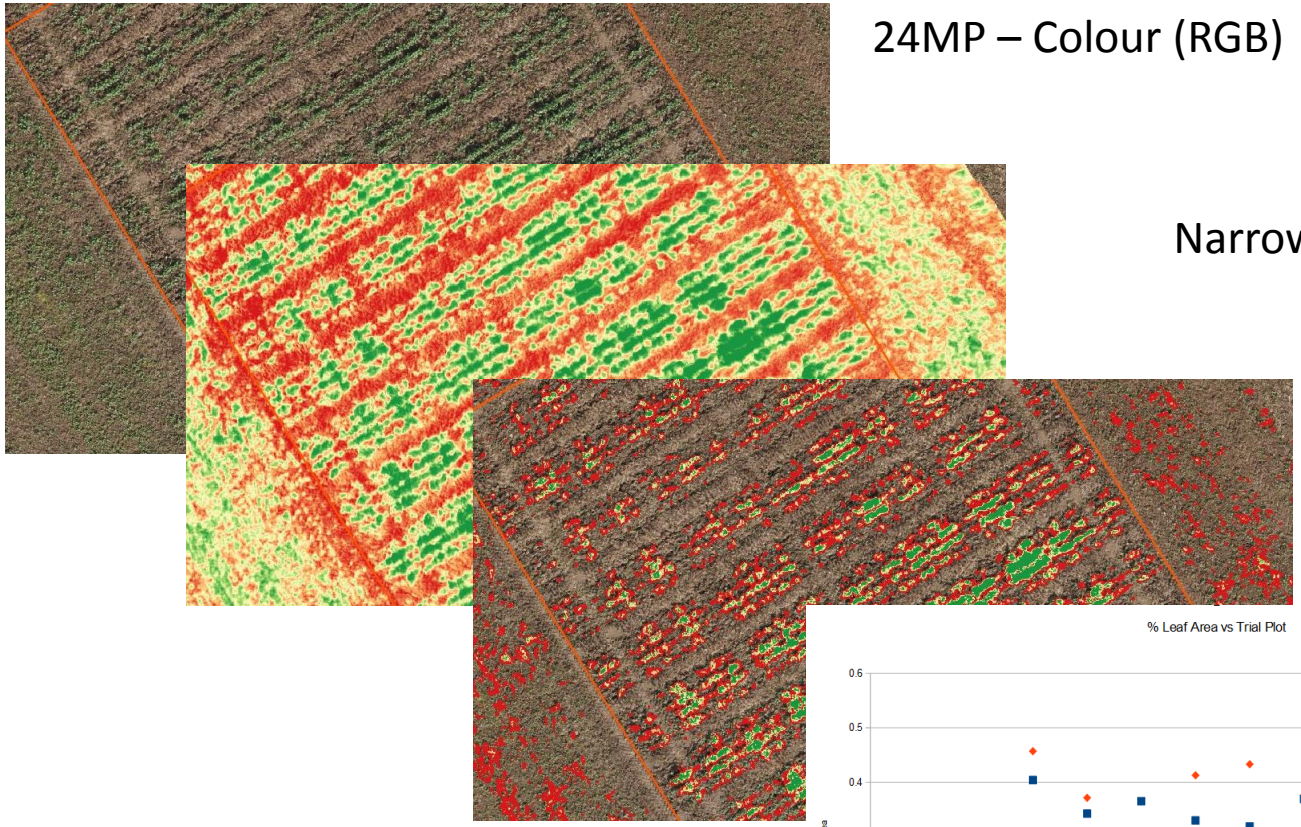
SOYLsight UAV – Geo Copter X-8000

Replicated plot analysis

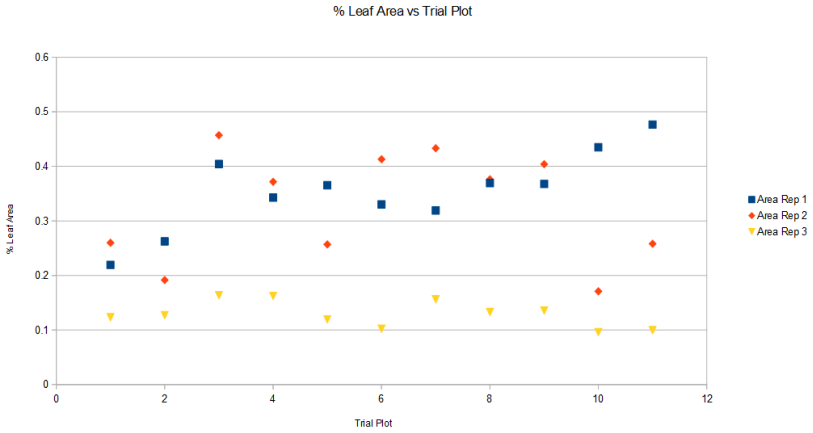


24MP – Colour (RGB)

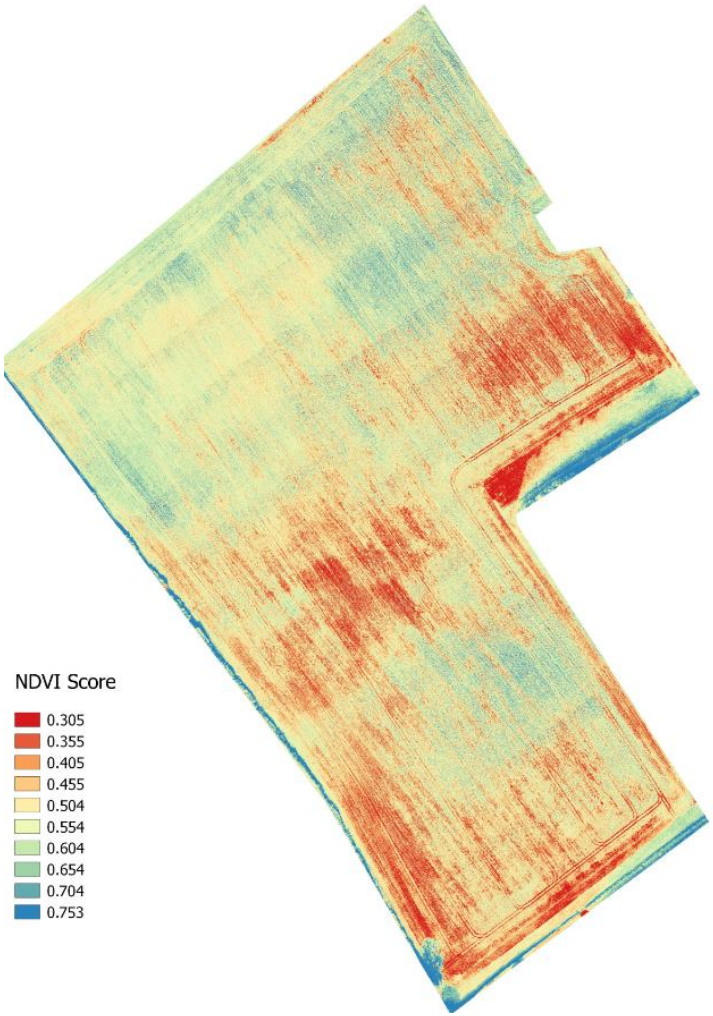
Narrow band multispectral

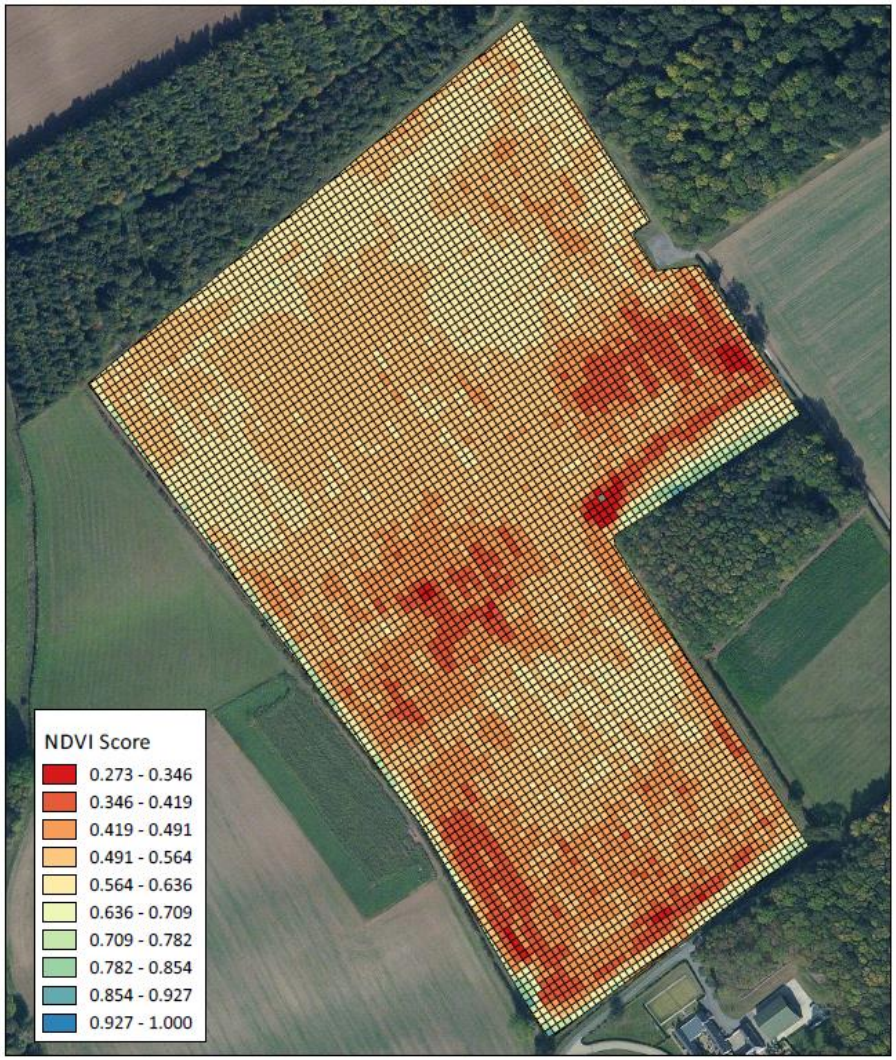
Combined
RGB & MS

Analysis



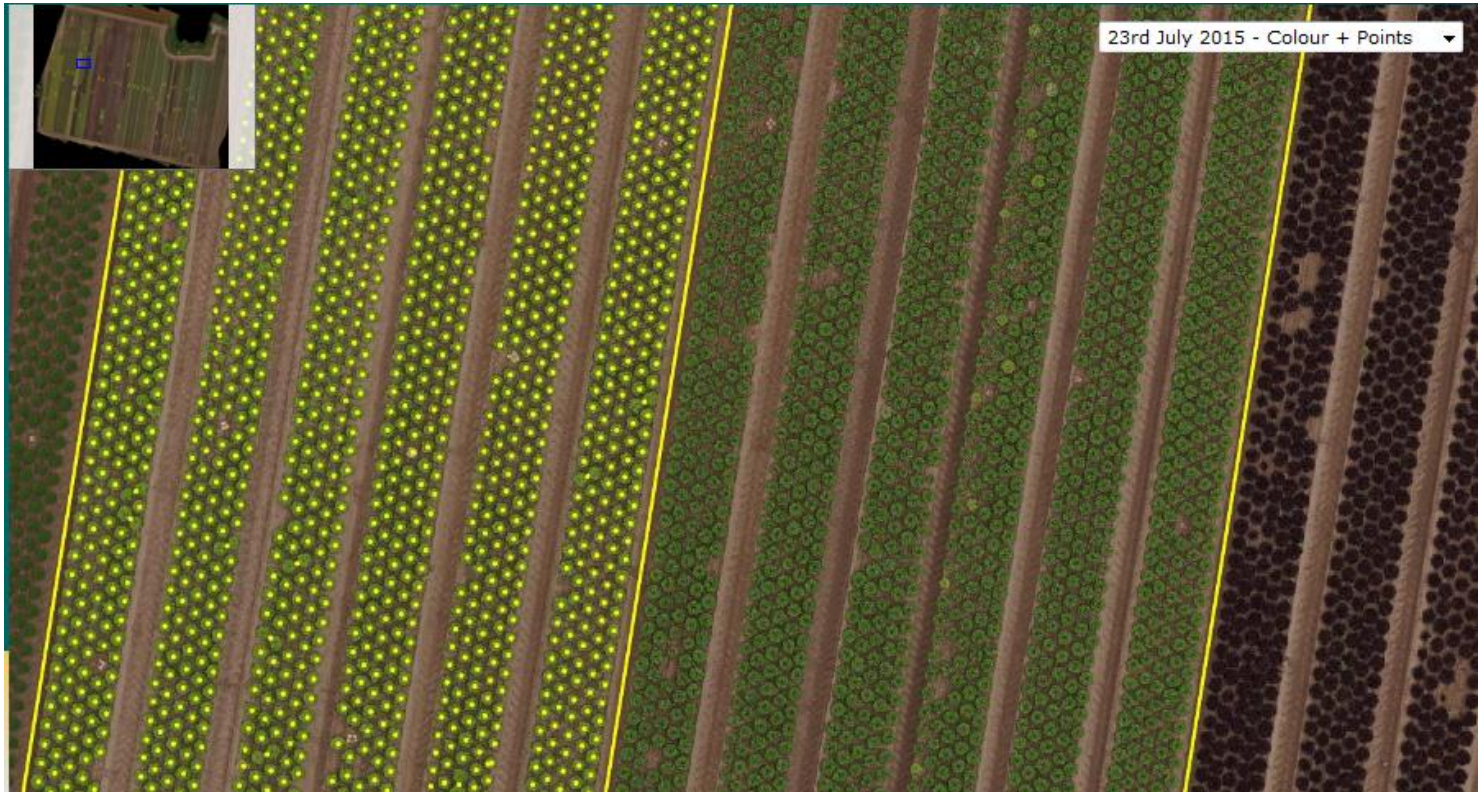
Field scale assessment





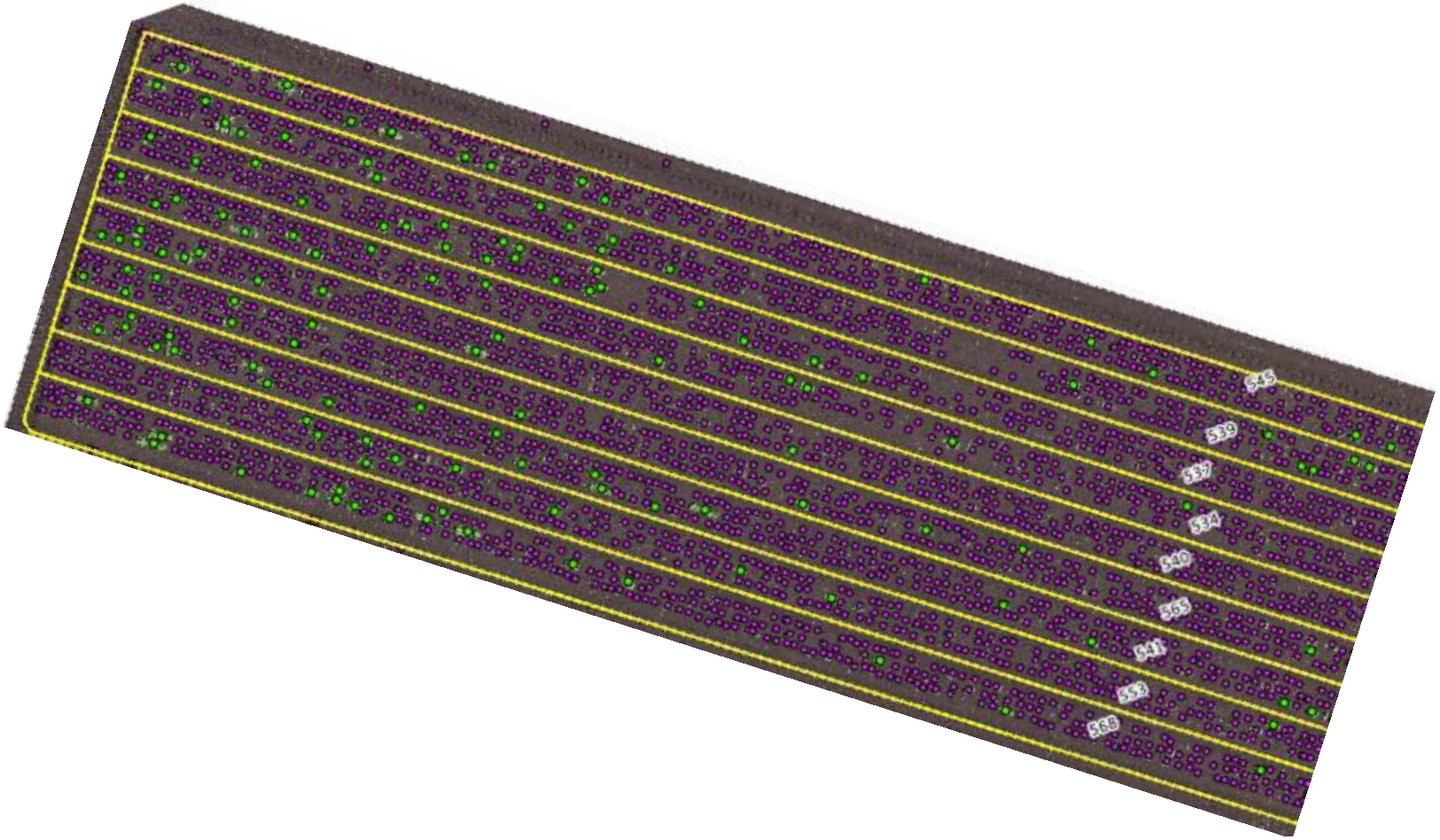
Example data

Plant counts: Lettuce



Example data

Plant counts: Potatoes



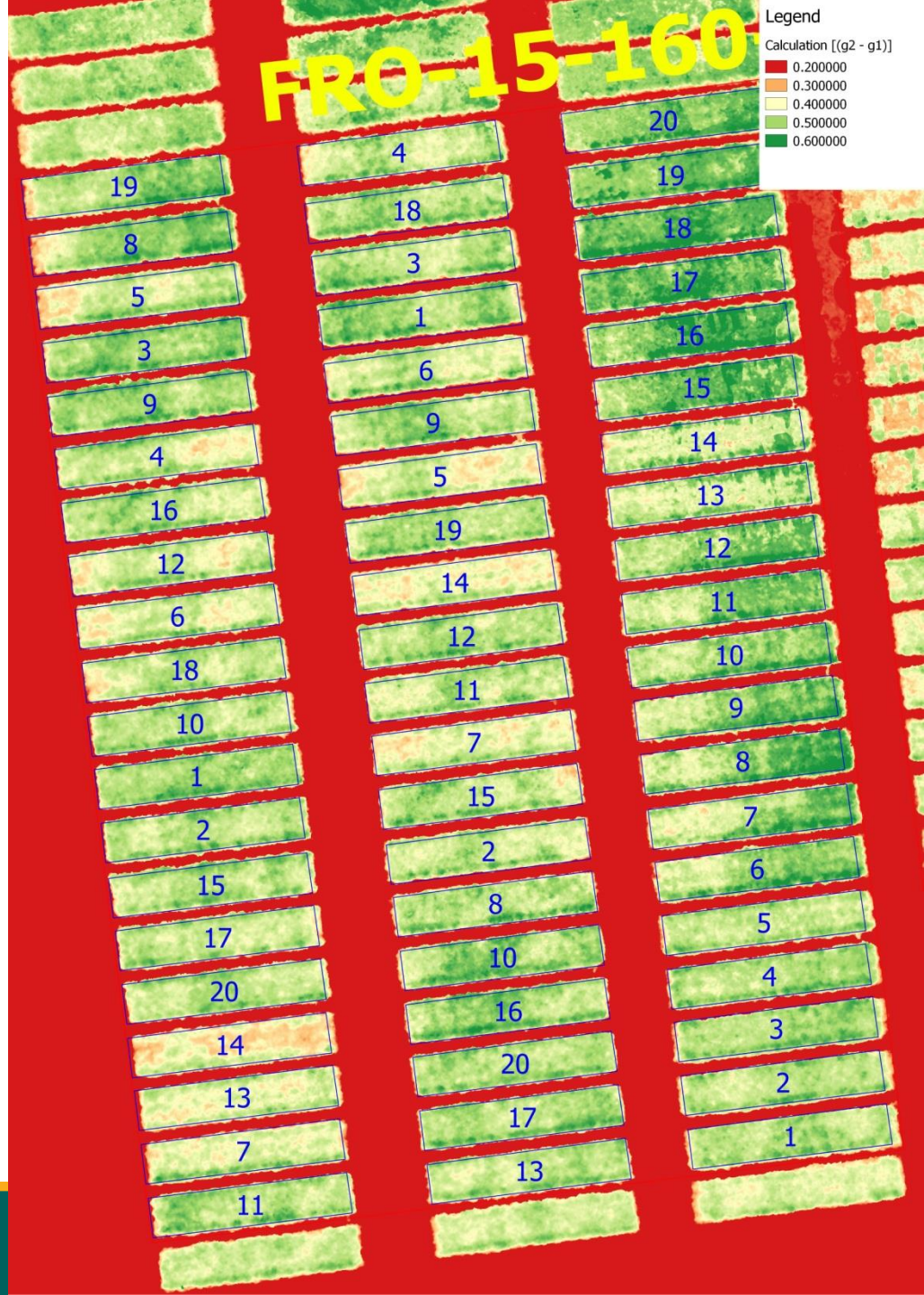
Example data

Canopy heights:

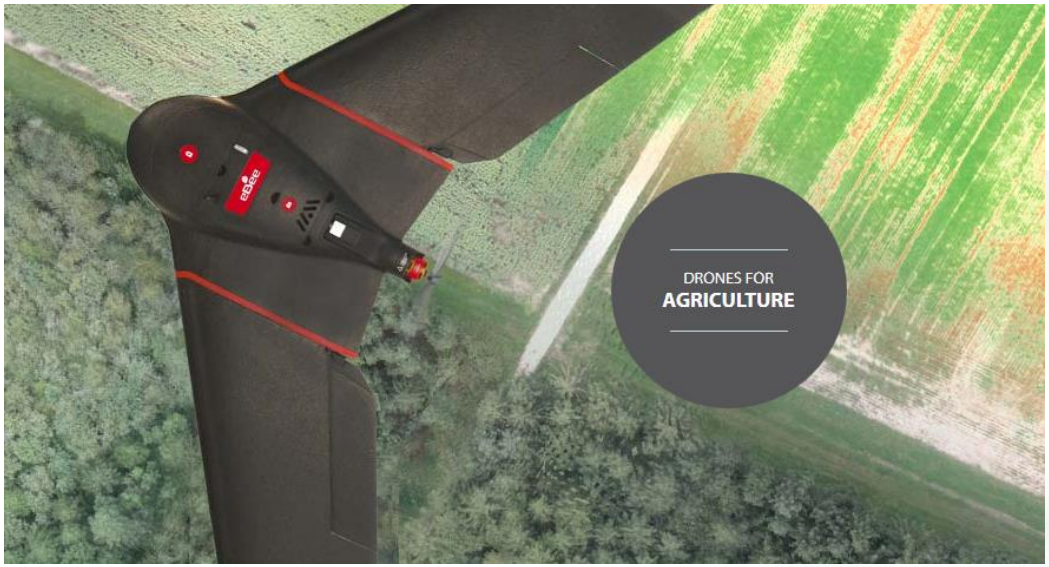
PGR cereals trial

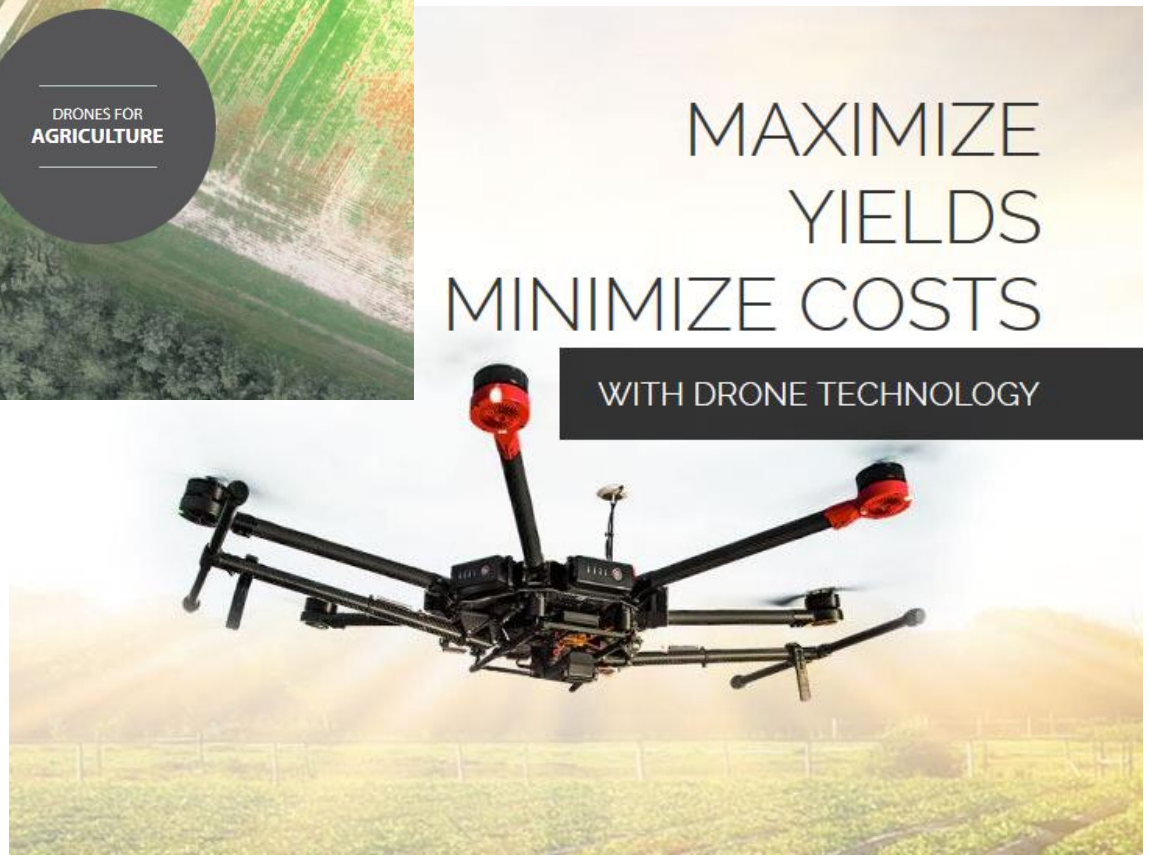
Units in metres

Height at canopy (G2) – height at bare ground (G1)



Precision crop protection – Commercial drones



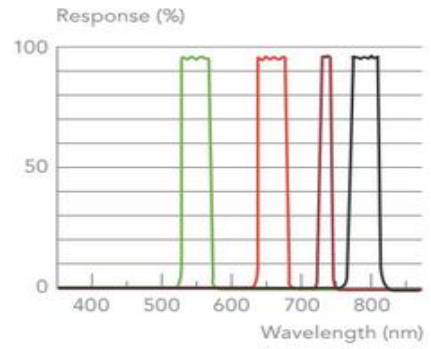


Precision crop protection - Commercial sensors

RedEdge™ by MicaSense

Band Name	Center Wavelength (nm)	Bandwidth (nm)
Blue	475	20
Green	560	20
Red	668	10
Red Edge	717	10
Near IR	840	40

Parrot SEQUOIA

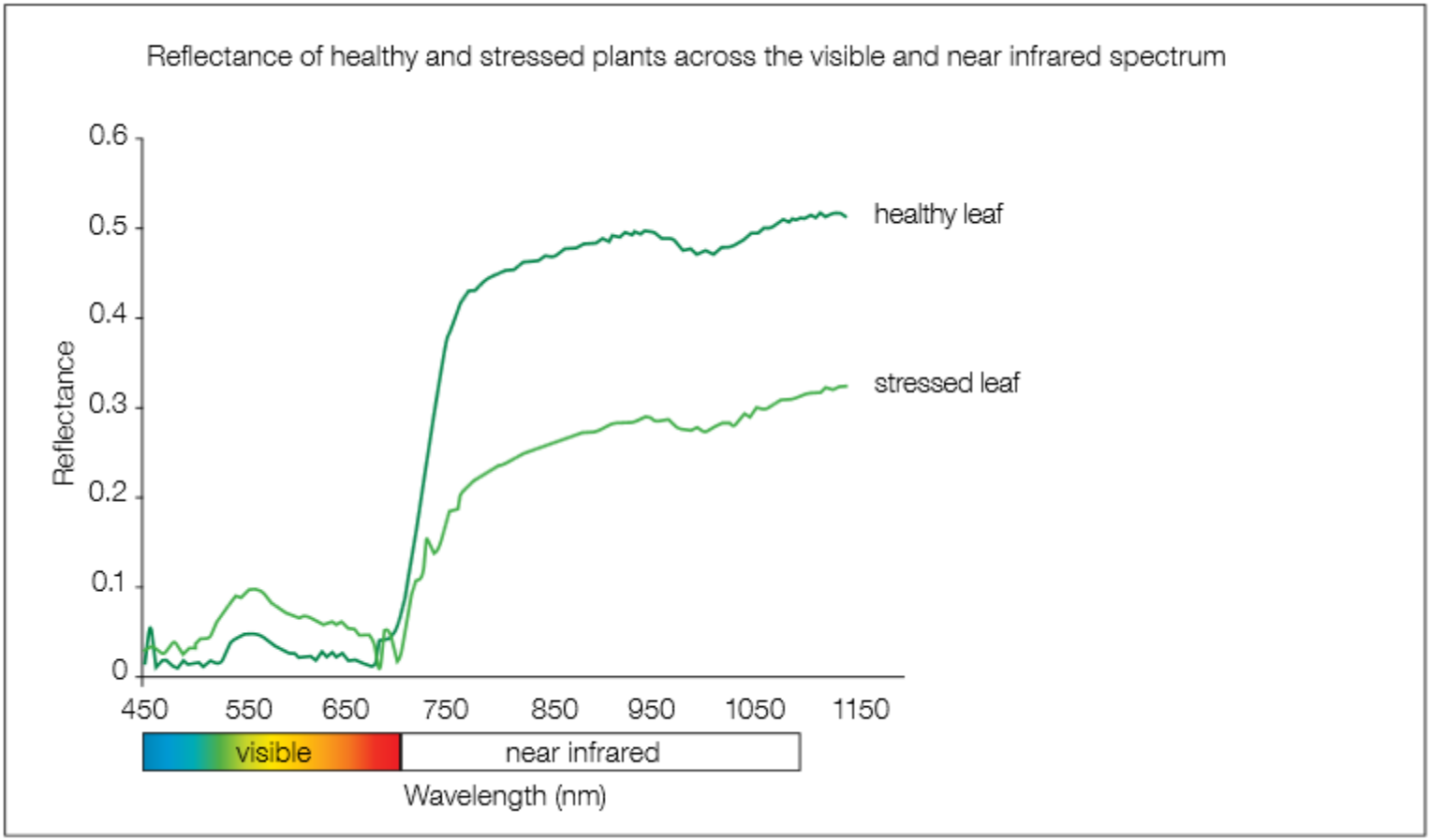


Discrete spectral bands

- Green (550BP40)
- Red (660BP40)
- Red Edge (735BP10)
- Near Infrared (790BP40)

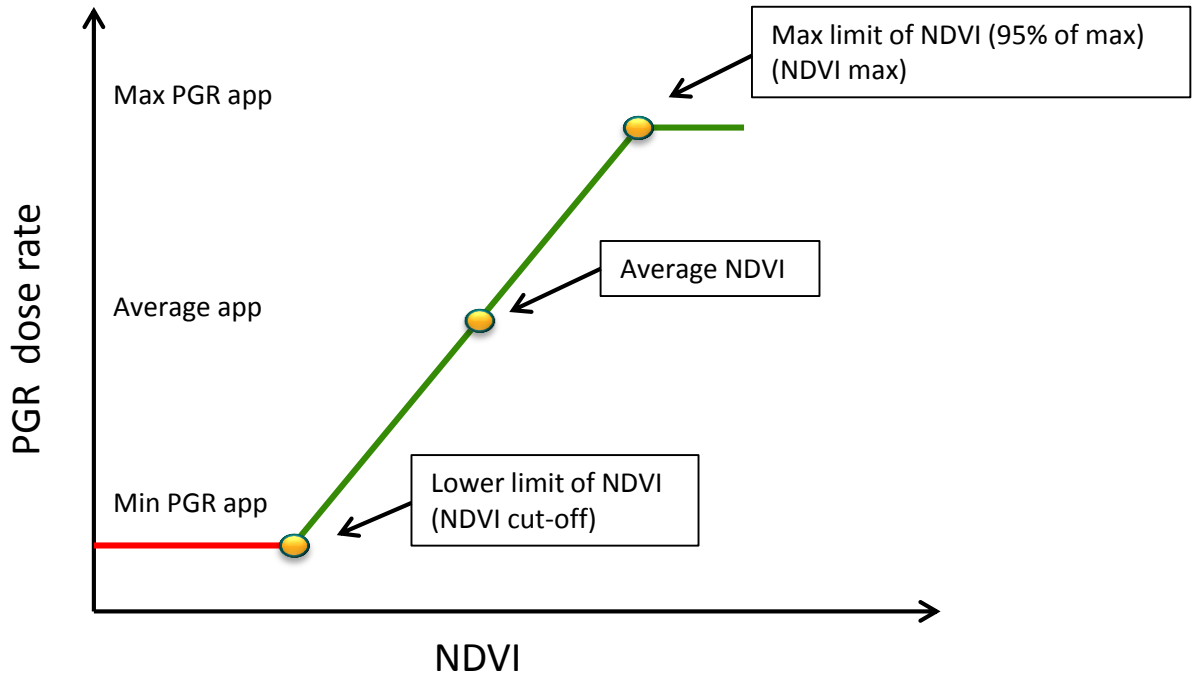
Precision crop protection – Data analysis

Precision crop protection - Commercial sensors



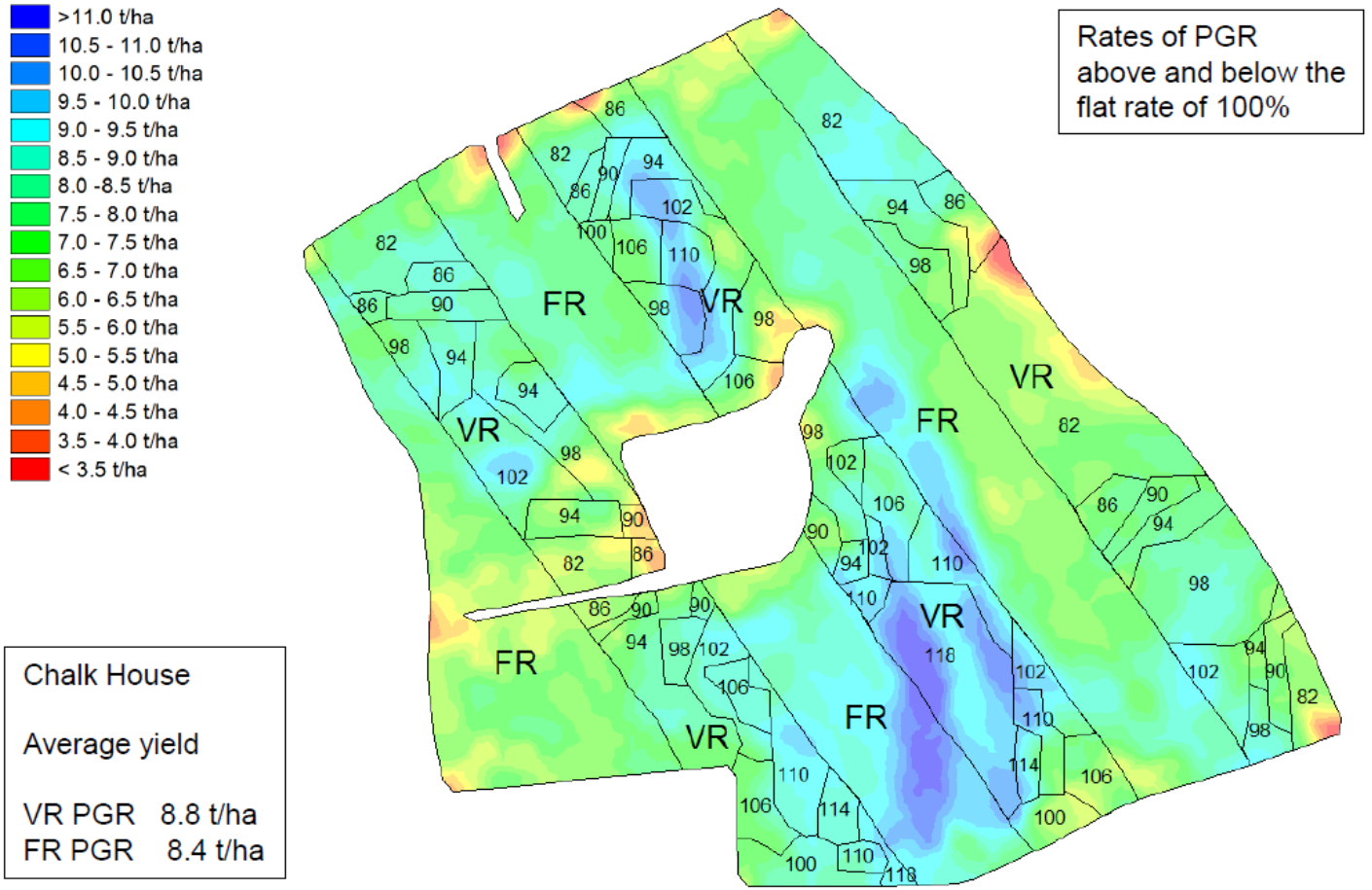
Precision agriculture approach – Variable PGR

Dose rate calculation



A linear PGR ramp to inform application rate

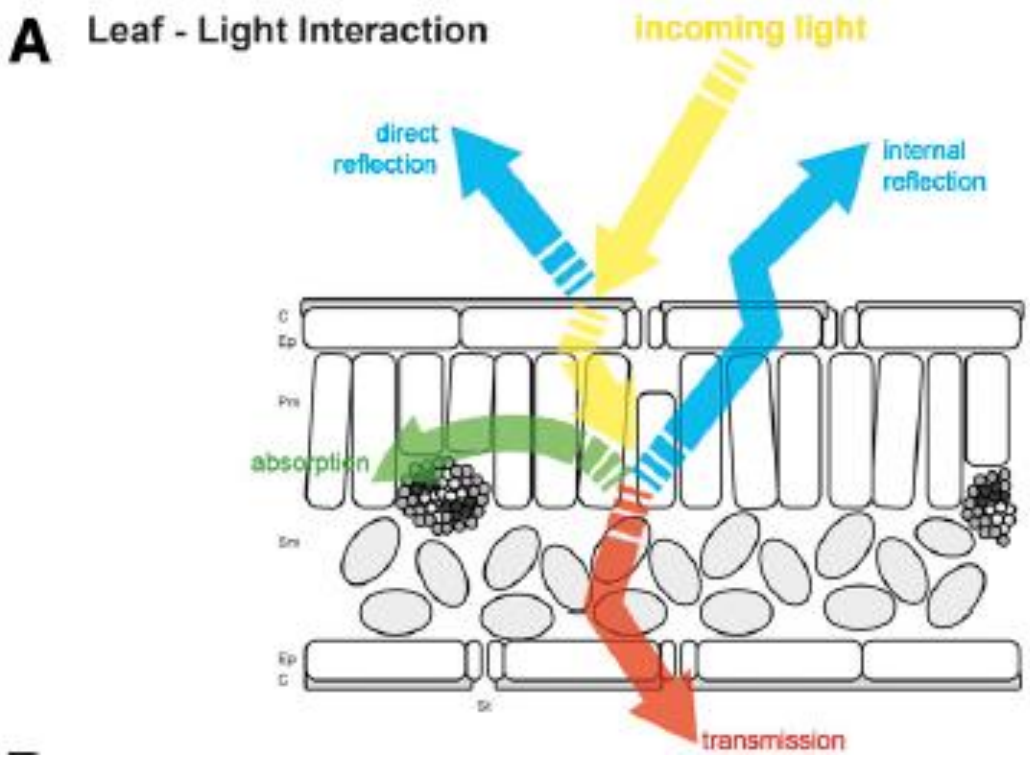
Precision agriculture approach – Variable PGR



Precision Crop Protection

The challenges of disease monitoring & management

Canopy sensing limitations -Speciation



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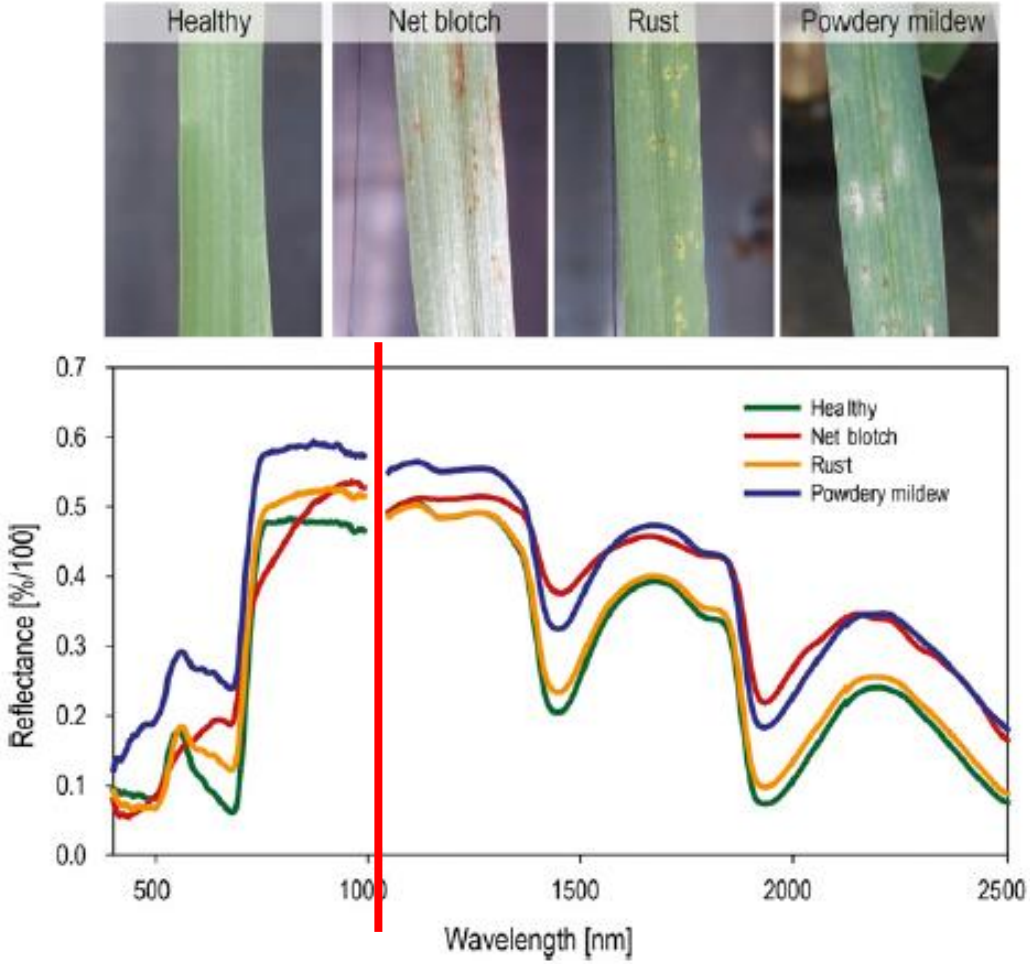
Characteristic spectral signatures



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Vegetation Index – A definition

- A **Vegetation Index** (VI) is a spectral transformation of two or more bands designed to enhance the contribution of vegetation properties and allow reliable spatial and temporal inter-comparisons of terrestrial photosynthetic activity and canopy structural variations

Huete, A.; Didan K., Miura T., Rodriquez E. P., Gao X. & Ferreria L. G. (2000). "Overview of the radiometric and biophysical performance of the MODIS vegetation indices". Remote Sensing of Environment. ***83****: 195–213.*

Disease monitoring – Vegetation Indexes

Red Edge Normalized Difference Vegetation Index (RENDVI)

This index is a modification of the traditional broadband NDVI. Applications include precision agriculture, forest monitoring, and vegetation stress detection. This VI differs from the NDVI by using bands along the red edge, instead of the main absorption and reflectance peaks. It capitalizes on the sensitivity of the vegetation red edge to small changes in canopy foliage content, gap fraction, and senescence.

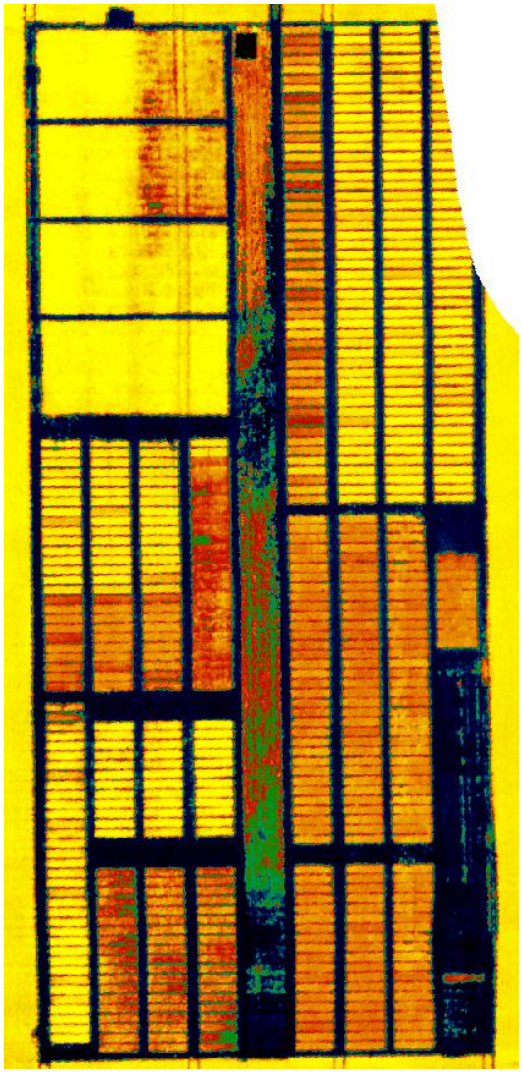
$$RENDVI = \frac{\rho_{750} - \rho_{705}}{\rho_{750} + \rho_{705}}$$

Transformed Chlorophyll Absorption Reflectance Index (TCARI)

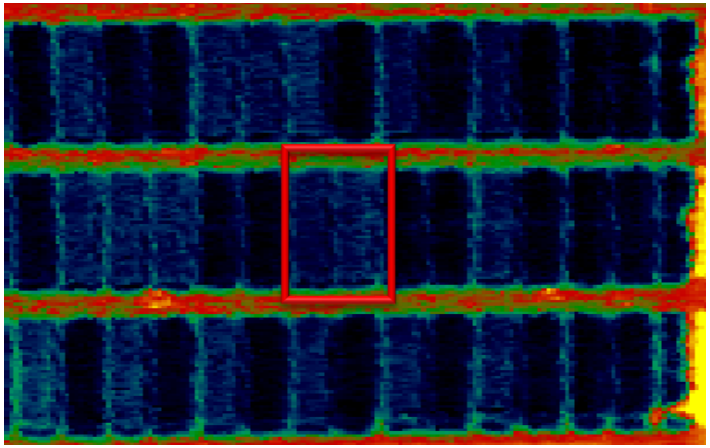
This index is one of several CARI indices that indicates the relative abundance of chlorophyll. It is affected by the underlying soil reflecance, particularly in vegetation with a low LAI.

$$TCARI = 3\left[(\rho_{700} - \rho_{670}) - 0.2(\rho_{700} - \rho_{550})\left(\frac{\rho_{700}}{\rho_{670}}\right)\right]$$

Disease monitoring – Trials



Disease monitoring – Vegetation Indexes



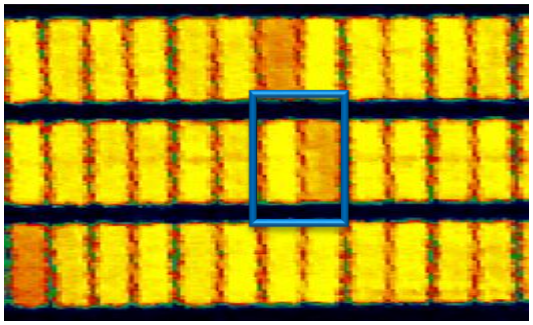
		Pre-T0 GS26 3rd March	**T0 BBCH 30-31** 2nd April	**T1 BBCH 31-32** (leaf 3 50%) 3rd May	**T1.5 (Leaf 2 50%)** 9th May	**T2 BBCH 39** 22nd May	**T3 BBCH 59-65** 9th June
1	KWS Kielder	untreated	untreated	untreated	untreated	untreated	untreated
2	KWS Siskin	untreated	untreated	untreated	untreated	untreated	untreated
3	KWS Kielder	-	-	Strand 0.75 + Piper 1.0	-	Skyway 1.0	Prosaro 0.8
4	KWS Siskin	-	-	Strand 0.75 + Piper 1.0	-	Skyway 1.0	Prosaro 0.8
5	KWS Kielder	-	Timpani 1.5	Ceriax 1.0 + Piper 1.0	-	Skyway 1.0	**Prosaro 0.6**
6	KWS Siskin	-	Timpani 1.5	Ceriax 1.0 + Piper 1.0	-	Skyway 1.0	**Prosaro 0.6**
7	KWS Kielder	-	Timpani 2.0	Ceriax 1.5 + Piper 1.0	-	Skyway 1.25	Prosaro 0.8
8	KWS Siskin	-	Timpani 2.0	Ceriax 1.5 + Piper 1.0	-	Skyway 1.25	Prosaro 0.8
9	KWS Kielder	-	Timpani 2.0 + Piper 1.0	Ceriax 1.5 + Piper 1.0	-	Skyway1.25	Prosaro 0.8
10	KWS Siskin	-	Timpani 2.0 + Piper 1.0	Ceriax 1.5 + Piper 1.0	-	Skyway1.25	Prosaro 0.8
11	KWS Kielder	Toledo 0.3	Timpani 2.0	Ceriax 1.5 + Piper 1.0	Strand 0.75	Skyway 1.25	Prosaro 0.8
12	KWS Siskin	Toledo 0.3	Timpani 2.0	Ceriax 1.5 + Piper 1.0	Strand 0.75	Skyway 1.25	Prosaro 0.8

REP3	12	9	8	10	3	5	1	6	7	4	11	2
REP2	4	3	5	7	10	2	11	1	12	6	9	8
REP1	1	2	3	4	5	6	7	8	9	10	11	12
	Kielder	Siskin	Kielder	Siskin								

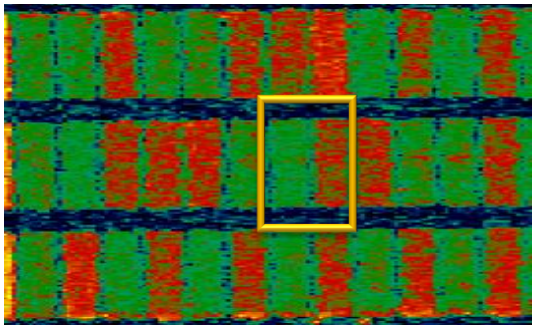
Disease monitoring – NDVI 23/05/16

			Septoria sp.	Septoria sp.	Septoria sp.	Yellow rust	Yellow rust	Yellow rust	Yellow rust	
		YIELD	LEAF3 P	LEAF4 P	LEAF5 P	LEAF2 P	LEAF3 P	LEAF4 P	LEAF5 P	LEAF4 C
		t/ha	PESSEV	PESSEV	PESSEV	PESSEV	PESSEV	PESSEV	PESSEV	green area
			%	%	%	%	%	%	%	INDEX
		09/08/2016	23/05/2016	23/05/2016	23/05/2016	23/05/2016	23/05/2016	23/05/2016	23/05/2016	23/05/2016
1	KWS Kielder	7.97	0.93	8.53	23.03	3.57	12.53	8.3	2.26	71.4
2	KWS Siskin	9.25	0.23	2.42	8.57	0	0	0	0	87.23
3	KWS Kielder	10.15	0.03	1.37	23.5	0.75	2.82	0.97	0.46	93.77
4	KWS Siskin	10.41	0.17	1.43	7.48	0	0	0	0	96.77
5	KWS Kielder	10.33	0.07	0.33	14.8	0.52	1.37	0.28	0.63	97.73
6	KWS Siskin	10.51	0.07	0.52	5.75	0	0.03	0.03	0	97.17
7	KWS Kielder	10.43	0	0	7.6	0.15	0.78	0.13	1.37	98.73
8	KWS Siskin	10.14	0.08	0.2	4.78	0	0	0	0	98.67
9	KWS Kielder	10.12	0	0.2	4.73	0	0.23	0.03	0	98.97
10	KWS Siskin	9.98	0	0.65	4.43	0	0	0.03	0	97.3
11	KWS Kielder	10.72	0	0.37	6.3	0	0.05	0.03	0	97.4
12	KWS Siskin	10.11	0	0.37	3.57	0	0	0.02	0.17	98.03

RENDVI



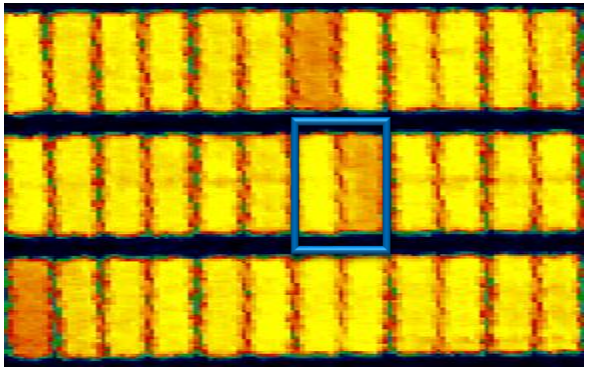
TCARI



Disease monitoring – NDVI 13/06/16

		YIELD	LEAF1 P	LEAF2 P	LEAF3 P	PLANT C
		t/ha	PESSEV	PESSEV	PESSEV	green area
			%	%	%	INDEX
		09/08/2016	13/06/2016	13/06/2016	13/06/2016	13/06/2016
1	KWS Kielder	7.97	1	16.67	56.67	41.67
2	KWS Siskin	9.25	0.17	0.67	13.33	73.33
3	KWS Kielder	10.15	0.33	3.67	16.67	63.33
4	KWS Siskin	10.41	0	0	6.67	80
5	KWS Kielder	10.33	0.33	3.67	16.67	66.67
6	KWS Siskin	10.51	0	0	3.67	81.67
7	KWS Kielder	10.43	0	6	15	68.33
8	KWS Siskin	10.14	0	0	3.67	75
9	KWS Kielder	10.12	0	4.33	10	70
10	KWS Siskin	9.98	0	0	6.33	77.67
11	KWS Kielder	10.72	0	0.33	6	75
12	KWS Siskin	10.11	0	0	2.67	81.67

RENDVI



TCARI

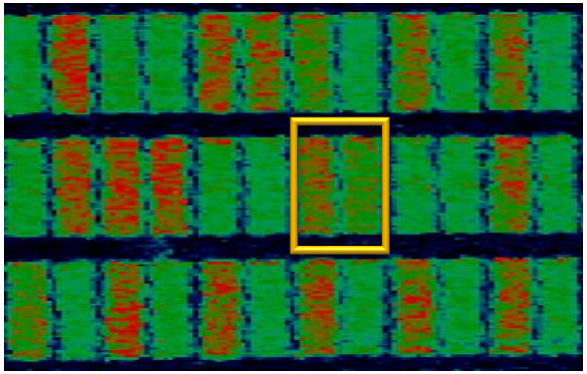
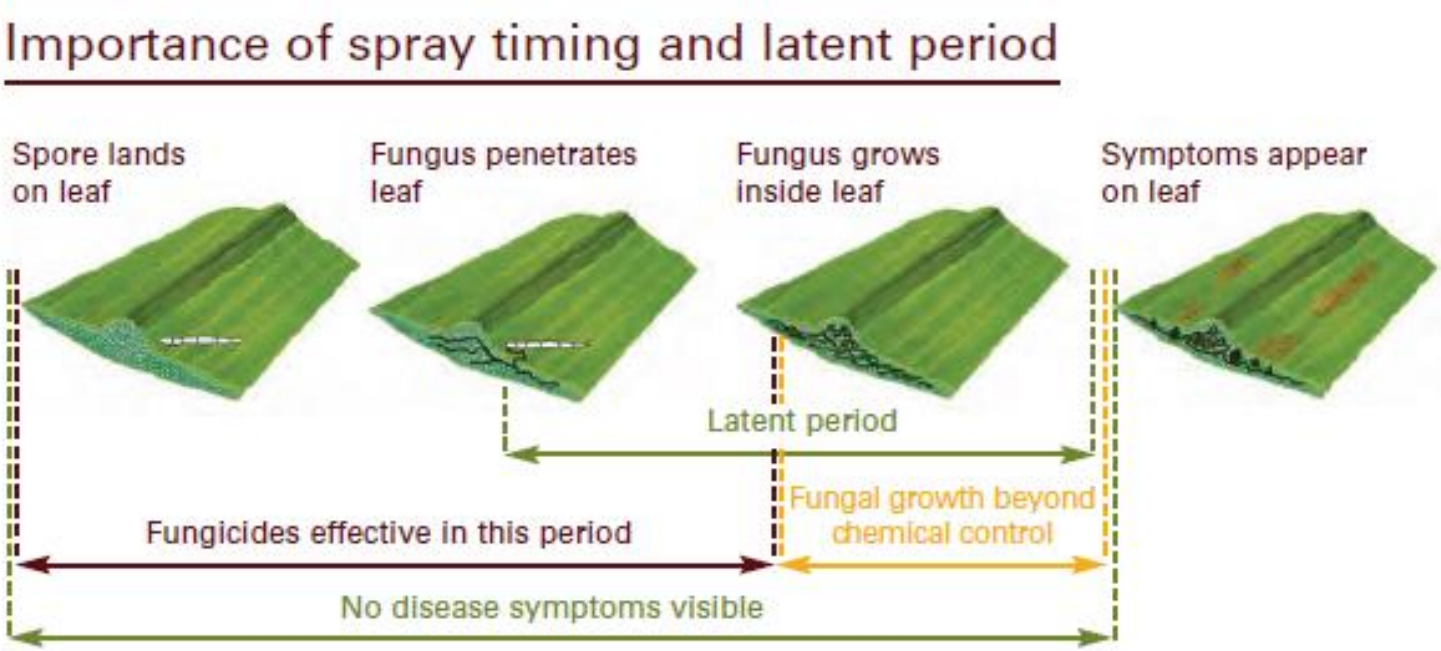


Image Timing



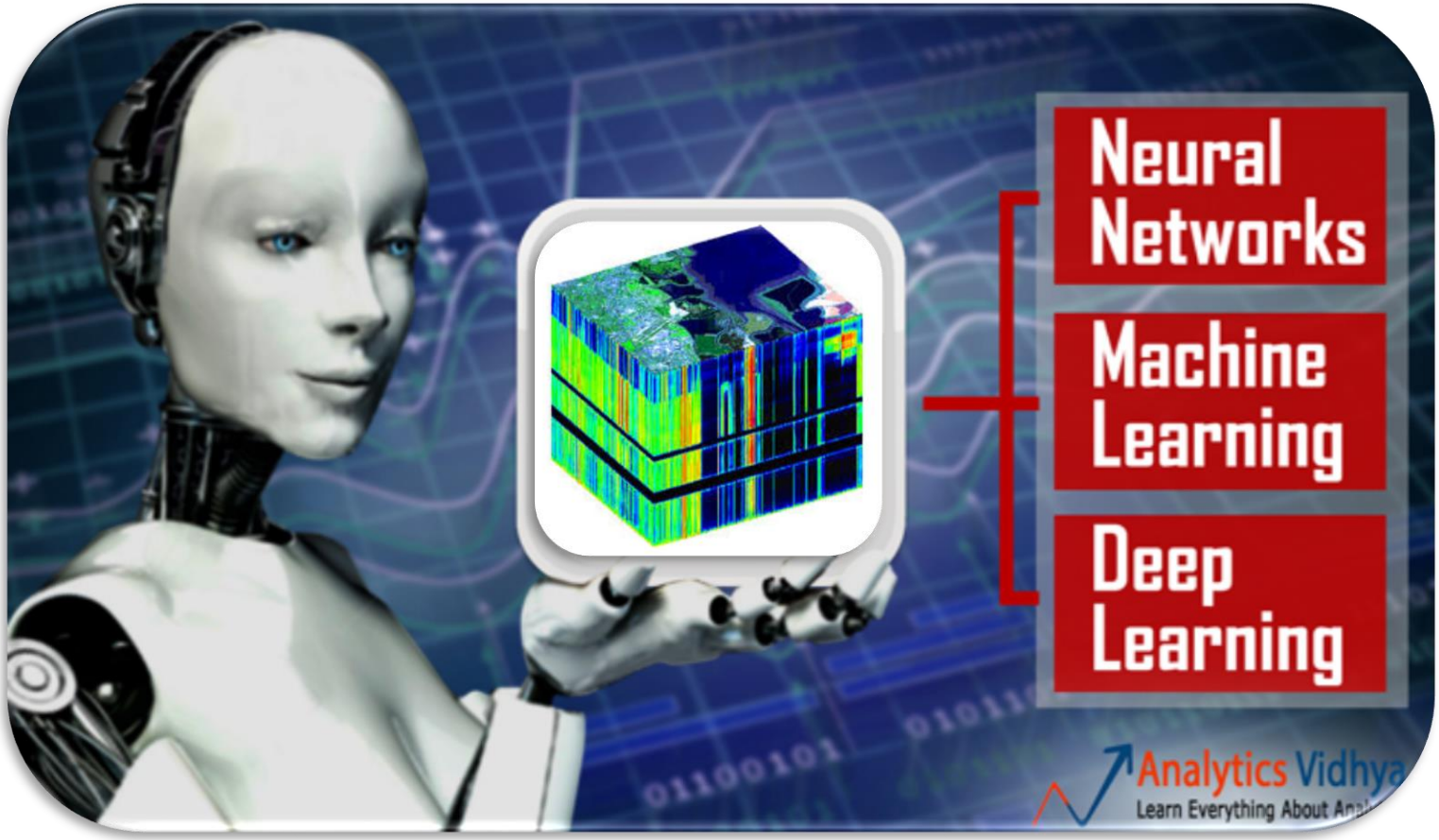
Latent periods can be as short as 4–5 days for mildew and brown rust. Strategies to manage these diseases depend largely on protecting leaves as they emerge.

AHDB Cereals & Oilseed

Additional factors affecting canopy sensing

- Different crops and row spacing
- Temporal & season changes
- Ambient light conditions
- Soil nutrition imbalances
- Weed patches
- Disease
- Water-logging

Disease Management – Big data analytics



Summary

- Drones are just the platform, it is the sensor that is key.
- Effective results will only be achievable through correctly interpreted data.
- Disease monitoring is possible.
- Disease management will be possible.

Thank you

David Whattoff - Agricultural Development Manager

SOYL