Real-time assessment of soil organic carbon across farms in Gloucestershire

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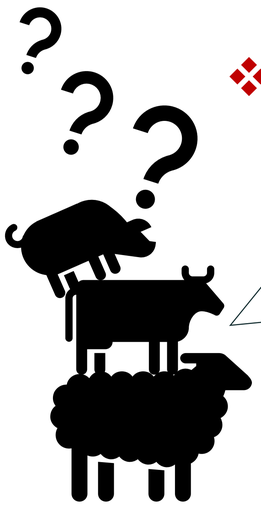
1 Measuring soil properties on-farm

- Previous studies ***promoted carbon assessment*** and ***flow of human and natural capital*** for ***ecological resilience***. But this often does ***not account***:



- ***Differences among farm and land uses***

Question:
Does soil organic carbon (SOC) differ among farms and agricultural land types?

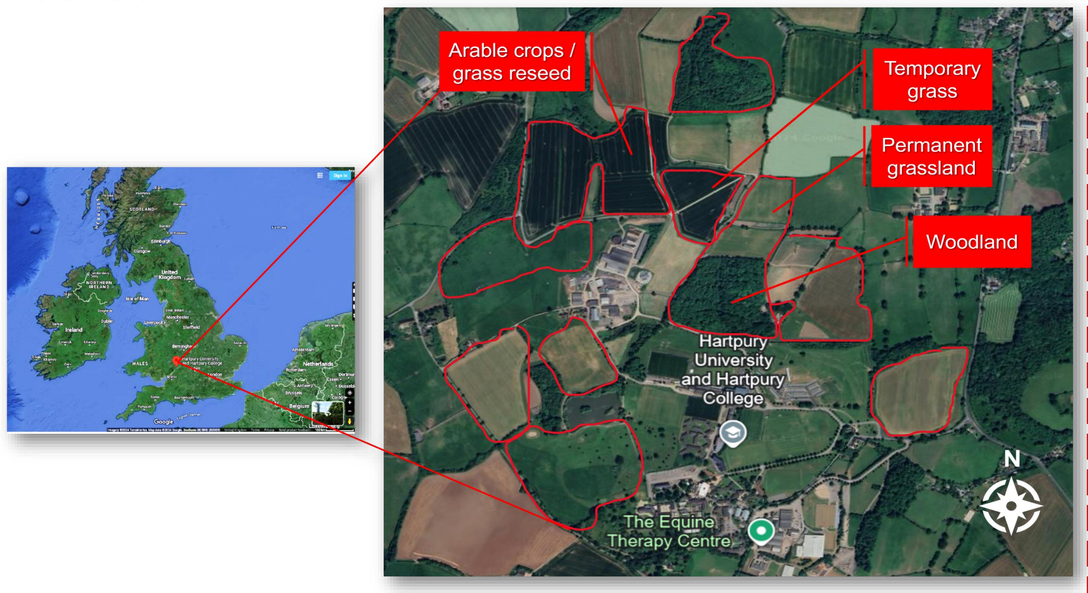


Figure 1: Study area at Hartpury University & partnered farms, UK

2 Solution: Real-time near-infrared spectroscopy (NIRS) technology

Figure 2a-c (left to right): (a)-(b) Arable and grassland fields; (c) NIRS Agrocares device for soil nutrients

1. Collect ***fresh soil cores (30cm depth)*** in ***'W' pattern***
2. Perform ***multiple NIRS scans*** on the fresh samples
3. Process ***linear mixed models*** by SPSS with fixed effects of ***farm, land type*** and ***farm X land type***

5 Conclusion

- The study shows that ***NIRS*** can serve as a ***user-friendly*** and ***practical alternative*** for ***large scale measurements*** to monitor ***soil properties*** among agricultural land uses.
- ***Further work*** is needed to ***evaluate*** the NIRS measurements against ***standard measurement*** approaches across ***a range of soil types*** to support ***large-scale field monitoring***

3 Key Results

Table 1: Predicted mean[1] soil organic carbon (SOC) properties for farms and land types

Fixed effects		Properties (unit)				
		Soil depth (cm)	SOC (g/kg)	SOC (t/ha)	SOC/TN[3] ratio	SOC/clay ratio
Farm[1]	A	24.7[a]	36.7[a]	56.1[ab]	9.7[a]	0.12
	B	30.0[b]	26.5[b]	62.7[a]	10.4[b]	0.15
	C	22.3[a]	34.1[a]	48.5[bc]	10.7[bc]	0.13
	D	22.7[a]	33.6[a]	42.7[c]	11.0[c]	0.12
	E	18.3[a]	35.6[a]	46.2[bc]	9.7[a]	0.12
	SED[2]	**1.0**	**2.8**	**5.4**	**0.2**	**0.02**
	P value	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**0.232**
Land type[1]	Arable	23.6[ab]	29.7[a]	51.1	10.3	0.11[a]
	Temporary ley	22.4[b]	29.5[a]	47.4	10.2	0.11[a]
	Permanent grass	24.8[a]	40.8[b]	55.2	10.4	0.17[b]
	SED[2]	**0.8**	**2.2**	**4.2**	**0.2**	**0.02**
	P value	**<0.05**	**<0.001**	**0.190**	**0.458**	**<0.001**
Farm X Land type						
A	Arable	22.7	27.2	52.1	9.5	0.08
	Temporary ley	24.0	26.7	48.7	9.6	0.08
	Permanent grass	22.3	56.4	67.4	10.1	0.20
B	Arable	30.0	24.9	62.9	10.6	0.15
	Temporary ley	30.0	22.9	55.5	10.1	0.11
	Permanent grass	30.0	31.7	69.8	10.6	0.18
C	Arable	25.0	27.0	49.5	10.6	0.10
	Temporary ley	19.3	33.3	45.2	10.7	0.12
	Permanent grass	22.7	42.1	50.8	10.8	0.17
D	Arable	17.3	35.6	40.7	11.2	0.12
	Temporary ley	21.7	33.1	46.1	11.0	0.12
	Permanent grass	29.0	32.0	41.2	10.8	0.12
E	Arable	18.0	33.7	50.3	9.7	0.11
	Temporary ley	17.0	31.3	41.4	9.7	0.10
	Permanent grass	20.0	41.7	46.8	9.8	0.16
	SED[2]	**1.2**	**3.3**	**6.5**	**0.2**	**0.02**
	P value	**<0.001**	**<0.05**	**0.730**	**0.422**	**0.241**

[1] Means for farm and land type within a column and with different superscript letters (i.e., a,b,c) differ significantly at P values < 0.001 or 0.05. [2] SED = standard errors of differences between means. [3] TN = total nitrogen.

- Among the study farms, ***Farm B*** had ***deeper soil depth (30 cm; P<0.001), higher SOC stock (62.7 t/ha; P<0.001)*** and ***SOC/clay ratio (0.15; P<0.232),*** but ***lower SOC levels (26.5 g/kg; P<0.001)***. ***Permanent grass*** had the ***highest SOC content (55.2 t/ha; P<0.001)*** and ***SOC/clay ratio (0.17; P<0.001)*** compared to both arable and temporary ley fields.
- A significance level of ***small P value <0.001*** or ***<0.05*** showed that there is a statistically ***significant relationship or difference*** in the ***soil properties*** under the fixed effects. Different superscript letters differed significantly at the small P values of the properties.
- This study also suggests that soil in ***arable and temporary ley fields altogether*** could ***store more organic carbon (g/kg)*** when compared with permanent grass fields.

4 Summary and Outlook on NIRS

Acknowledgement

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