Differences in soil carbon among farmland types

Hartpury Research Conference 2024

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11 July 2024

Agenda

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01 Background and rationale

02 Timeline for project objectives

03 Methodology and challenges (UAV imaging)

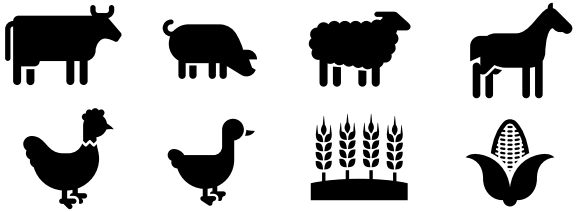
04 Initial UAV imaging review

05 Initial NIRS results recap

06 Final wrap-up

01 Background

- Utilised agricultural area in UK (Defra, 2023)



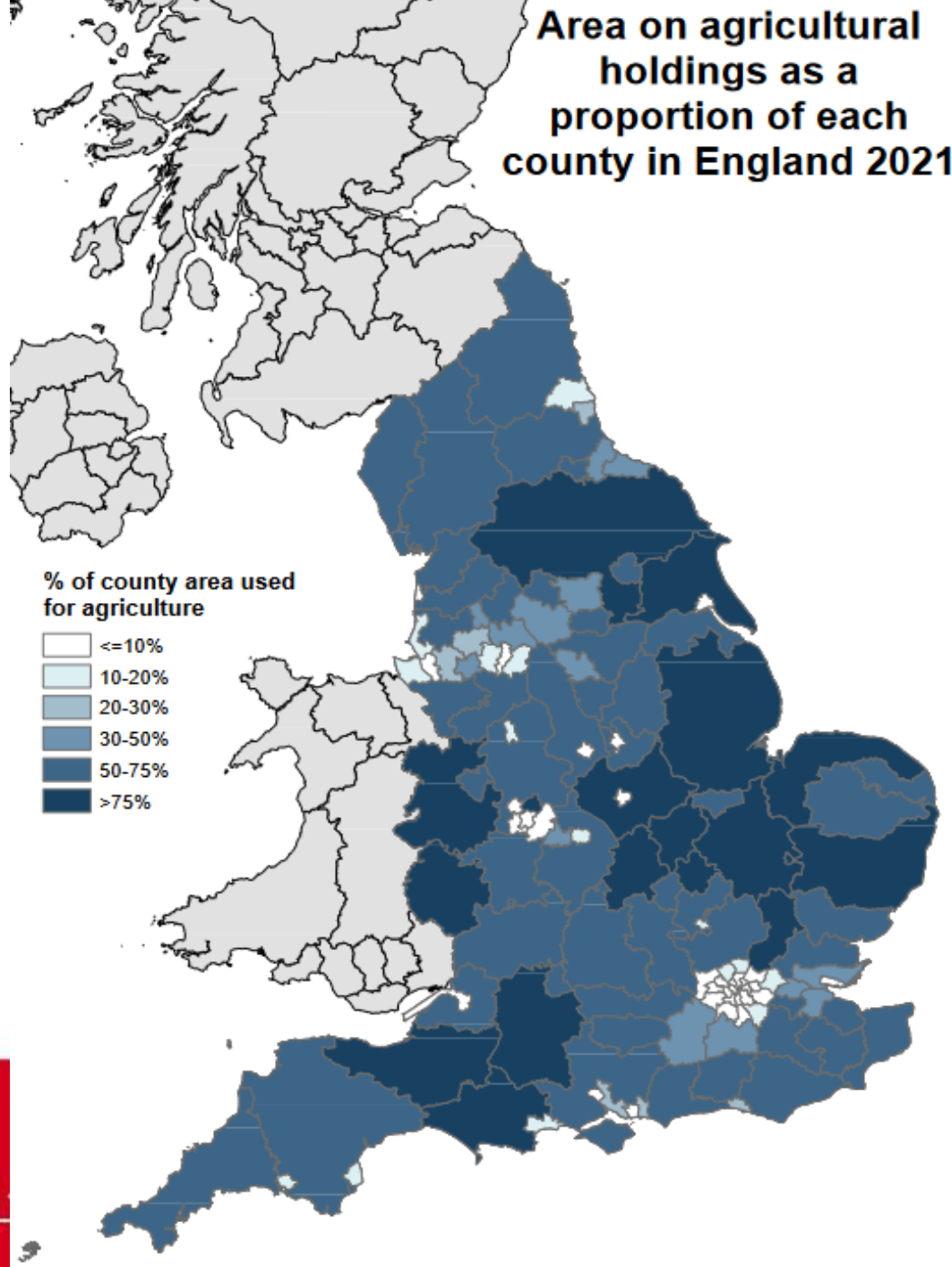
70%

agrecalc

Cool Farm®

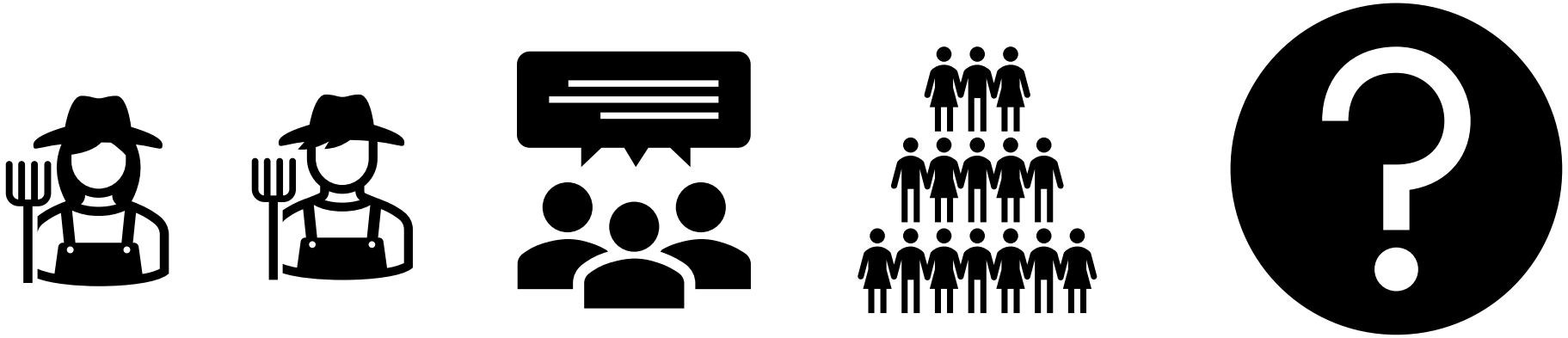
Farm Carbon Calculator

- No standard prescription from the poplular and available carbon assessment tools for agricultural benchmarking and practice use and (NFU, 2019; CIEL, 2020; Arla, 2021)



Source: Defra June Survey of Agriculture and Horticulture 2021

01 Rationale



How about soil and plant variabilities across agricultural land use change over seasons (Vickery et al., 2009; Bell et al., 2014, 2018; Macedo et al., 2022)?

02 Timeline for project objectives

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Start

Research proposal and ethics application in 2022

Objective 1

Near-infrared spectroscopy (NIRS) measurements for field variabilities on Hartpury and Wildlife Trust Cirencester mixed farms in 2023-2024

Processing…

Objective 3

Evaluate actual farm seasonal changes with aerial remote-sensing technique in 2023-2024

Patience…

AFCP Blog

3 things I learned from on-farm carbon assessment

Objective 2

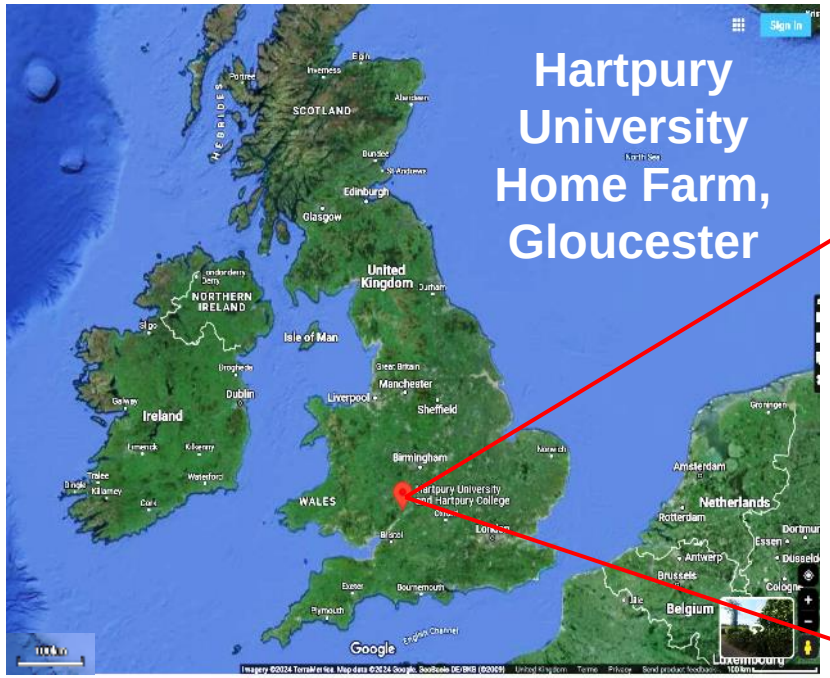
Compare the ground-truth measurements with golden laboratory standard in 2024

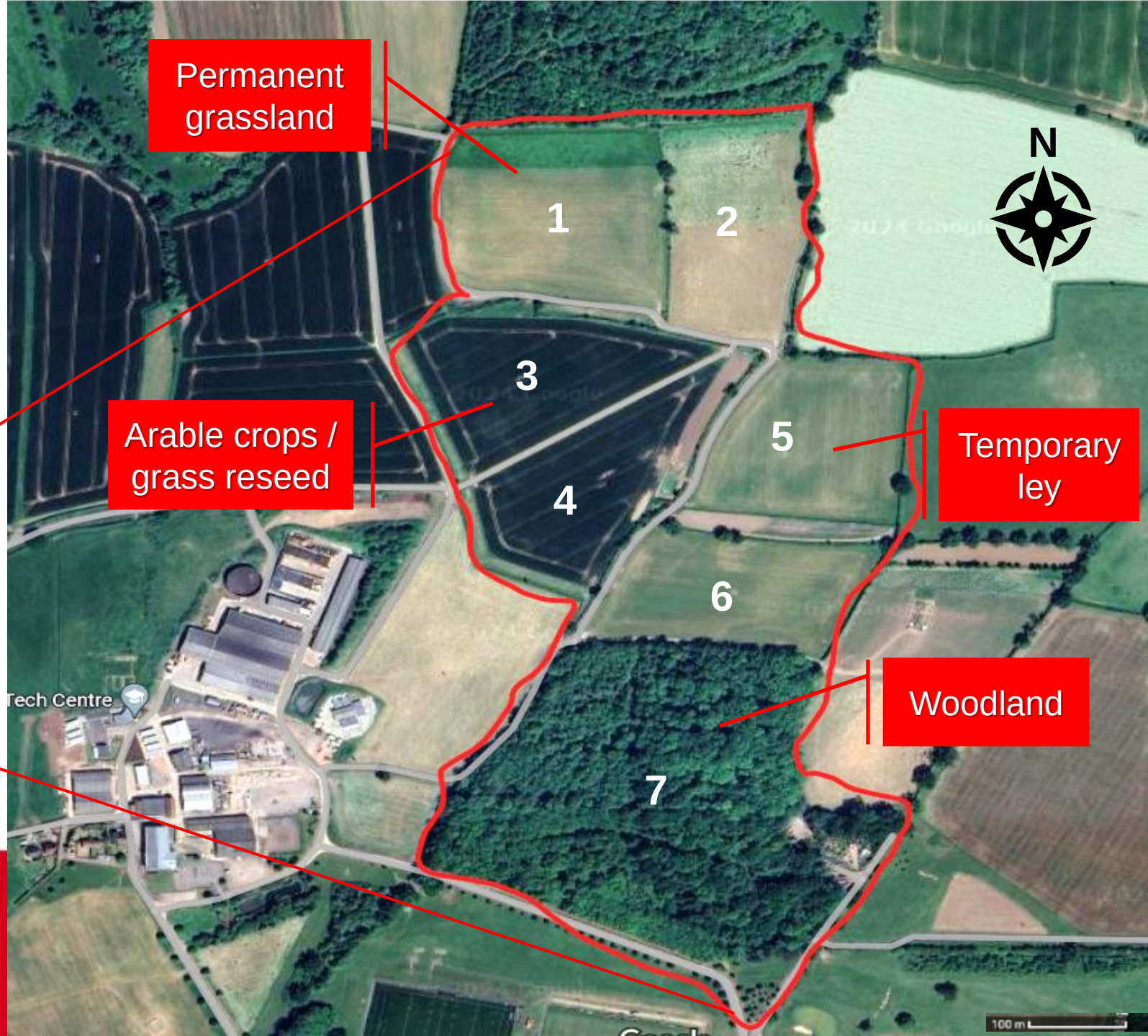
Objective 4 Determine how different carbon assessment techniques applied on-farm for more quality data in 2025

Fruits

Publications, thesis write-up and oral defense

03 Field study area





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03 Data collection

UAV calibration

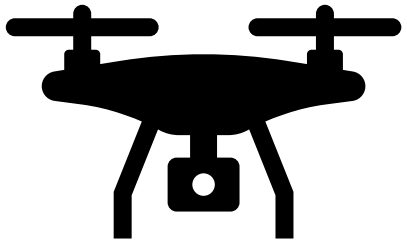
1

Advanced wireless connection

2

Flight route

Adjust UAV setting



3

Establish GCPs

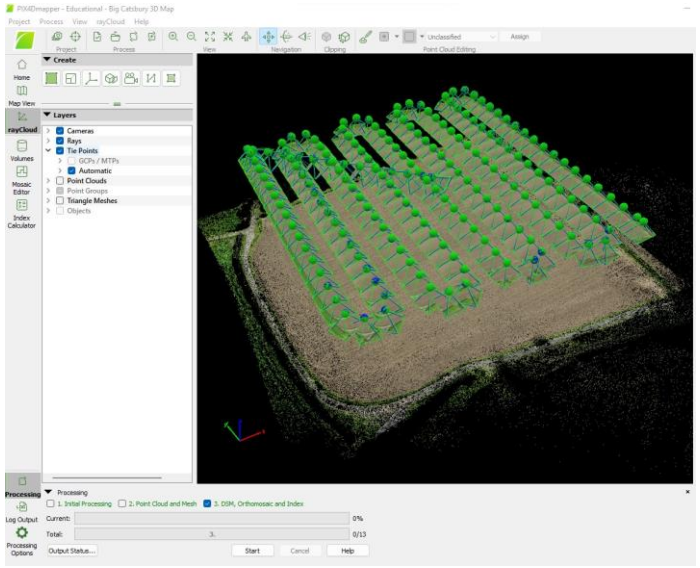
4

Fly the drone!

03 Data processing

PIX4Dmapper

(Photogrammetry)



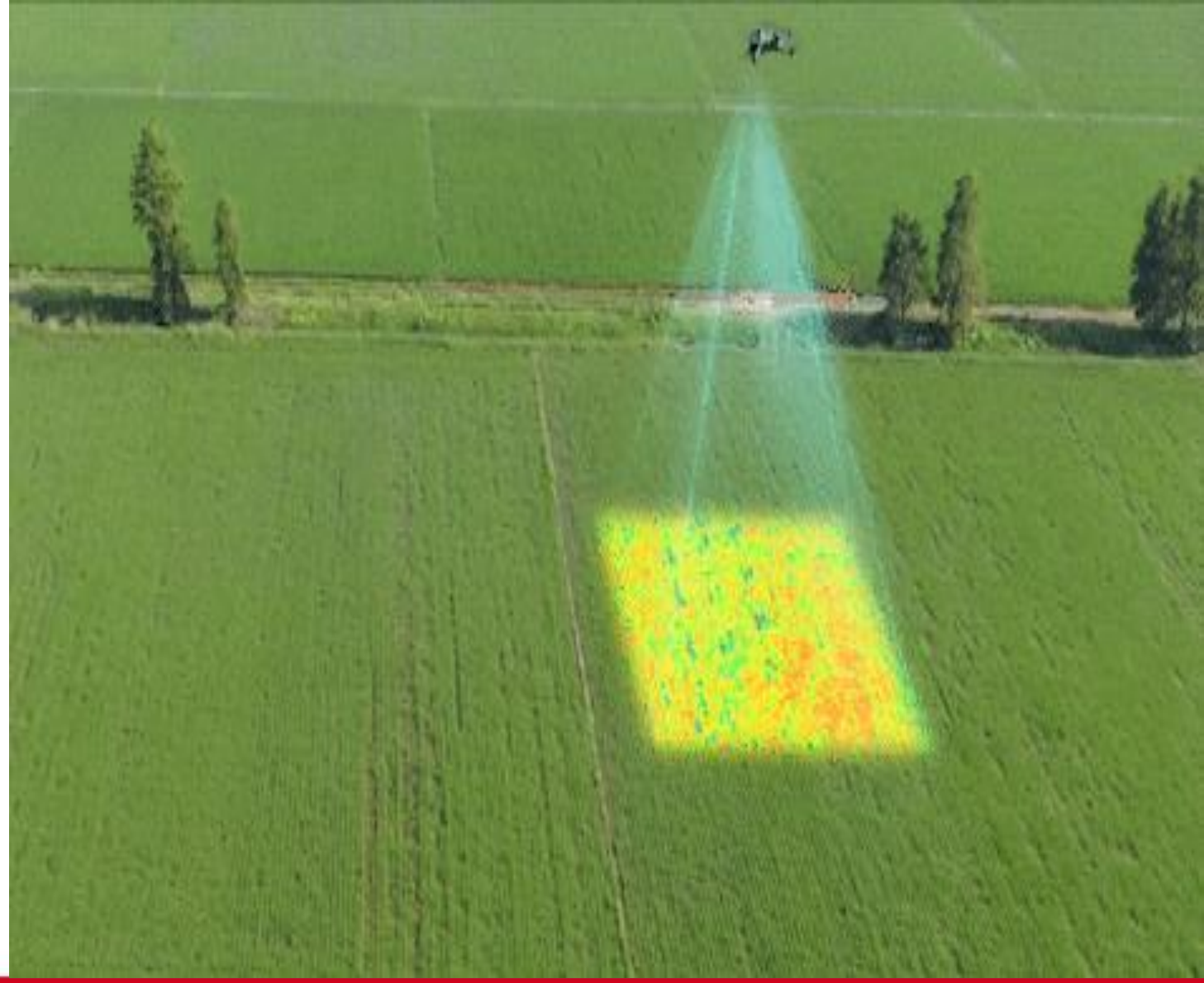
ArcGIS® Pro

(Field comparison)

Imagery data	Critical vegetation indices (vegetation changes and sensitivity monitoring)					
	GCI	GLI	NDVI	GNDVI	VARI	VIgreen
RGB		√			√	√
Multispectral	√		√	√		

03 Key challenges

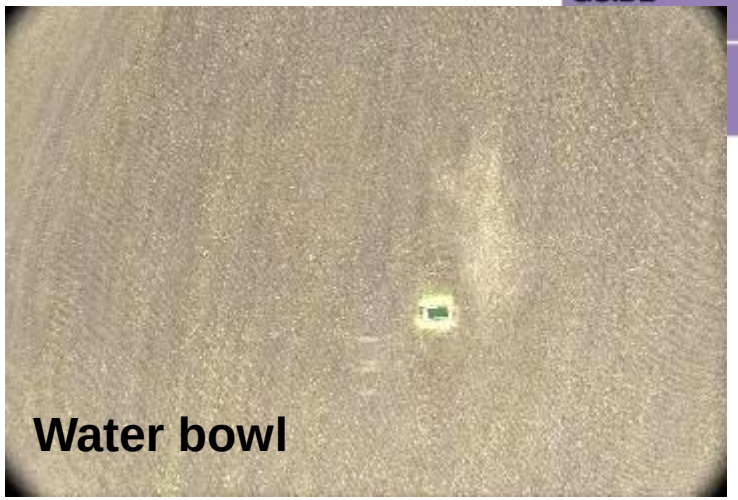
- Good weather?
- Flying altitude (≤ 120m)?
- Flying speed (5-8m/s)?
- Overlap rate (≥ 80%)?



04 Initial UAV imaging review


Tractor trace


Ground control points


Water bowl


My supervisor


Other objects


Ash trees

05 Initial NIRS results recap

Table 1: Predicted mean (s.e.) of soil and plant nutrients for samples at Hartpury and Wildlife Trust farms (extracted)

Variables	Units	Arable Crops	Temporary Leys	Permanent Grass	Woodland
[1]Soil					
Organic carbon (SOC)	g/kg	26.4 (1.5)^{a}	27.4 (1.8)^{a}	34.8 (1.3)^{b}	36.5 (3.9)^{b}
Total nitrogen (TN)	g/kg	2.5 (0.1)^{a}	2.7 (0.2)^{a}	3.3 (0.1)^{b}	3.3 (0.4)^{ab}
Clay	%	23.0 (0.9)^{a}	26.5 (1.1)^{b}	21.4 (0.8)^{a}	18.4 (2.3)^{a}
SOC/ TN	ratio	10.4 (0.1)^{ab}	10.1 (0.1)^{a}	10.6 (0.1)^{bc}	11.0 (0.3)^{c}
SOC/ Clay	ratio	0.13 (0.009)^{a}	0.12 (0.010)^{a}	0.17 (0.007)^{b}	0.22 (0.022)^{b}
[1]Plant					
Height	cm	7.1 (0.4)^{a}	6.3 (0.5)^{a}	4.5 (0.4)^{b}	-
Fresh density	kg FM ha^{-1}cm^{-1}	1073 (127)^{a}	1093 (150)^{a}	1502 (108)^{b}	-
Dry density	kg FM ha^{-1}cm^{-1}	198 (30)^{a}	290 (35)^{ab}	349 (26)^{b}	-
Crude protein	g/kg DM	223 (5.8)^{a}	200 (6.9)^{b}	235 (5.0)^{a}	-
Oil	g/kg DM	22.6 (0.37)^{a}	18.9 (0.44)^{b}	21.5 (0.32)^{c}	-

[1]Means within a column for the variable field and with different superscript letters (i.e., a,b,c) differ significantly and **attributed at P value <0.05**.

06 Final wrap-up

NIRS & aerial imaging analysis

- Gather key field variables like SOC, TN, Clay, crude protein, oil, plant height and vegetation cover information
- Considerable variation between critical soil and plant parameters across land uses

Accuracy and practicability

- Reduce time, cost and human efforts on real-time precision farm monitoring
- Verify confidence levels for both techniques with laboratory analysis

Future exploration

- Soil carbon stock estimates
- Vegetation performance indices
- Tillage practice monitoring
- Plant health status assessment

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