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The State of Soil Health in Vermont: Summary statistics from Vermont agriculture in 2021

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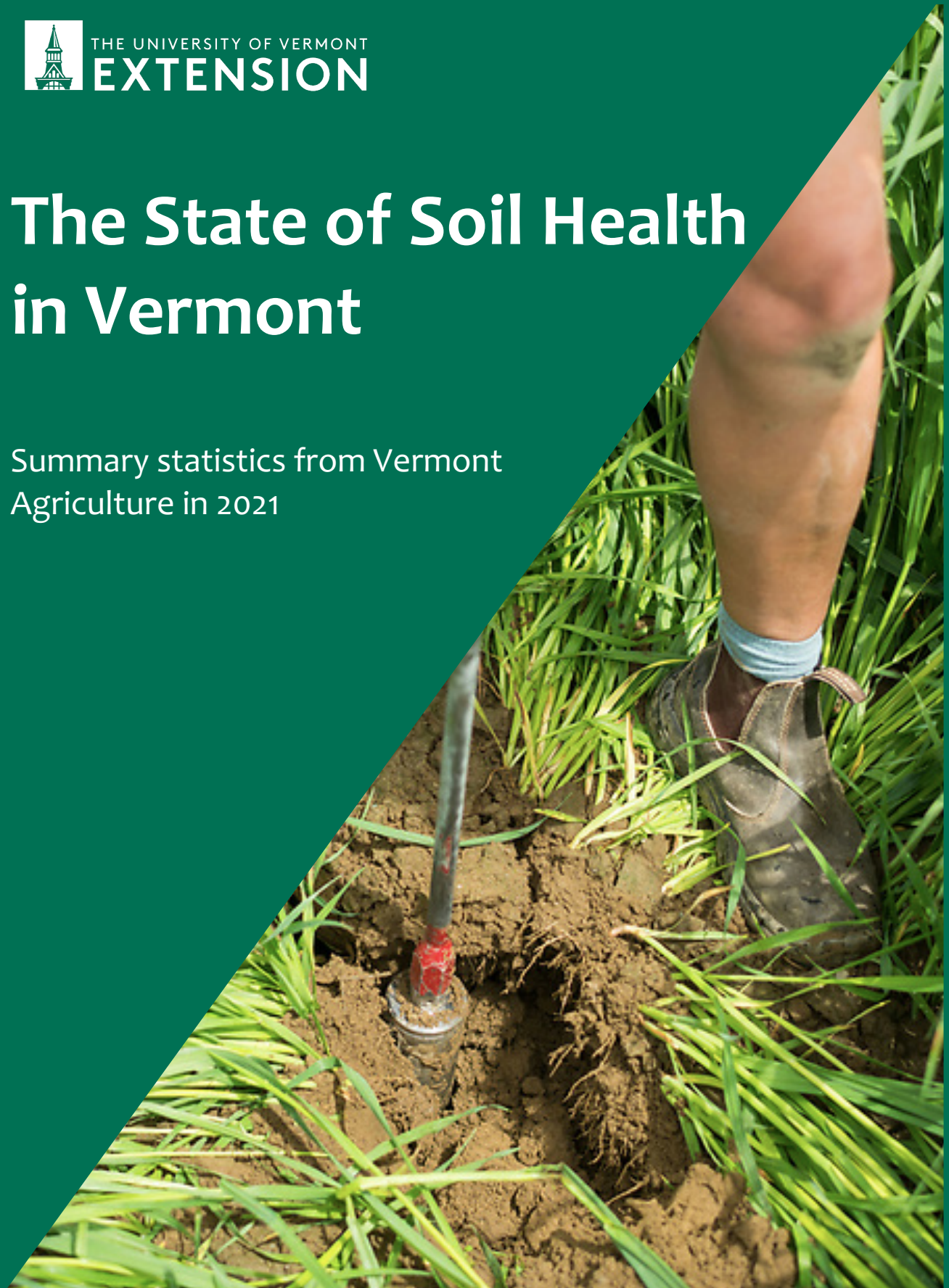
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EXTENSION

The State of Soil Health in Vermont

Summary statistics from Vermont Agriculture in 2021

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Contents

Introduction

This report shares the summary statistics of the soil health indicators evaluated in the 2021 State of Soil Health project on farms in Vermont. The aim of this report it to share the data in a simple format that can be accessed by farmers, advisors and policy makers. Subsequent reports and publications associated with the project may explore the implications and findings from this dataset in more detail.

About the project

The *State of Soil Health in Vermont* is an initiative to measure soil health and soil carbon on farms across the state of Vermont. This project is coordinated by UVM Extension and has relied on field support, in kind-donations and data sharing from partnering organizations. The project has five primary objectives:

- Establish a baseline of soil health indicators, carbon stocks, and associated ecosystem services in Vermont's agricultural landscapes

- Create soil health soil sampling standards across management types

- Provide farmers with contextualized information about soil health on their participating fields

- Support collaboration among the many organizations that work with farmers towards shared goals around soil health

- Build skills and capacity for measuring soil health and soil carbon stocks

Collaborators include UVM Extension, UVM Department of Plant & Soil Science, the Gund Institute for Environment, Dartmouth College, the Vermont Environmental Stewardship Program of the Vermont Agency of Agriculture, Food & Markets, the White River Conservation District, Vermont Association of Conservation Districts, Ben & Jerry's Caring Dairy Program and The Nature Conservancy Vermont.

What we measured

There are many methods for assessing aspects of soil health and soil characteristics. For this project, we prioritized methods which could be comparable to other standard procedures and efficient. Three types of samples were collected from most fields:

- 15 cm (6 inches) composite soil sample, which is a standard used for assessing soil health in many labs
- 30 cm (12 inches) composite soil sample, which was used for assessing soil carbon content to 30 cm depth
- Three undisturbed soil cores taken to a 30 cm depth to measure bulk density
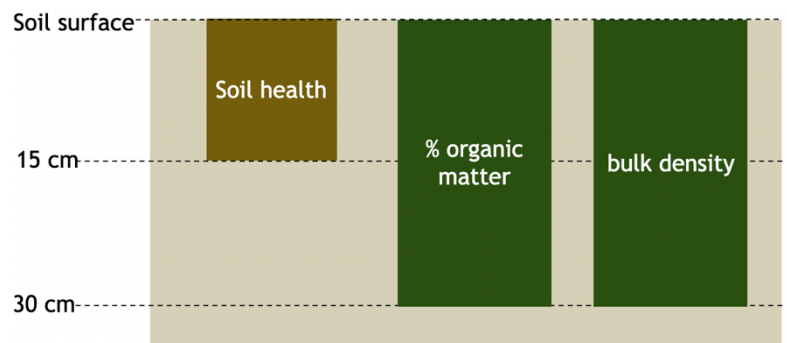
Figure 1. Sampling depths for State of Soil Health assays.

The 15 cm depth samples were analyzed by three labs to assess multiple soil health indicators. First, a portion of the 15 cm depth sample was submitted to the Cornell Soil Health Lab for the Comprehensive Assessment of Soil Health (CASH) test which is used across the United States to assess a package of over 10 different soil health indicators. Second, a portion of the 15 cm depth sample was analyzed at UVM's E.E. Cummings Crop Testing Lab for biological activity using a carbon substrate test called Ecoplate. Third, a portion of the 15 cm depth sample was assessed for different carbon fractions at the Dartmouth Hicks Pries Lab. The bulk density cores and 30 cm deep composite samples were used to assess soil carbon stocks, and were processed by the University of Vermont Agricultural and Environmental Testing Lab and DairyOne.

In our approach, we tried to capture varying soil health by asking some farms to sample a 'best' and 'worst' field in order to offer them an on-farm comparison and measure the breadth of soil health potential at each site. As a result, the average organic matter to 30 cm depth from all sampled fields in this project is 4.3%, which is 1% lower than the average organic matter content of samples received by the UVM soil testing lab.

Soil health indicators

We used the Comprehensive Assessment of Soil Health (CASH) developed by Cornell University as a foundation for our assessment. The CASH test includes a suite of physical, chemical and biological soil health indicators. We also measured additional biological, physical and carbon focused indicators that reflect the current interests of farmers, scientists and policy. Bulk density and organic matter to 30 cm depth were measured to provide data on soil carbon stocks to international IPCC standards. The bulk density measurement is also a good indicator of soil physical structure. A carbon substrate assay called EcoPlate by Biolog was used to explore biological diversity in the soil community and provided measure of functional metabolic diversity and metabolic vigor. Organic carbon in the soil samples was separated by size into particulate and mineral-associated fractions as an indicator of soil carbon durability.

Physical
- Bulk density
- Available water capacity
- Aggregate stability

Biological
- Organic matter
- ACE soil protein index
- Soil respiration
- Active carbon
- Metabolic diversity
- Metabolic vigor

Chemical
- Soil carbon
- Soil PH
- Extractable phosphorus
- Extractable potassium
- Minor elements
- Particulate and mineral associated carbon fractions
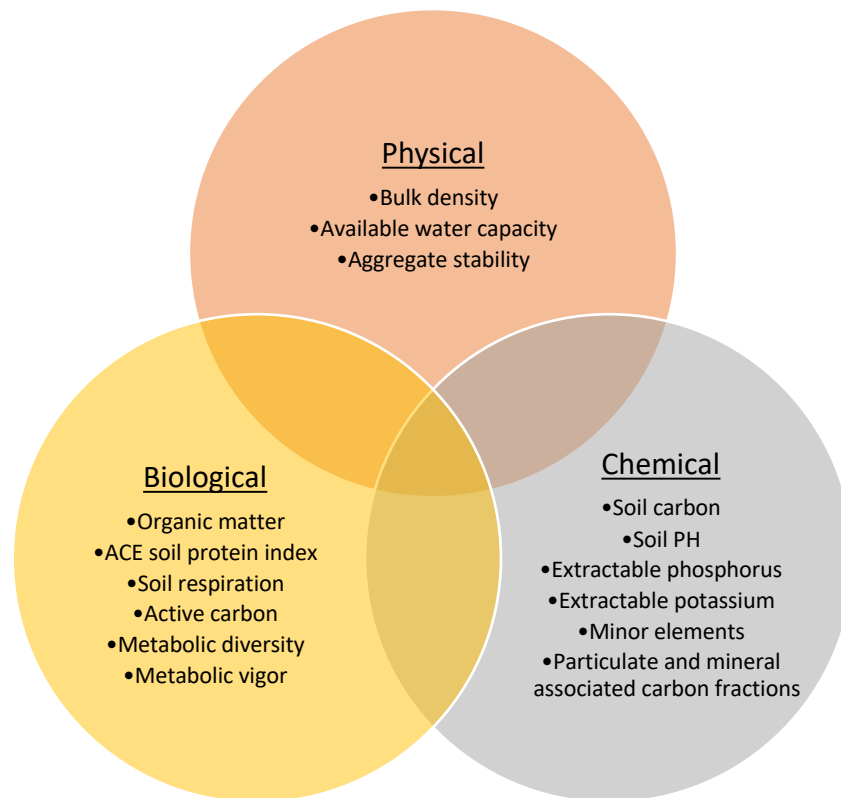
Figure 2. Physical, Chemical and Biological indicators of soil health measured by the 2021 State of Soil Health initiative.

Interpreting the summary statistics tables

This report contains two tables of summary statistics for each soil health indicator-- one grouped by crop type and one grouped by soil texture. Each table is accompanied by a box plot figure which visualizes the same data in the table.

Each table contains the following information:

- *n* is the number of samples .
- *minimum* is the smallest value recorded.
- *Q1* is the 25th percentile, or lower quartile. ¼ of the data are lower than this number.
- *Median* is the 50th percentile. This is the middle of the data. ½ of the data is lower that this number, and ½ of the data is larger than this number.
- *Mean* is the average value.
- *Q3* is the 75th percentile, or upper quartile. ¾ (75%) of the data are lower than this number.
- *Maximum* is the highest value recorded.
- *Standard deviation* is a measure of variance, and how dispersed the data is. A large standard deviation means the values are spread out over a wide range. A smaller standard deviation means most of the measured values were close to the mean (average).

Reading the boxplot figures

The boxplot figures visually present the summary statistics in the tables. Key features include:

- The line in the middle is the *median.*
- The box shows the range between the *25th percentile* and *the 75th percentile*. Half of the data values are in this range. This range is also known as the interquartile range.
- The vertical line is called the 'whisker', and it extends 1.5 times the interquartile range.
- Data points beyond the whisker range are considered outliers, represented by dots.
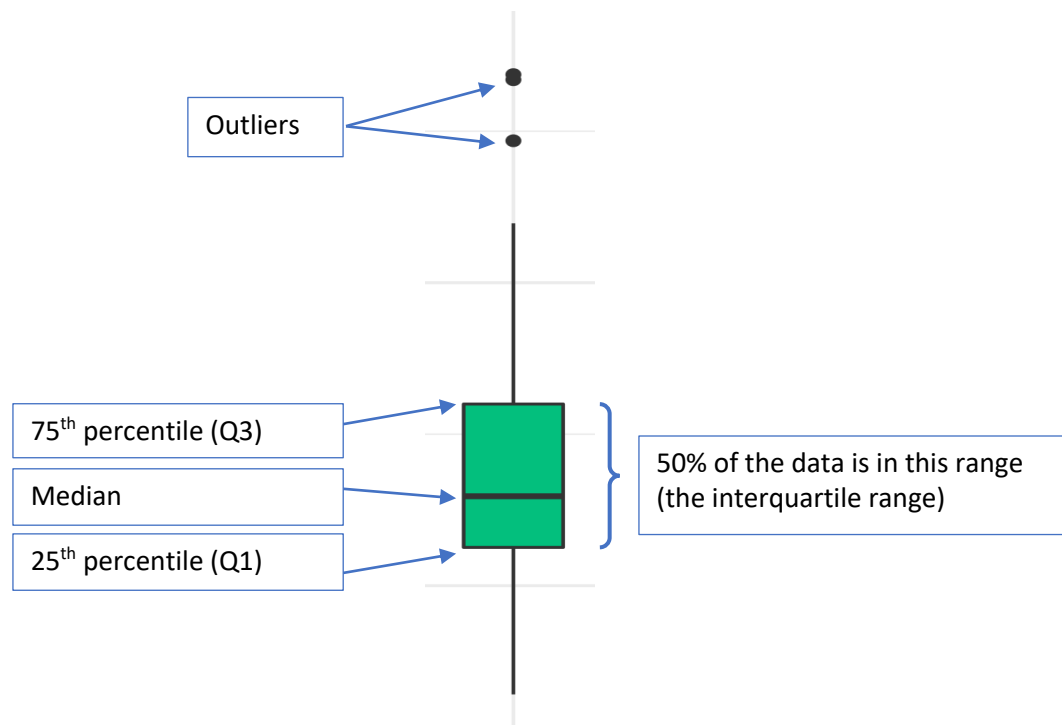
Organic matter

Organic matter content to 30 cm depth by crop type

Table 1. Descriptive statistics of organic matter content by crop type

Type	n	Minimum	Q1	Median % soil organic matter	Mean % soil organic matter	Q3	Maximum	Standard deviation
Veg	20	1.45	2.56	3.71	3.65	4.85	6.24	1.44
Field crops	4	3.63	4.29	5.53	5.50	6.73	7.30	1.71
Corn	113	1.57	3.42	3.96	4.09	4.67	7.17	1.08
Pasture	21	3.12	3.86	5.40	5.25	6.16	9.05	1.67
Hay	38	2.25	3.53	4.63	4.75	5.80	7.51	1.42
All fields	196	1.45	3.48	4.03	4.33	5.28	9.05	1.35
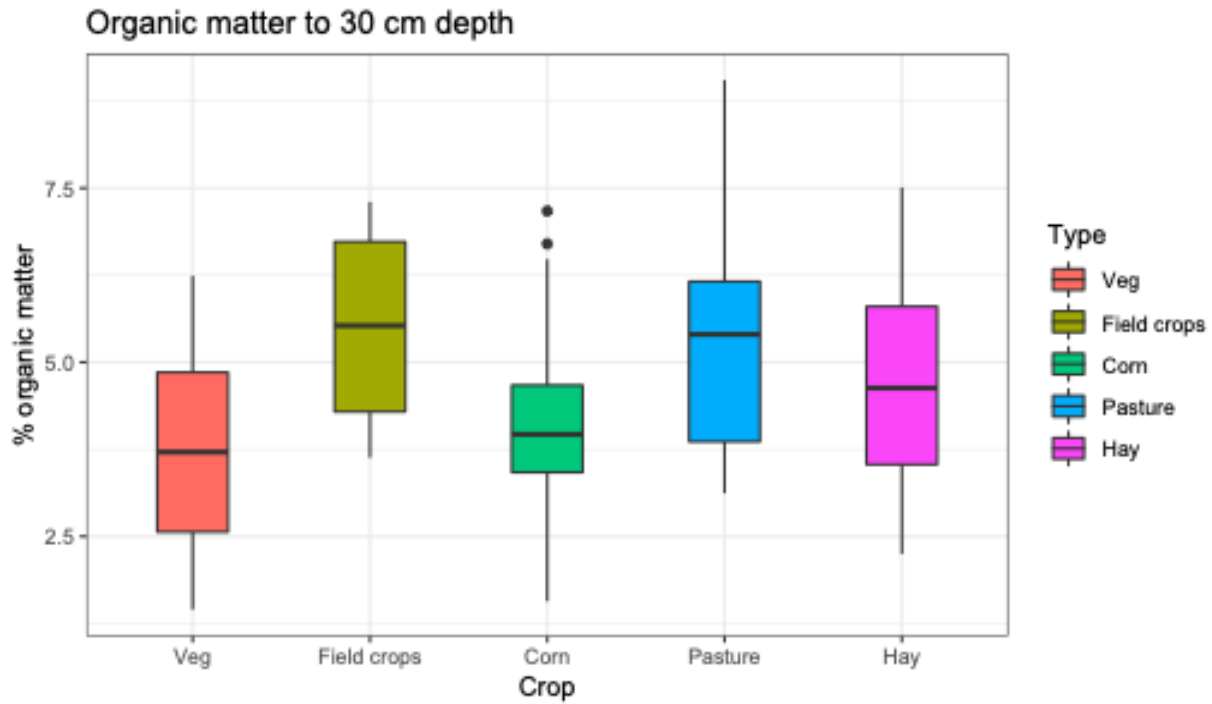
Figure 3. Boxplot of organic matter by crop type.

Soil organic matter 30 cm depth by soil texture

Table 2. Descriptive statistics of organic matter by soil texture class.

Soil texture	n	Minimum	Q1	Median % soil organic matter	Mean % soil organic matter	Q3	Maximum	Standard deviation
loamy sand	2	1.45	1.61	1.78	1.78	1.95	2.11	0.47
sandy loam	39	1.57	2.46	3.59	3.59	4.57	7.51	1.36
loam	89	2.23	3.51	3.96	4.22	4.85	7.23	1.05
silt loam	26	2.68	3.44	4.06	4.60	5.38	9.05	1.58
sandy clay loam	2	4.52	4.83	5.14	5.14	5.46	5.77	0.88
silty clay loam	10	4.12	5.69	5.84	5.99	6.29	8.68	1.32
clay loam	12	3.49	3.82	4.32	4.75	5.34	6.71	1.23
silty clay	10	3.26	4.25	5.19	5.00	5.83	6.34	1.05
clay	6	3.96	5.51	5.61	5.41	5.77	5.98	0.73
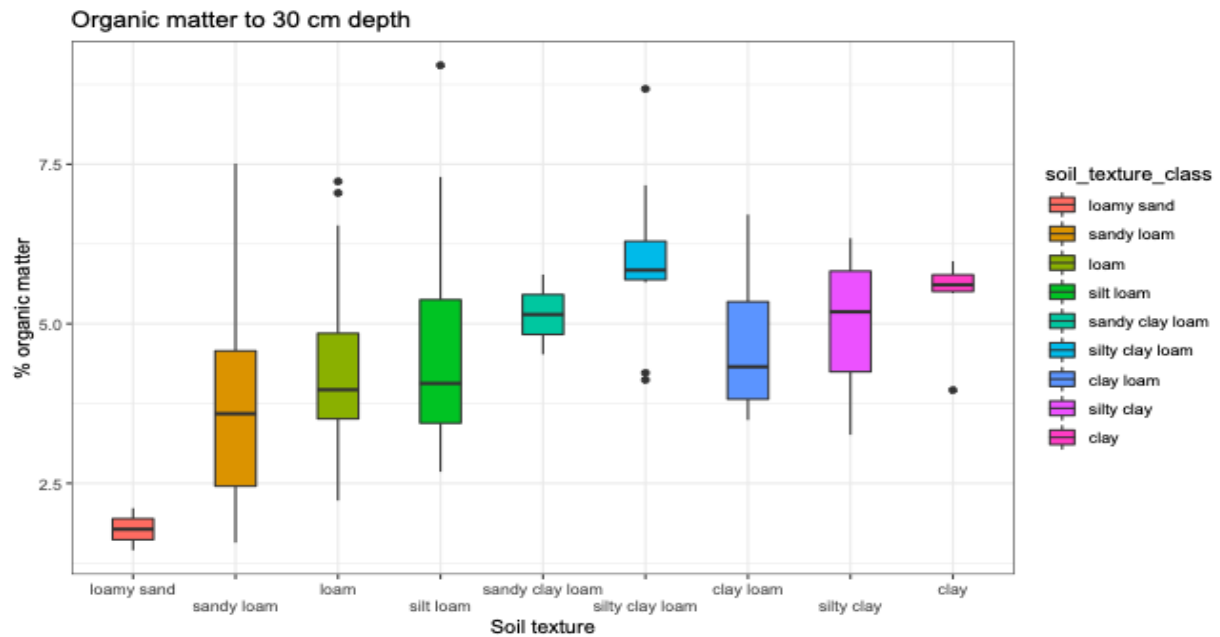
Figure 4. Boxplot of organic matter by soil texture.

Bulk density

Bulk density content to 30 cm depth by crop type

Table 3. Descriptive statistics of bulk density by crop type

Type	n	Minimum	Q1	Median bulk density g/cm³	Mean bulk density g/cm³	Q3	Maximum	Standard deviation
Veg	17	1.09	1.23	1.35	1.33	1.44	1.49	0.13
Field crops	4	1.18	1.3	1.35	1.32	1.37	1.39	0.09
Corn	113	1.09	1.28	1.38	1.38	1.46	2.17	0.16
Pasture	21	0.98	1.18	1.27	1.23	1.32	1.42	0.13
Hay	37	0.93	1.23	1.32	1.33	1.41	1.83	0.18
All fields	192	0.93	1.25	1.34	1.35	1.44	2.17	0.17
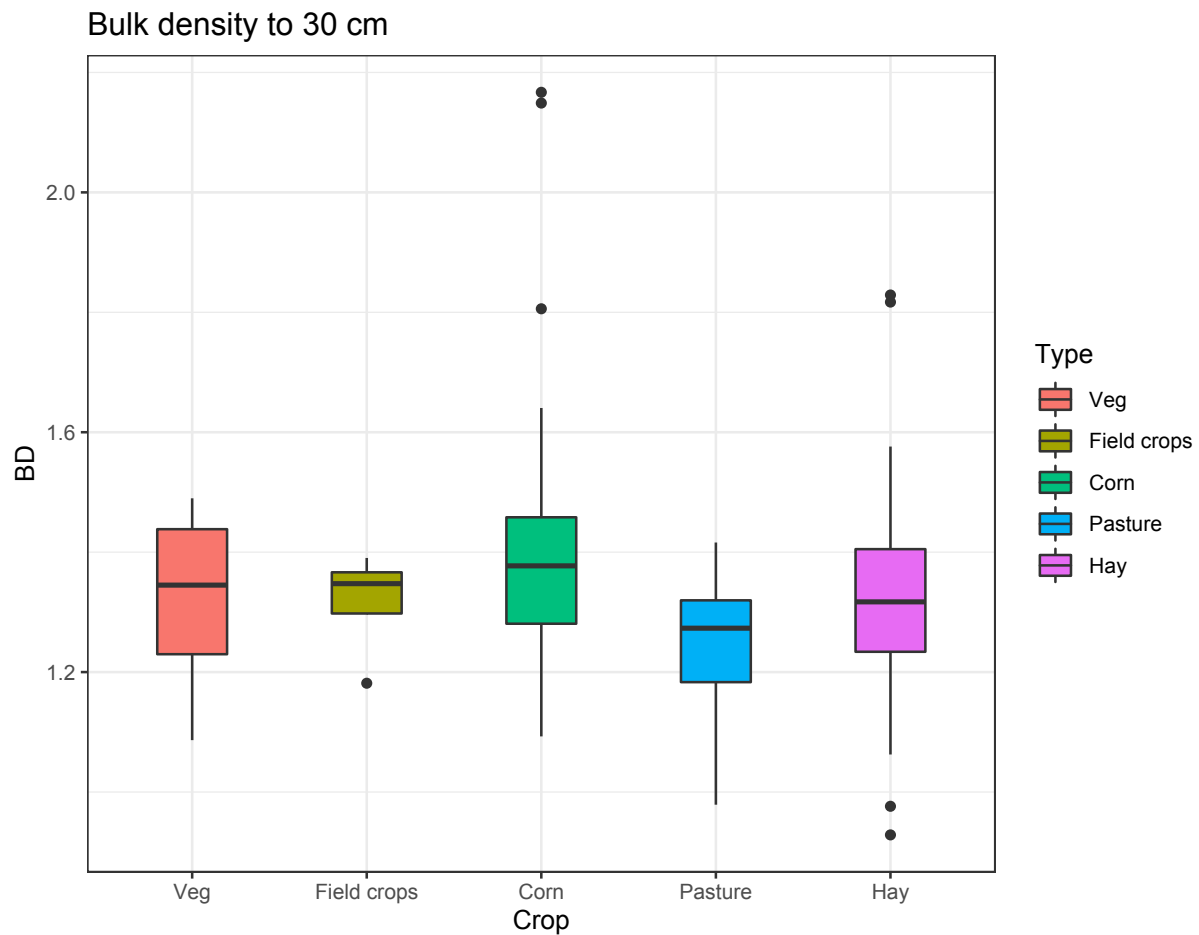
Figure 5. Boxplot of bulk density g/cm³ by crop type.

Bulk density to 30 cm depth by soil texture

Table 4. Descriptive statistics of bulk density by soil texture class.

Soil texture	n	Minimum	Q1	Median bulk density g/cm³	Mean bulk density g/cm³	Q3	Maximum	Standard deviation
loamy sand	2	1.44	1.45	1.47	1.47	1.48	1.49	0.03
sandy loam	40	0.93	1.32	1.38	1.38	1.44	1.83	0.15
loam	86	0.98	1.23	1.34	1.35	1.46	2.17	0.19
silt loam	24	1.01	1.25	1.33	1.31	1.39	1.57	0.12
sandy clay loam	2	1.23	1.23	1.24	1.24	1.24	1.24	0
silty clay loam	10	1.28	1.3	1.31	1.33	1.34	1.48	0.07
clay loam	12	1.19	1.28	1.44	1.42	1.52	1.63	0.15
silty clay	10	1	1.2	1.32	1.28	1.39	1.51	0.16
clay	6	1.09	1.16	1.26	1.25	1.31	1.42	0.12
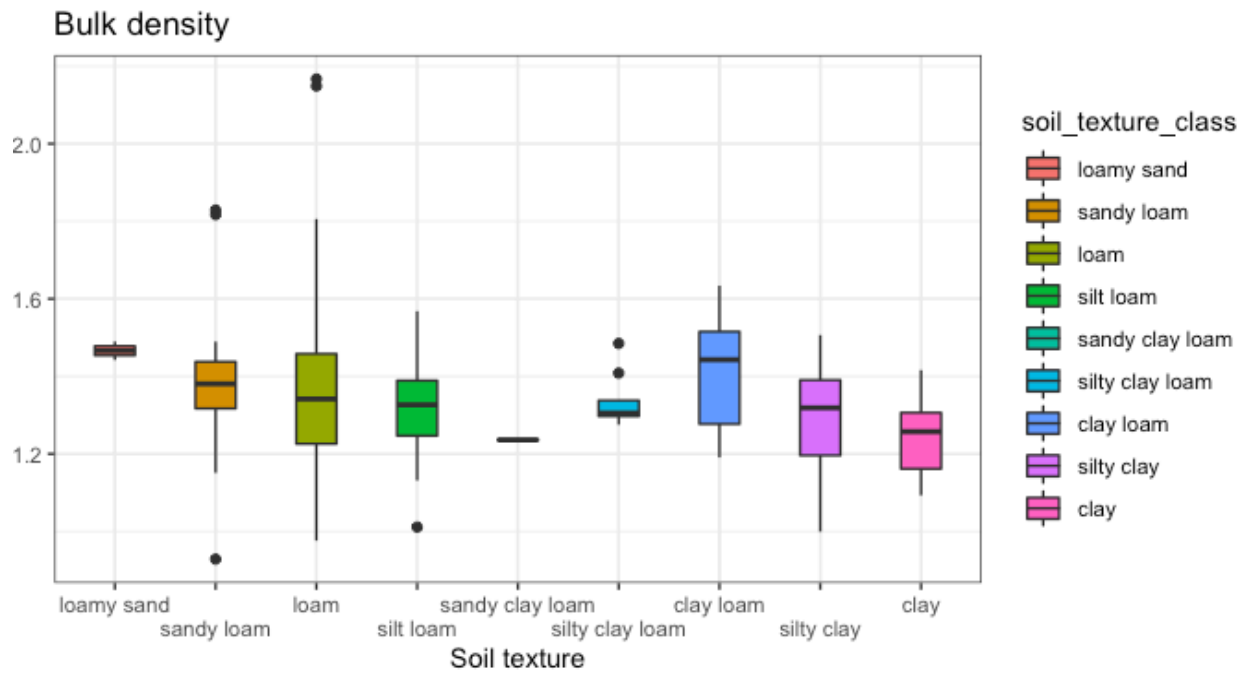
Figure 6. Boxplot of bulk density in g/cm³ by soil texture.

Soil carbon stocks

Soil carbon stocks to 30 cm depth by crop type

Table 5. Descriptive statistics of soil carbon stocks in MT C/ha by crop type

Type	n	Minimum	Q1	Median	Mean	Q3	Maximum	Standard deviation
Veg	17	31.10	52.53	56.90	65.05	80.45	97.60	20.27
Field crops	4	75.70	86.74	103.16	107.69	124.11	148.75	32.01
Corn	112	33.35	70.02	81.94	84.11	95.76	143.95	21.16
Pasture	21	63.44	73.43	84.11	95.76	116.84	170.41	28.85
Hay	37	31.34	72.51	92.15	94.07	111.09	164.12	28.06
All fields	*191*	*31.1*	*69.94*	*83.53*	*86.12*	*99.6*	*170.41*	*24.97*
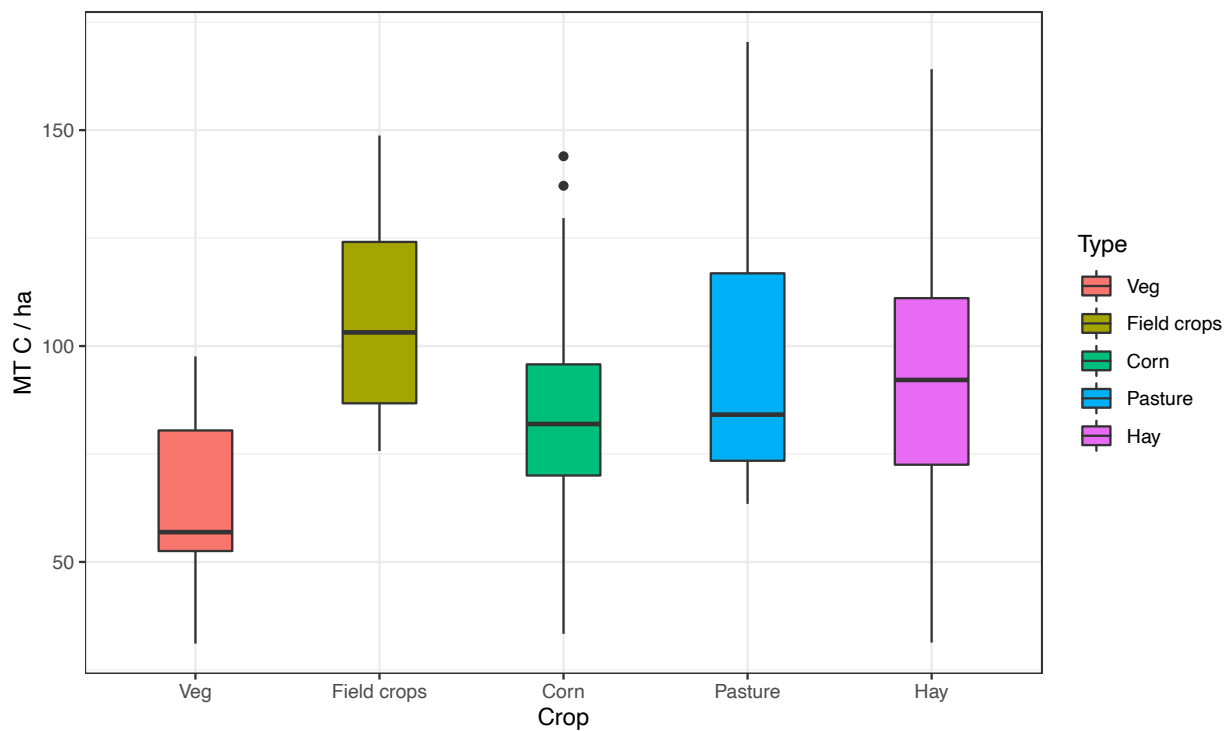
Figure 7. Boxplot of soil carbon stocks by crop type.

Soil carbon stocks to 30 cm depth by soil texture

Table 6. Descriptive statistics of soil carbon stocks in MT C/ha by soil texture class.

Soil texture	n	Minimum	Q1	Median	Mean	Q3	Maximum	Standard deviation
loamy sand	2	31.10	34.74	38.37	38.37	42.00	45.64	10.28
sandy loam	39	31.34	55.33	73.20	73.73	91.25	164.12	28.51
loam	86	52.49	70.53	79.98	83.66	91.23	142.93	18.20
silt loam	24	52.00	67.84	83.65	90.38	113.55	148.75	28.04
sandy clay loam	2	83.66	89.53	95.41	95.41	101.29	107.17	16.63
silty clay loam	10	80.45	111.83	120.94	119.93	128.74	170.41	26.64
clay loam	12	80.61	89.12	92.40	98.99	104.24	137.11	17.49
silty clay	10	66.25	87.46	93.18	95.24	99.10	143.27	19.93
clay	6	84.11	94.48	102.29	100.26	107.76	111.43	10.40
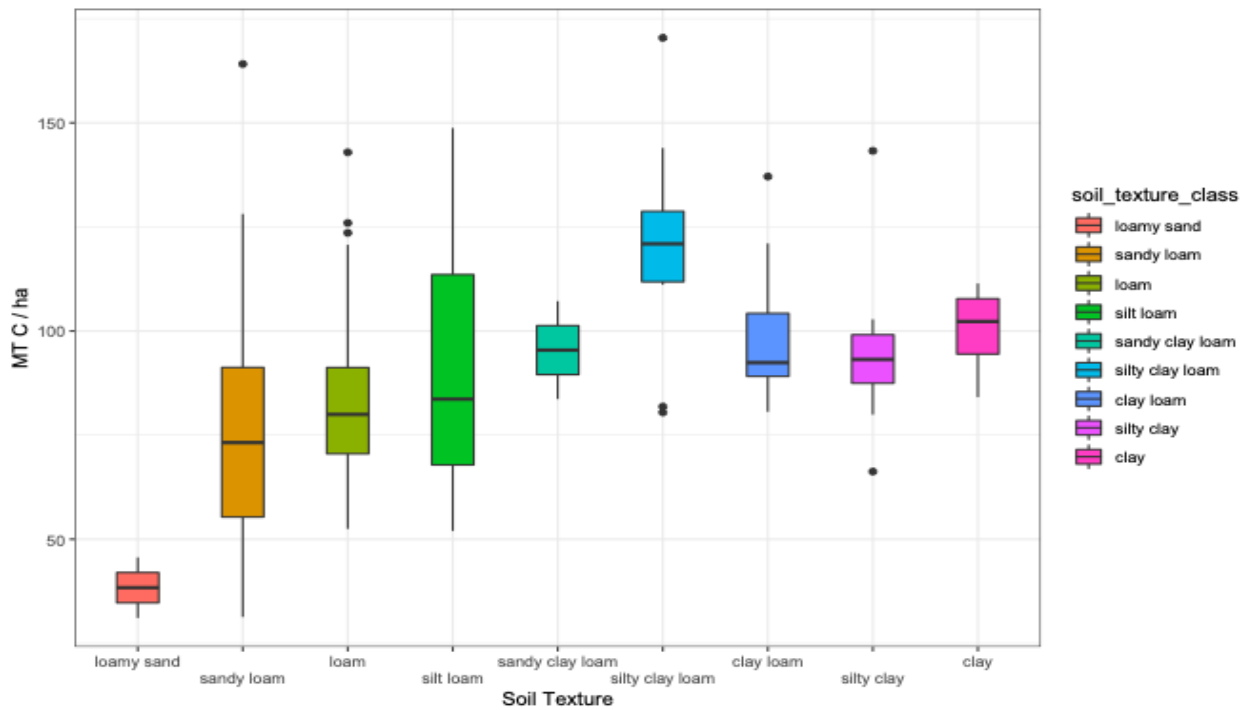
Figure 8. Boxplot of soil carbon stocks by soil texture class.

Aggregate stability

Aggregate stability to 15 cm depth by crop type

Table 7. Descriptive statistics of aggregate stability by crop type

Type	n	Minimum	Q1	Median % stable aggregates	Mean % stable aggregates	Q3	Maximum	Standard deviation
Veg	22	11.57	22.63	34.86	38.48	53.18	74.23	19.31
Field crops	4	26.28	37.96	56.21	56.12	74.37	85.78	26.97
Corn	114	1.88	25.74	39.98	39.77	49.41	80.97	17.25
Pasture	37	14.97	29.61	64.55	57.63	80.70	92.13	26.28
Hay	44	19.03	39.46	62.33	58.79	77.49	90.53	20.88
All fields	221	1.88	29.41	43.48	46.72	64.49	92.13	21.89
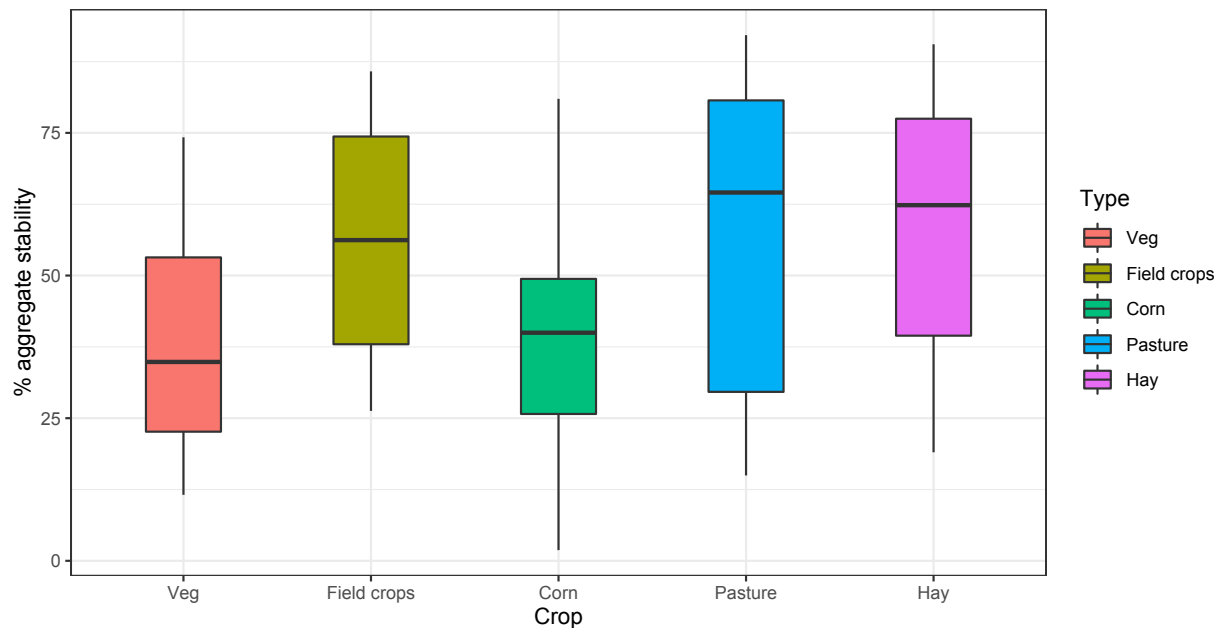
Figure 9. Boxplot of aggregate stability by crop type.

Aggregate stability by soil texture

Table 8. Descriptive statistics of aggregate stability by soil texture class.

Soil texture	n	Minimum	Q1	Median % stable aggregates	Mean % stable aggregates	Q3	Maximum	Standard deviation
loamy sand	2	25.74	34.23	42.73	42.73	51.22	59.72	24.03
sandy loam	40	1.88	36.60	47.93	49.78	67.18	86.87	21.46
loam	95	12.01	28.18	43.81	48.38	66.88	92.13	22.65
silt loam	28	3.93	35.25	44.86	50.97	69.81	87.25	22.60
sandy clay loam	2	68.89	70.18	71.48	71.48	72.77	74.07	3.66
silty clay loam	19	16.31	28.21	35.27	41.93	57.83	79.36	20.76
clay loam	14	9.79	20.31	30.31	38.27	55.64	85.18	23.57
silty clay	15	14.97	22.24	34.90	34.46	39.77	62.31	14.25
clay	6	19.78	36.89	41.27	38.70	45.60	47.40	10.23
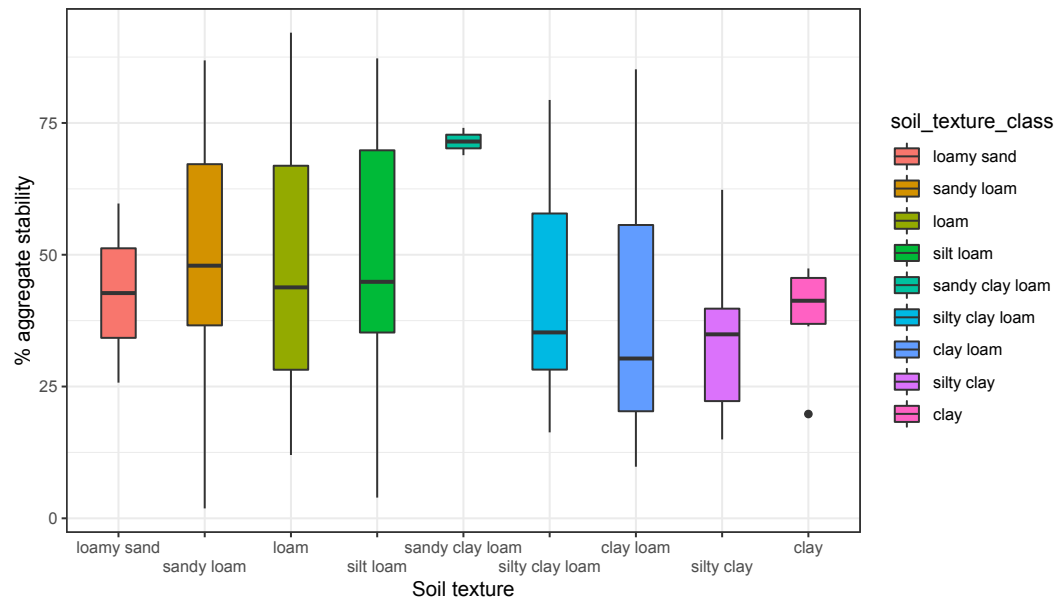
Figure 10. Boxplot of aggregate stability by soil texture.

Respiration

Respiration by crop type

Table 9. Descriptive statistics of respiration in mg CO_2 /g by crop type

Type	n	Minimum	Q1	Median	Mean	Q3	Maximum	Standard deviation
Veg	22	0.26	0.47	0.62	0.67	0.81	1.38	0.29
Field crops	4	0.69	0.73	0.79	0.85	0.91	1.13	0.20
Corn	114	0.32	0.56	0.65	0.69	0.80	1.34	0.19
Pasture	37	0.46	0.92	1.09	1.12	1.25	1.85	0.32
Hay	44	0.47	0.70	0.91	0.95	1.12	1.70	0.30
All fields	*221*	*0.26*	*0.6*	*0.74*	*0.81*	*0.99*	*1.85*	*0.3*
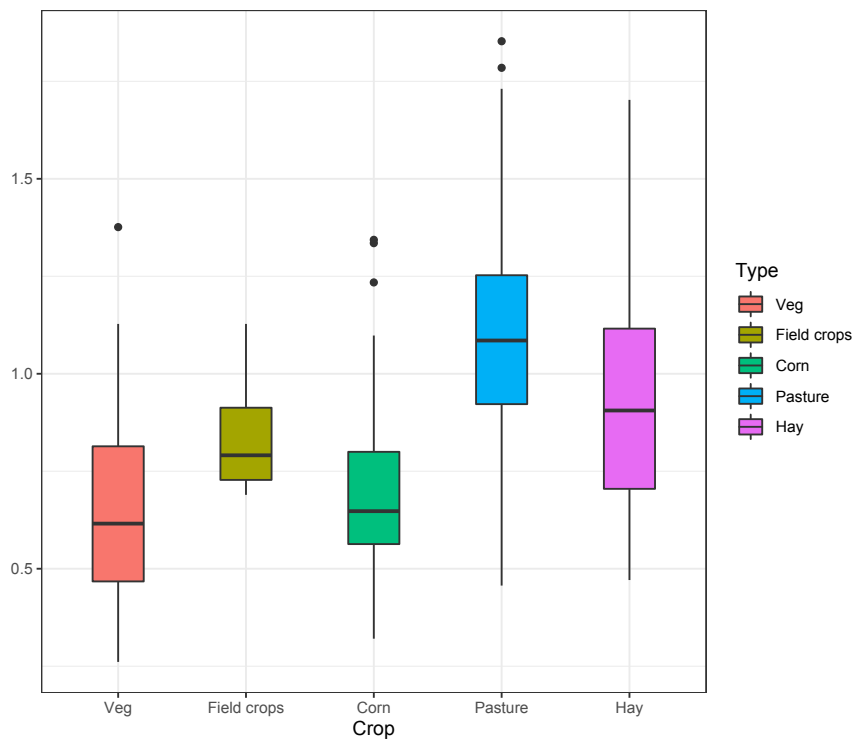
Figure 11. Boxplot of respiration in mg CO_2 /g by crop type.

Respiration by soil texture

Table 10. Descriptive statistics of respiration in mg CO_2 /g by soil texture class.

Soil texture	n	Minimum	Q1	Median	Mean	Q3	Maximum	Standard deviation
loamy sand	2	0.26	0.32	0.37	0.37	0.43	0.48	0.16
sandy loam	40	0.32	0.51	0.61	0.63	0.68	1.14	0.19
loam	95	0.40	0.60	0.74	0.79	0.89	1.85	0.29
silt loam	28	0.29	0.63	0.74	0.88	1.19	1.70	0.35
sandy clay loam	2	1.12	1.25	1.37	1.37	1.50	1.62	0.35
silty clay loam	19	0.54	0.93	1.07	1.07	1.21	1.51	0.25
clay loam	14	0.55	0.67	0.90	0.93	1.02	1.78	0.35
silty clay	15	0.52	0.69	0.87	0.86	1.04	1.16	0.21
clay	6	0.46	0.70	0.76	0.76	0.82	1.07	0.20
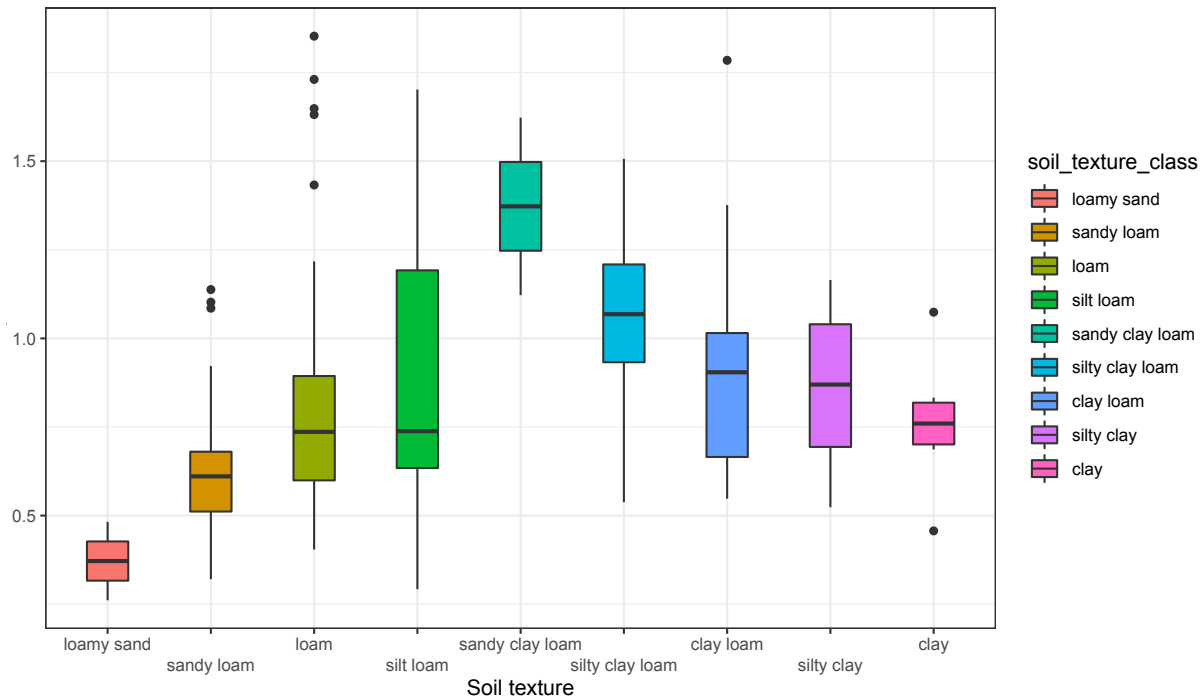
Figure 12. Boxplot of respiration in mg CO_2 /g by soil texture class.

Active carbon

Active carbon by crop type

Table 11. Descriptive statistics of active carbon in ppm by crop type

Type	n	Minimum	Q1	Median	Mean	Q3	Maximum	Standard deviation
Veg	22	249.28	533.11	717.42	737.02	905.90	1316.15	283.96
Field crops	4	681.38	758.02	788.97	771.61	802.56	827.13	62.94
Corn	114	369.26	647.08	709.84	731.01	812.78	1083.95	139.31
Pasture	37	457.19	720.50	842.07	826.46	956.94	1128.24	170.40
Hay	44	420.00	647.52	775.29	775.10	881.92	1054.96	147.59
All fields	*221*	*249.28*	*648.57*	*740.05*	*757.1*	*875.94*	*1316.15*	*167.33*
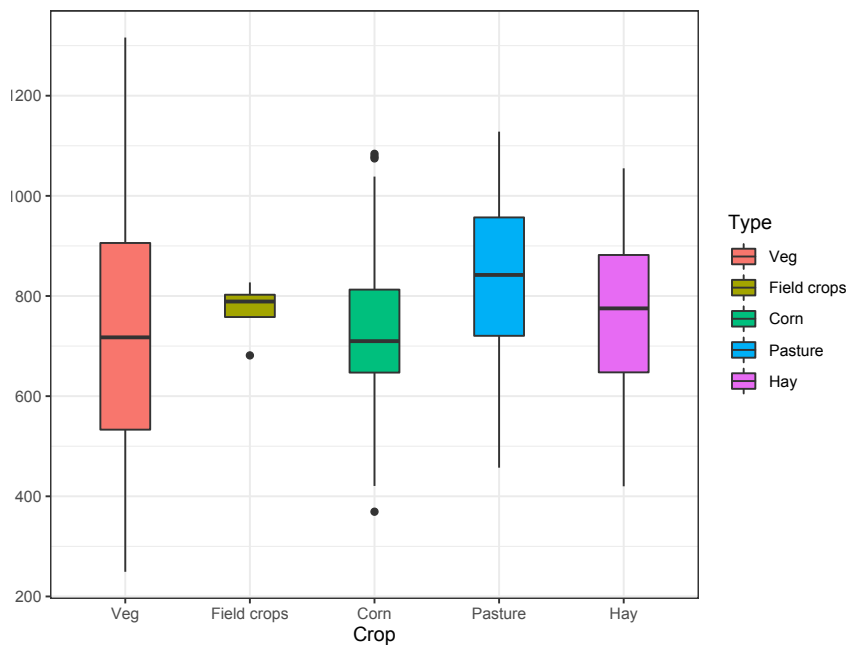
Figure 13. Boxplot of active carbon in ppm by crop type.

Active carbon by soil texture

Table 12. Descriptive statistics of active carbon in ppm by soil texture class.

Soil texture	n	Minimum	Q1	Median	Mean	Q3	Maximum	Standard deviation
loamy sand	2	249.28	360.77	472.26	472.26	583.75	695.24	315.34
sandy loam	40	336.53	552.87	662.96	661.30	746.97	1029.70	160.61
loam	95	420.00	646.19	725.58	747.67	833.70	1316.15	148.32
silt loam	28	436.33	645.26	728.26	754.16	884.60	1128.24	166.46
sandy clay loam	2	867.76	891.66	915.56	915.56	939.45	963.35	67.60
silty clay loam	19	567.77	877.01	940.61	933.35	1031.80	1096.49	129.55
clay loam	14	602.42	764.07	836.60	849.97	903.50	1296.03	167.55
silty clay	15	648.57	748.25	797.28	808.96	882.39	970.50	93.03
clay	6	457.19	667.45	740.99	696.58	780.71	803.44	129.74
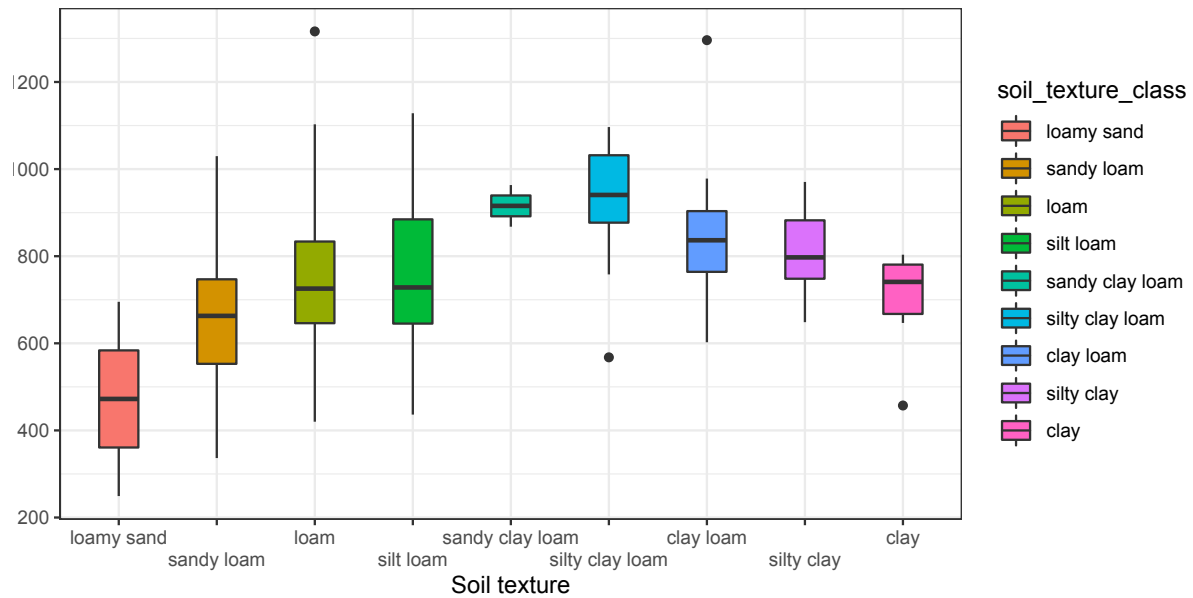
Figure 14. Boxplot of active carbon in ppm by soil texture class.

Average metabolic rate

Average metabolic rate by crop type

Table 13. Descriptive statistics of average metabolic rate in A$_{590}$ (absorbance at 590nm at 72 hours incubation) by crop type

Type	n	Minimum	Q1	Median	Mean	Q3	Maximum	Standard deviation
Veg	11	0.58	0.84	0.99	0.98	1.09	1.39	0.25
Field crops	1	1.12	1.12	1.12	1.12	1.12	1.12	NA
Corn	74	0.33	0.63	0.79	0.81	0.95	1.41	0.25
Pasture	17	0.32	0.57	0.72	0.79	1.01	1.27	0.27
Hay	17	0.28	0.53	0.82	0.78	0.97	1.38	0.29
All fields	*120*	*0.28*	*0.64*	*0.8*	*0.82*	*0.99*	*1.41*	*0.26*
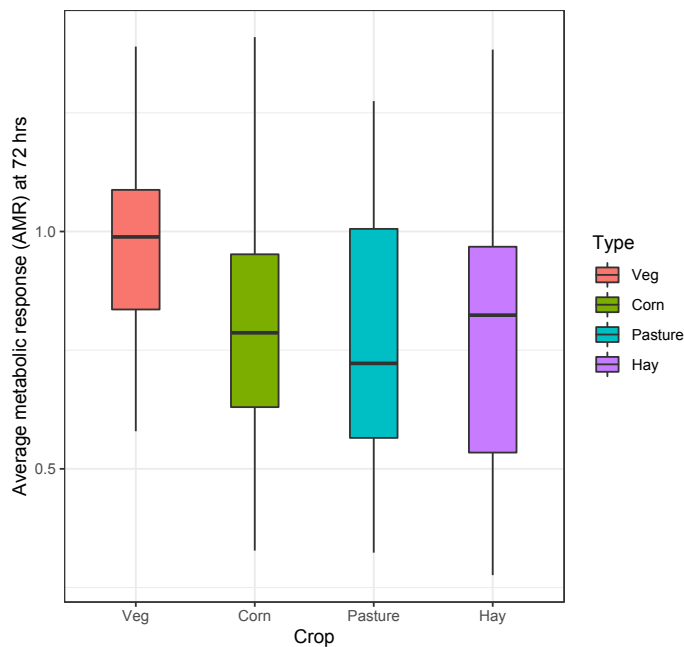
Figure 15. Boxplot of average metabolic rate in A$_{590}$ by crop type.

Average metabolic rate by soil texture

Table 14. Descriptive statistics of average metabolic rate in A$_{590}$ by soil texture class.

Soil texture	n	Minimum	Q1	Median	Mean	Q3	Maximum	Standard deviation
loamy sand	0	NA	NA	NA	NA	NA	NA	NA
sandy loam	26	0.33	0.64	0.83	0.81	0.98	1.37	40
loam	44	0.32	0.58	0.77	0.81	0.99	1.41	95
silt loam	21	0.28	0.69	0.79	0.81	0.95	1.32	28
sandy clay loam	1	1.38	1.38	1.38	1.38	1.38	1.38	2
silty clay loam	8	0.65	0.69	0.78	0.84	0.93	1.27	19
clay loam	8	0.56	0.76	0.99	0.90	1.08	1.10	14
silty clay	8	0.46	0.71	0.81	0.82	0.99	1.10	15
clay	4	0.53	0.53	0.72	0.74	0.93	1.01	6
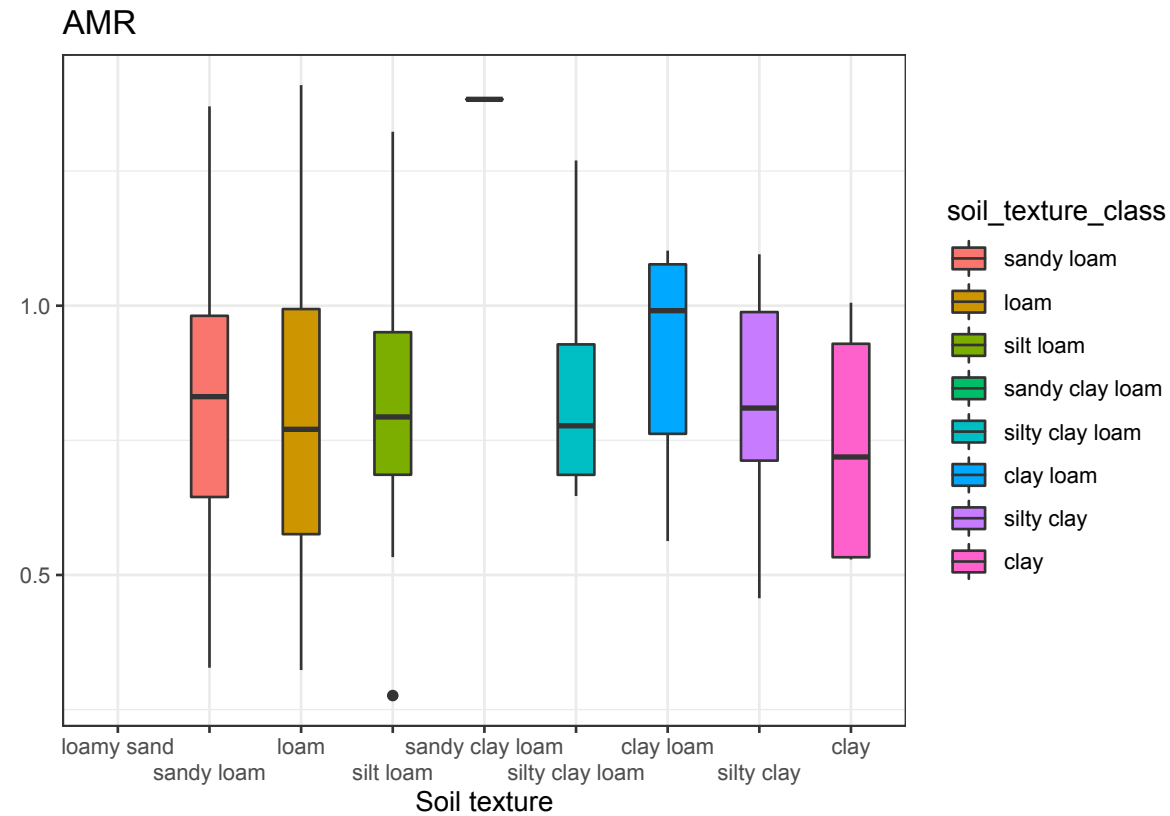
Figure 16. Boxplot of average metabolic rate in A$_{590}$ by soil texture class.

Functional metabolic diversity

Functional metabolic diversity by crop type

Table 15. Descriptive statistics of functional metabolic diversity as % (percent of available carbon substrates metabolized within 72 hours) by crop type

Type	n	Minimum	Q1	Median %	Mean %	Q3	Maximum	Standard deviation
Veg	11	52.69	67.74	70.97	71.46	75.27	86.02	9.39
Field crops	1	77.42	77.42	77.42	77.42	77.42	77.42	NA
Corn	74	34.41	57.26	64.52	65.13	75.27	88.17	13.03
Pasture	17	45.16	55.91	66.67	66.29	78.49	84.95	12.08
Hay	17	37.63	60.22	67.74	65.84	77.42	84.95	14.36
All fields	*120*	34.41	58.06	66.67	66.08	75.81	88.17	12.77
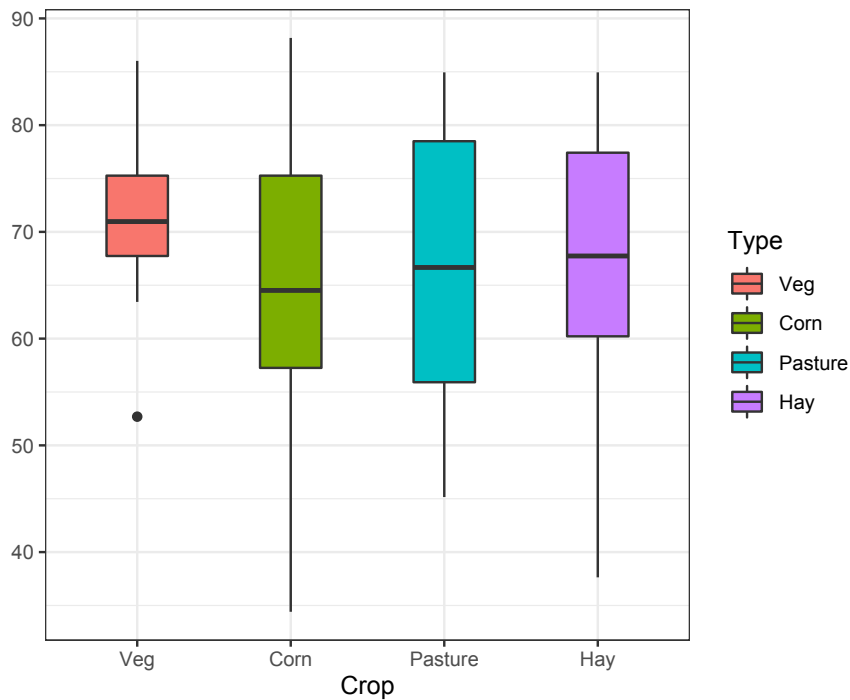
Figure 17. Boxplot of % functional metabolic diversity by crop type.

Functional metabolic diversity by soil texture

Table 16. Descriptive statistics of functional metabolic diversity by soil texture class.

Soil texture	n	Minimum	Q1	Median %	Mean %	Q3	Maximum	Standard deviation
loamy sand	0	NA	NA	NA	NA	NA	NA	NA
sandy loam	26	34.41	60.22	69.89	67.54	76.88	88.17	13.50
loam	44	38.71	53.49	63.44	64.30	75.81	86.02	13.89
silt loam	21	37.63	59.14	66.67	65.44	75.27	84.95	11.94
sandy clay loam	1	84.95	84.95	84.95	84.95	84.95	84.95	NA
silty clay loam	8	58.06	65.05	67.20	68.68	74.19	79.57	7.63
clay loam	8	55.91	65.05	69.89	71.51	80.91	87.10	11.74
silty clay	8	46.24	59.14	67.74	66.13	72.85	79.57	11.19
clay	4	48.39	50.00	56.45	58.60	65.05	73.12	11.46
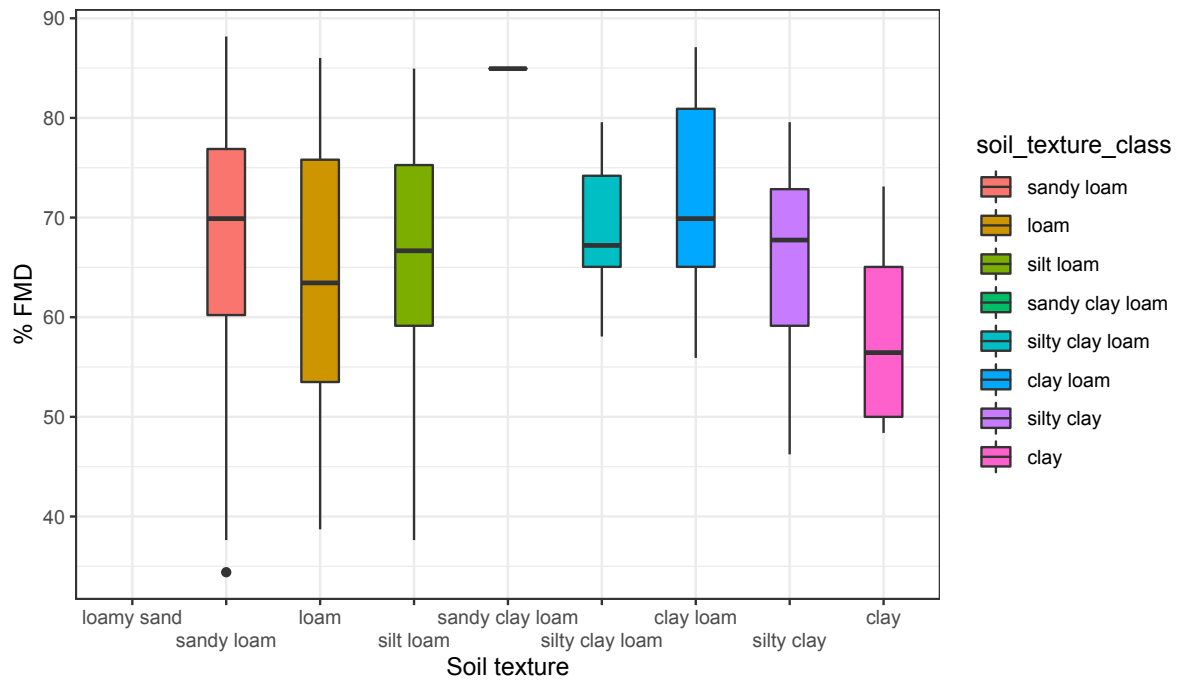
Figure 18. Boxplot of functional metabolic diversity by soil texture class.

ACE Soil Protein Index

ACE soil protein index by crop type

Table 17. Descriptive statistics of ACE soil protein index (mg/g dry weight) by crop type

Type	n	Minimum	Q1	Median	Mean	Q3	Maximum	Standard deviation
Veg	22	3.92	5.64	9.68	8.87	11.36	13.83	3.17
Field crops	4	8.04	8.51	9.70	9.66	10.86	11.20	1.55
Corn	114	3.77	7.11	8.02	8.53	9.56	16.20	2.45
Pasture	37	5.29	7.70	9.64	10.41	12.35	20.23	3.81
Hay	44	5.30	7.59	9.58	9.89	11.37	17.45	3.09
All fields	*221*	*3.77*	*7.14*	*8.48*	*9.17*	*10.84*	*20.23*	*2.98*
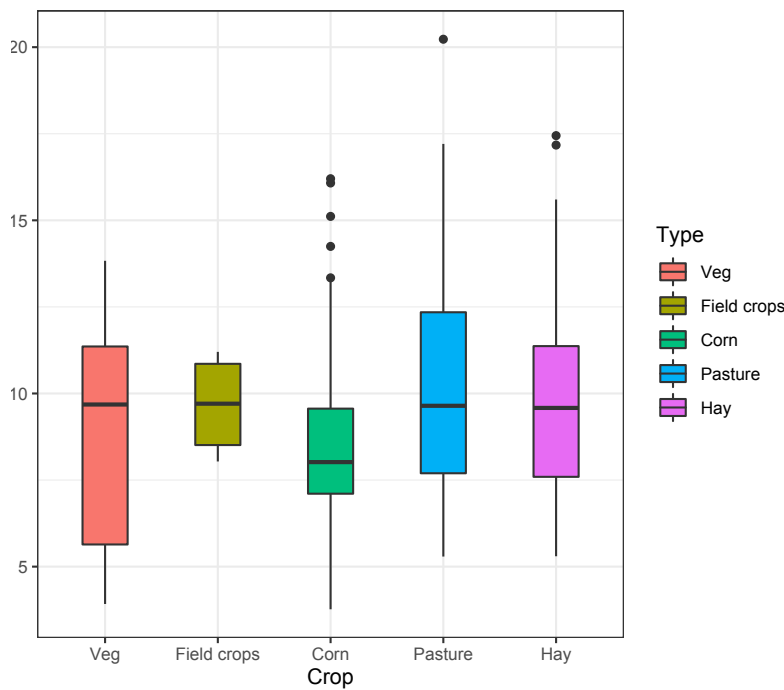
Figure 19. Boxplot of ACE soil protein (mg/g dry weight) by crop type.

ACE soil protein index by soil texture

Table 18. Descriptive statistics for ACE soil protein index (mg/g dry weight) by soil texture class.

Soil texture	n	Minimum	Q1	Median	Mean	Q3	Maximum	Standard deviation
loamy sand	2	3.92	4.95	5.99	5.99	7.02	8.05	2.92
sandy loam	40	4.22	7.03	8.32	9.10	11.59	15.60	3.13
loam	95	5.02	7.36	8.53	9.27	10.80	17.21	2.64
silt loam	28	4.83	7.47	9.12	9.87	11.09	20.23	3.87
sandy clay loam	2	13.58	13.90	14.22	14.22	14.53	14.85	0.90
silty clay loam	19	5.63	7.66	8.31	9.77	12.03	16.76	3.21
clay loam	14	6.56	7.39	8.92	9.04	9.40	14.58	2.16
silty clay	15	3.77	5.30	6.33	6.82	8.60	10.53	2.26
clay	6	6.61	7.99	8.51	8.43	8.73	10.31	1.21
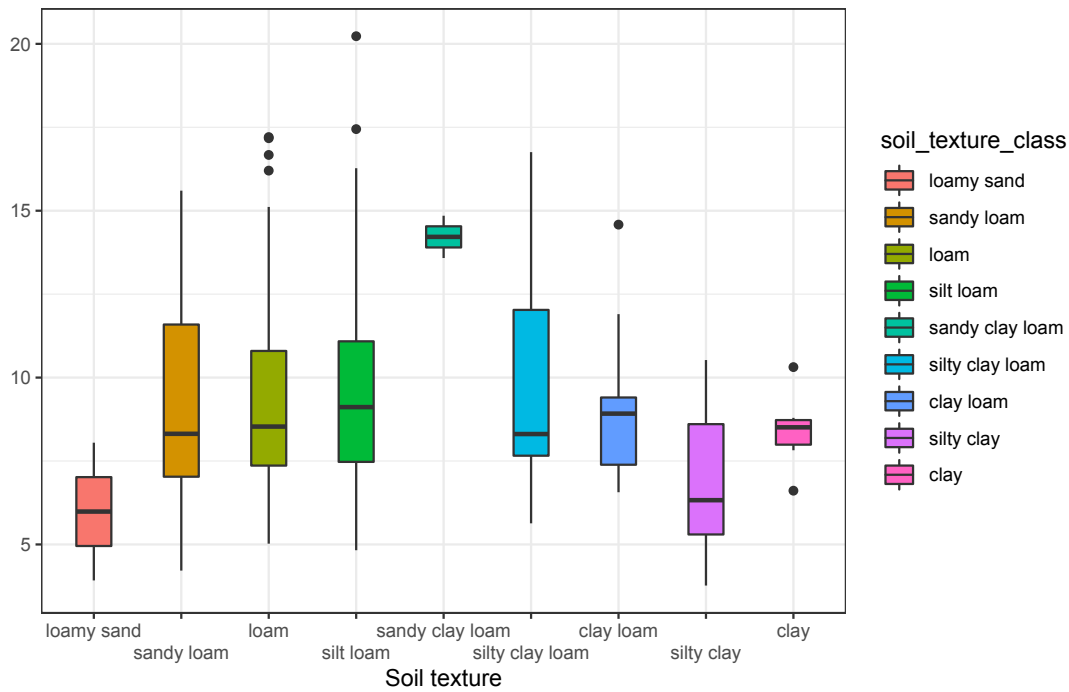
Figure 20. Boxplot of ACE soil protein (mg/g dry weight) by soil texture class.

Available water capacity

Available water capacity by crop type

Table 19. Descriptive statistics of available water capacity (g/g) by crop type

Type	n	Minimum	Q1	Median	Mean	Q3	Maximum	Standard deviation
Veg	22	0.10	0.17	0.22	0.21	0.24	0.27	0.05
Field crops	4	0.21	0.23	0.24	0.23	0.24	0.24	0.01
Corn	114	0.16	0.22	0.23	0.23	0.25	0.31	0.03
Pasture	37	0.18	0.24	0.25	0.26	0.28	0.30	0.03
Hay	44	0.16	0.22	0.24	0.24	0.26	0.32	0.03
All fields	*221*	*0.1*	*0.22*	*0.24*	*0.23*	*0.25*	*0.32*	*0.03*
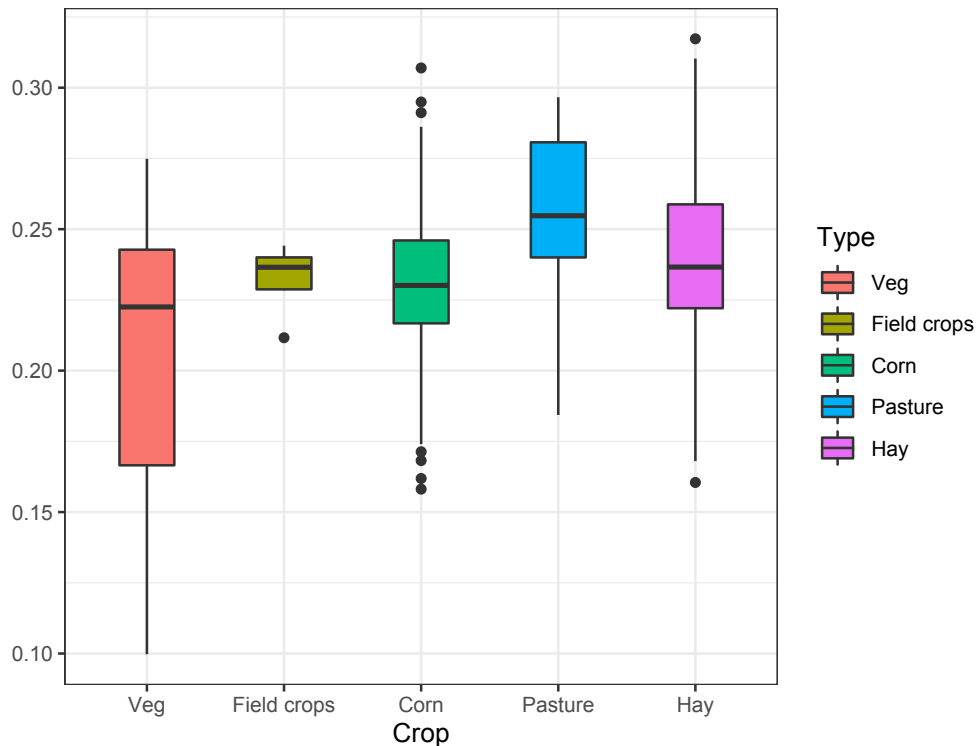
Figure 21. Boxplot of available water capacity (g/g) by crop type.

Available water capacity by soil texture

Table 20. Descriptive statistics for available water capacity (g/g) by soil texture class.

Soil texture	n	Minimum	Q1	Median	Mean	Q3	Maximum	Standard deviation
loamy sand	2	0.10	0.10	0.10	0.10	0.10	0.10	0.00
sandy loam	40	0.14	0.17	0.18	0.19	0.20	0.24	0.02
loam	95	0.19	0.22	0.23	0.23	0.24	0.31	0.02
silt loam	28	0.23	0.25	0.27	0.27	0.28	0.31	0.02
sandy clay loam	2	0.24	0.24	0.24	0.24	0.24	0.24	0.00
silty clay loam	19	0.19	0.25	0.26	0.27	0.28	0.32	0.03
clay loam	14	0.22	0.23	0.24	0.24	0.25	0.28	0.02
silty clay	15	0.21	0.24	0.25	0.25	0.27	0.30	0.02
clay	6	0.24	0.24	0.24	0.25	0.25	0.27	0.01
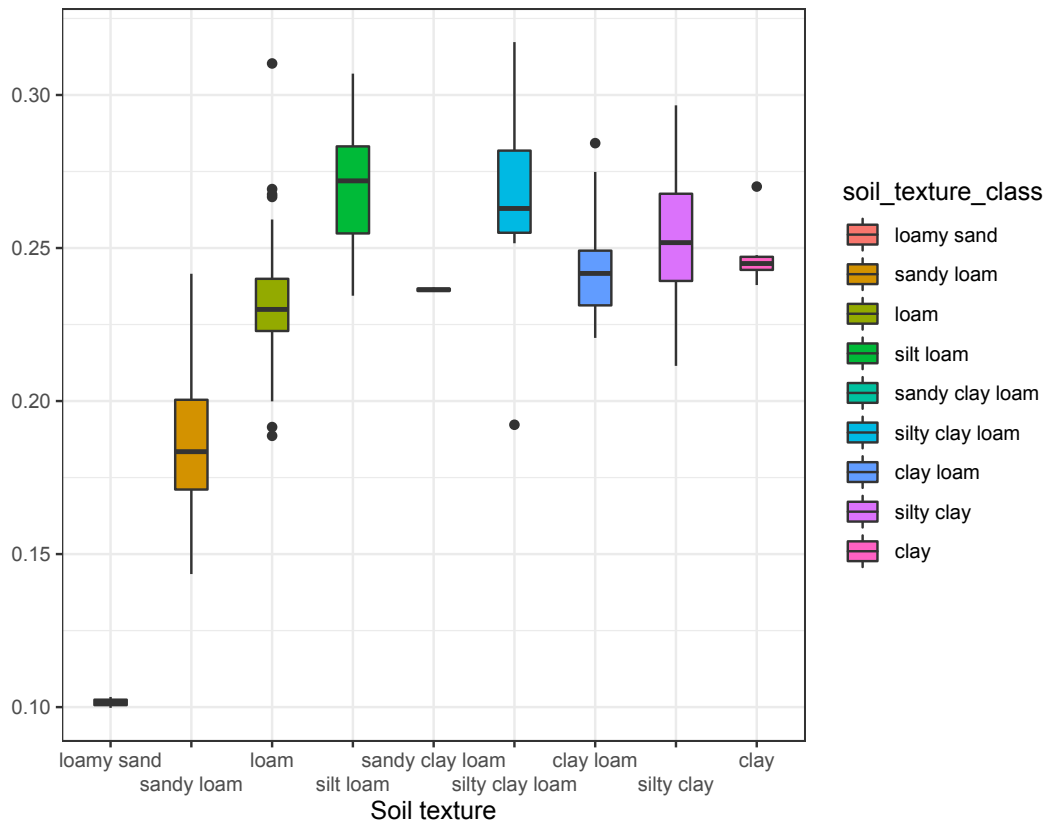
Figure 22. Boxplot of available water capacity (g/g) by soil texture class.

Particulate soil carbon

Particulate soil carbon by crop type

Table 21. Descriptive statistics of particulate soil carbon (mgC per g soil) by crop type.

Type	n	Minimum	Q1	Median	Mean	Q3	Maximum	Standard deviation
Veg	17	4.27	4.97	5.98	7.1	6.73	13.96	3.23
Corn	97	2.2	4.19	5.83	6.63	7.87	16.17	3.11
Pasture	17	4.29	11.09	13.94	13.94	15.31	25.41	5.35
Hay	31	4.25	7.7	9.24	11.94	15.89	31.99	6.94
All fields	162	2.2	4.82	6.7	8.33	10.25	31.99	4.99
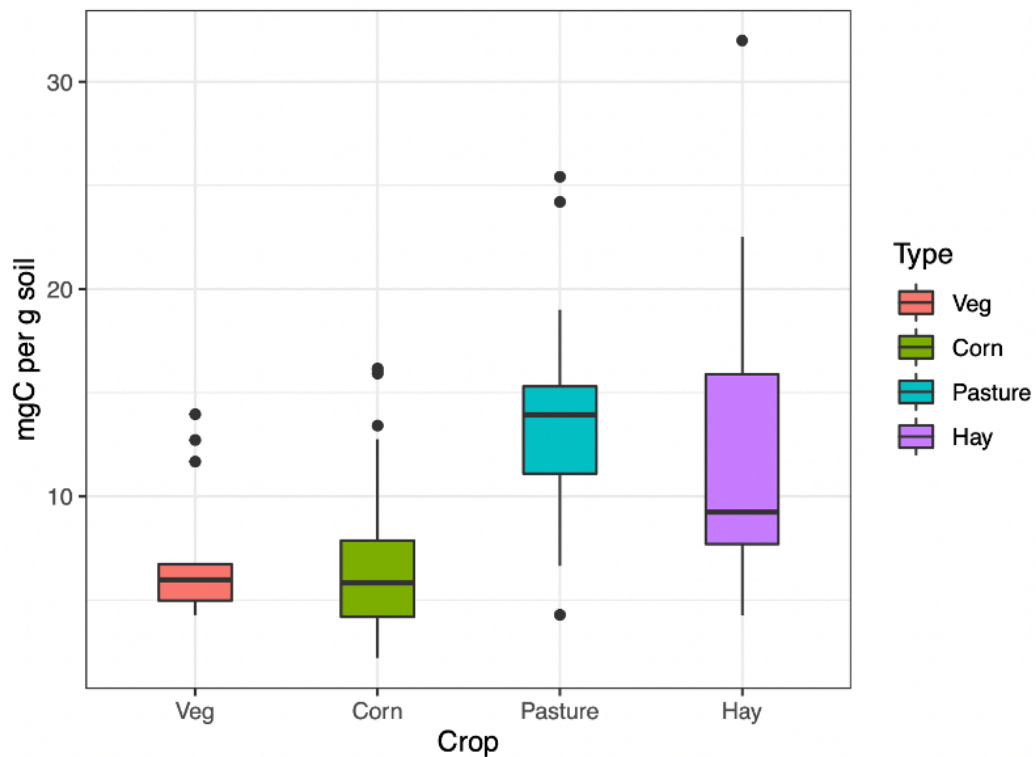
Figure 23. Boxplot of proportion of particulate soil carbon (mgC per g soil) by crop type.

Particulate soil carbon by soil texture

Table 22. Descriptive statistics for particulate soil carbon (mgC per g soil) by soil texture class.

Soil texture	n	Minimum	Q1	Median	Mean	Q3	Maximum	Standard deviation
loamy sand	2	4.27	6.12	7.97	7.97	9.82	11.68	5.24
sandy loam	33	2.37	5.78	7.61	9.08	10.81	24.2	5.28
loam	74	2.2	4.15	5.98	7.51	9.33	25.41	4.51
silt loam	19	2.95	4.95	8.38	9.18	11.38	21.28	5.11
sandy clay loam	2	18.83	22.12	25.41	25.41	28.7	31.99	9.31
silty clay loam	9	5.22	9.33	12.53	11.08	12.85	15.87	3.29
clay loam	10	2.72	5.29	5.52	5.75	6.21	9.87	1.91
silty clay	9	4.06	5.32	5.92	6.69	7.68	11.5	2.27
clay	4	4.29	6.79	8.39	8.75	10.35	13.94	4.01
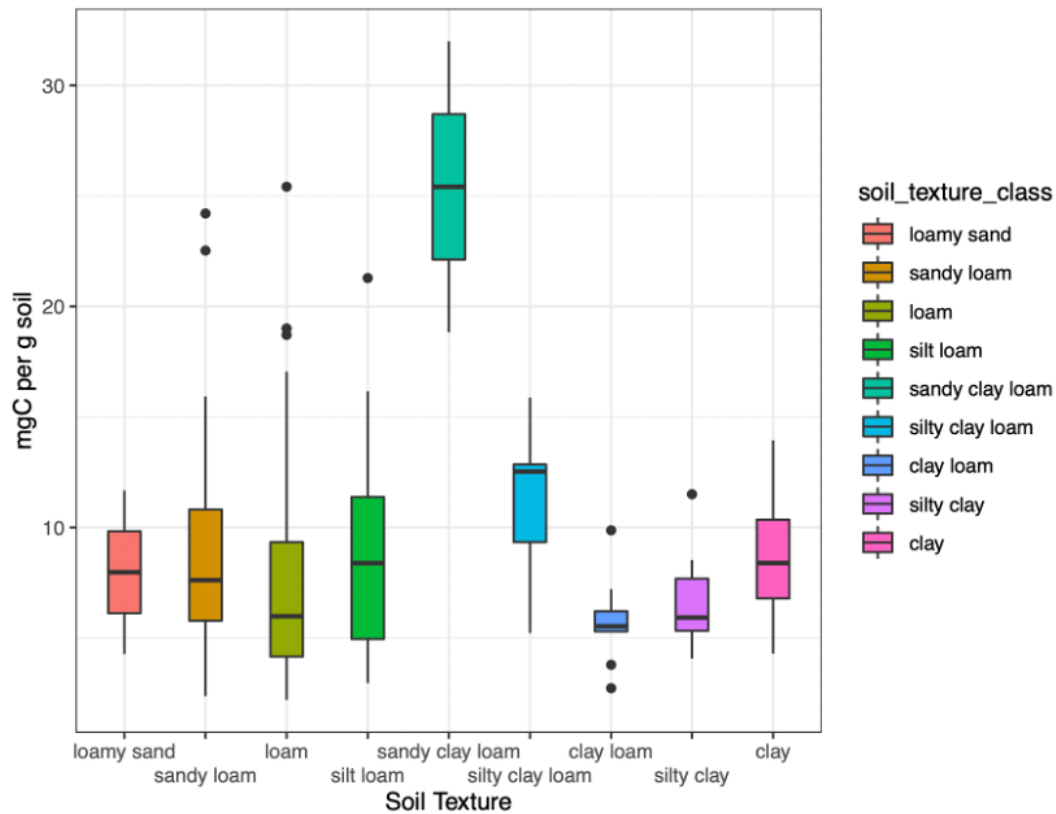
Figure 24. Boxplot of proportion of particulate soil carbon (mgC per g soil) by soil texture class.

Mineral-associated soil carbon

Mineral-associated soil carbon by crop type

Table 23. Descriptive statistics of mineral-associated soil carbon (mgC per g soil) by crop type.

Type	n	Minimum	Q1	Median	Mean	Q3	Maximum	Standard deviation
Veg	17	5.12	10.53	14.23	15.6	21.15	28.55	6.99
Corn	97	3.28	9.4	13.97	14.1	18.15	33.07	6.17
Pasture	17	6.86	11.49	16.36	18.39	27.51	32.39	8.63
Hay	31	5.07	14.03	17.16	16.87	20.64	27.27	5.07
All fields	162	3.28	9.96	14.66	15.16	19.85	33.07	6.55
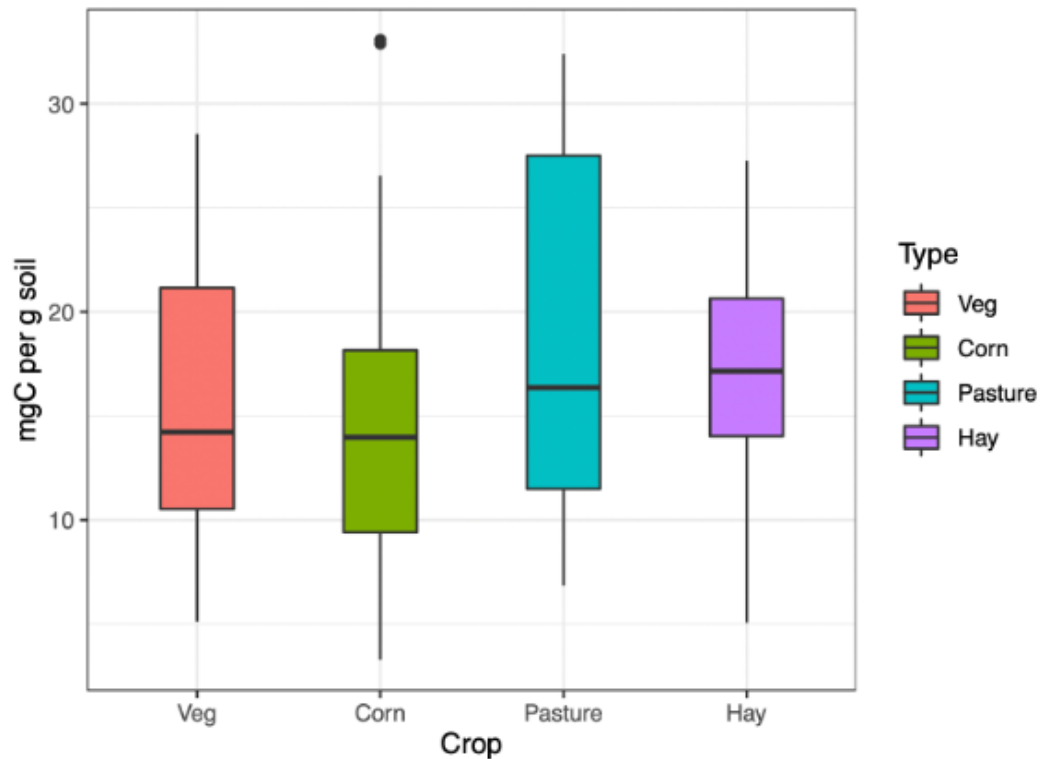
Figure 25. Boxplot of proportion of mineral-associated soil carbon (mgC per g soil) by crop type.

Mineral-associated soil carbon by soil texture

Table 24. Descriptive statistics for mineral-associated soil carbon (mgC per g soil) by soil texture class.

Soil texture	n	Minimum	Q1	Median	Mean	Q3	Maximum	Standard deviation
loamy sand	2	5.12	6.95	8.78	8.78	10.6	12.43	5.17
sandy loam	33	5.07	9.5	13.37	13.88	16.61	27.51	5.46
loam	74	3.28	9.12	14.09	14.77	20.01	32.39	7.29
silt loam	19	7.37	9.38	13.26	13.5	15.47	23.49	4.95
sandy clay loam	2	16.32	17.75	19.19	19.19	20.62	22.05	4.05
silty clay loam	9	6.39	16.36	18.59	19.75	20.87	33.07	7.96
clay loam	10	11.51	13.12	16.95	17.72	19.7	32.88	6.28
silty clay	9	12.79	14.73	14.83	16.93	20.57	22.59	3.52
clay	4	10.6	16.14	19.21	17.5	20.57	20.99	4.78
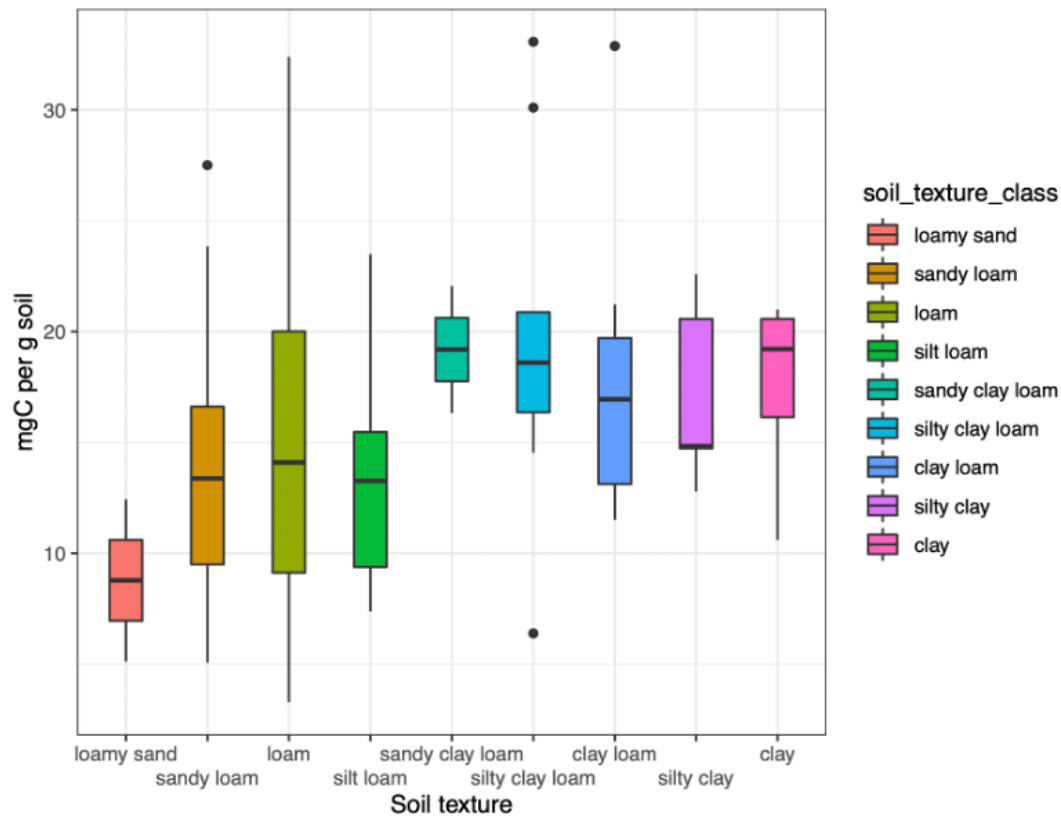
Figure 26. Boxplot of proportion of mineral-associated soil carbon (mgC per g soil) by soil texture class.

Proportion of organic carbon that is mineral-associated

Proportion of organic carbon that is mineral-associated by crop type

Table 25. Descriptive statistics of proportion of organic carbon that is mineral-associated by crop type.

Type	n	Minimum	Q1	Median	Mean	Q3	Maximum	Standard deviation
Veg	17	0.52	0.63	0.68	0.67	0.73	0.83	0.1
Corn	97	0.35	0.59	0.7	0.67	0.76	0.87	0.11
Pasture	17	0.32	0.4	0.6	0.56	0.68	0.74	0.15
Hay	31	0.33	0.54	0.63	0.6	0.7	0.78	0.13
All fields	162	0.32	0.58	0.69	0.65	0.73	0.87	0.12
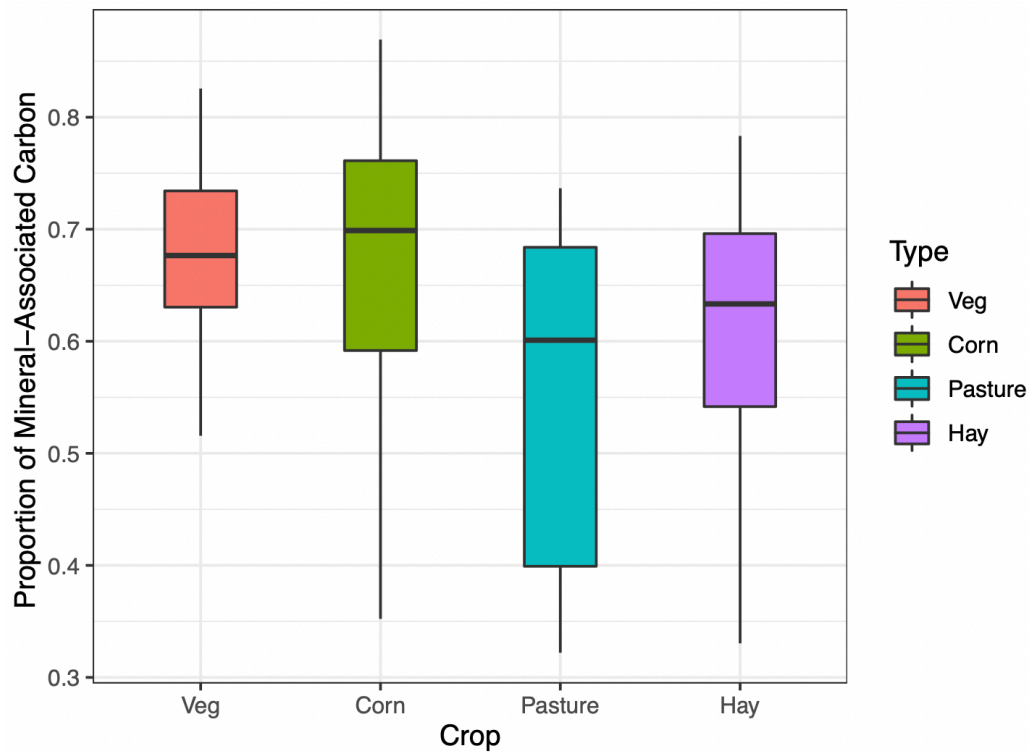
Figure 27. Boxplot of proportion of mineral-associated carbon by crop type.

Proportion of organic carbon that is mineral-associated carbon by soil texture

Table 26. Descriptive statistics for organic carbon that is mineral-associated by soil texture class.

Soil texture	n	Minimum	Q1	Median	Mean	Q3	Maximum	Standard deviation
loamy sand	2	0.52	0.52	0.53	0.53	0.54	0.55	0.02
sandy loam	33	0.32	0.56	0.63	0.61	0.7	0.81	0.12
loam	74	0.33	0.58	0.69	0.66	0.73	0.87	0.12
silt loam	19	0.36	0.51	0.6	0.61	0.73	0.79	0.15
sandy clay loam	2	0.34	0.39	0.44	0.44	0.49	0.54	0.14
silty clay loam	9	0.46	0.54	0.62	0.62	0.7	0.79	0.12
clay loam	10	0.59	0.69	0.76	0.75	0.81	0.86	0.09
silty clay	9	0.64	0.72	0.73	0.72	0.74	0.78	0.04
clay	4	0.6	0.67	0.7	0.68	0.7	0.71	0.05

Figure 28. Boxplot of organic carbon that is mineral-associated by soil texture class.

CASH scores

CASH scores for all parameters for all crop types

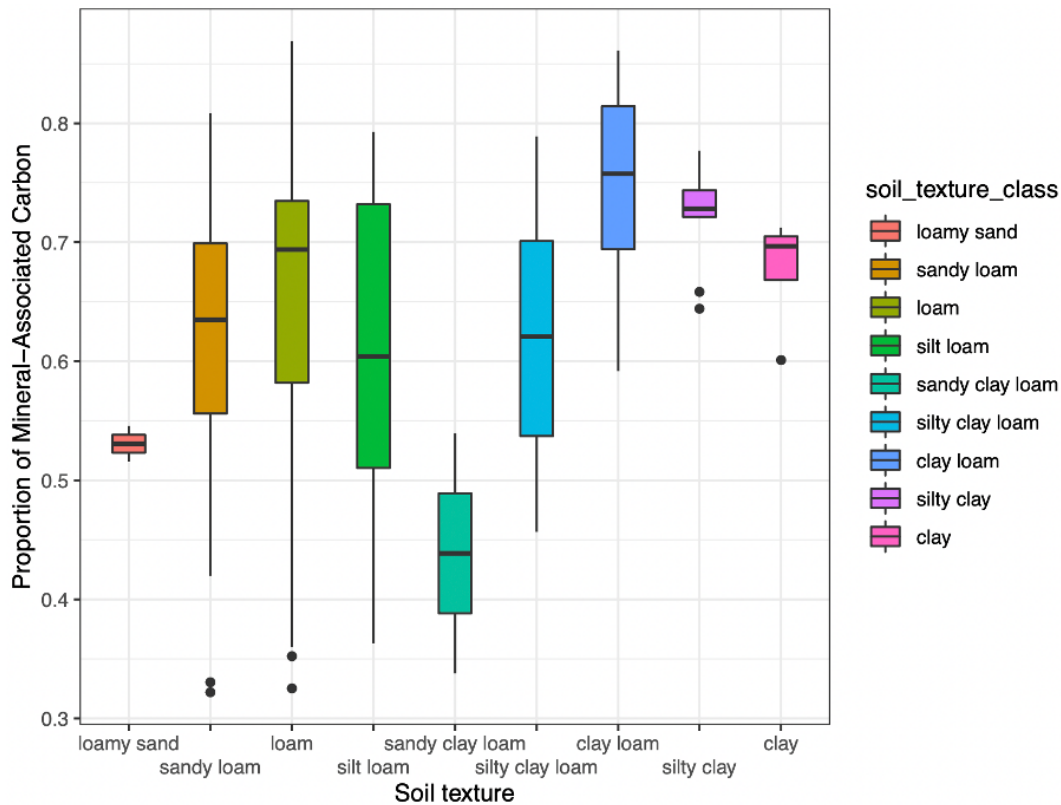**Table 27. Descriptive statistics of scores for all parameters for all crop types.**

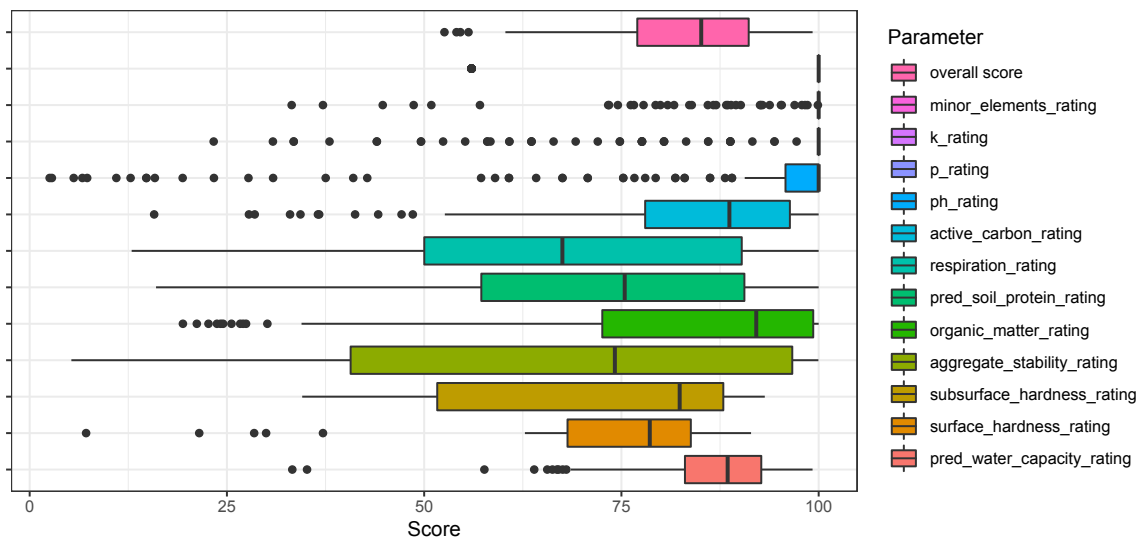| Parameter	Minimum	Q1	Median score	Mean score	Q3	Maximum
Available water capacity rating	33.29	83.05	88.46	86.55	92.73	99.22
Surface hardness rating	7.15	68.17	78.59	70.64	83.80	91.43
Subsurface hardness rating	34.54	51.65	82.38	71.97	87.91	93.17
Aggregate stability rating	5.29	40.68	74.17	67.84	96.65	99.97
Organic matter rating	19.42	72.57	92.09	82.51	99.31	100.00
Predicted soil protein rating	16.02	57.24	75.42	72.00	90.59	100.00
Respiration rating	12.93	50.01	67.52	67.83	90.25	100.00
Active carbon rating	15.78	78.01	88.69	84.60	96.35	100.00
pH rating	2.53	95.79	100.00	90.34	100.00	100.00
P rating	23.32	100.00	100.00	93.73	100.00	100.00
K rating	33.20	100.00	100.00	96.71	100.00	100.00
Minor elements rating	56.00	100.00	100.00	96.62	100.00	100.00
Overall score	52.57	77.01	85.11	83.67	91.13	99.23

Figure 29. Boxplot of scores for all parameters for all crop types.

CASH scores for all parameters for corn fields

Table 28. Descriptive statistics of scores for all parameters for corn fields.

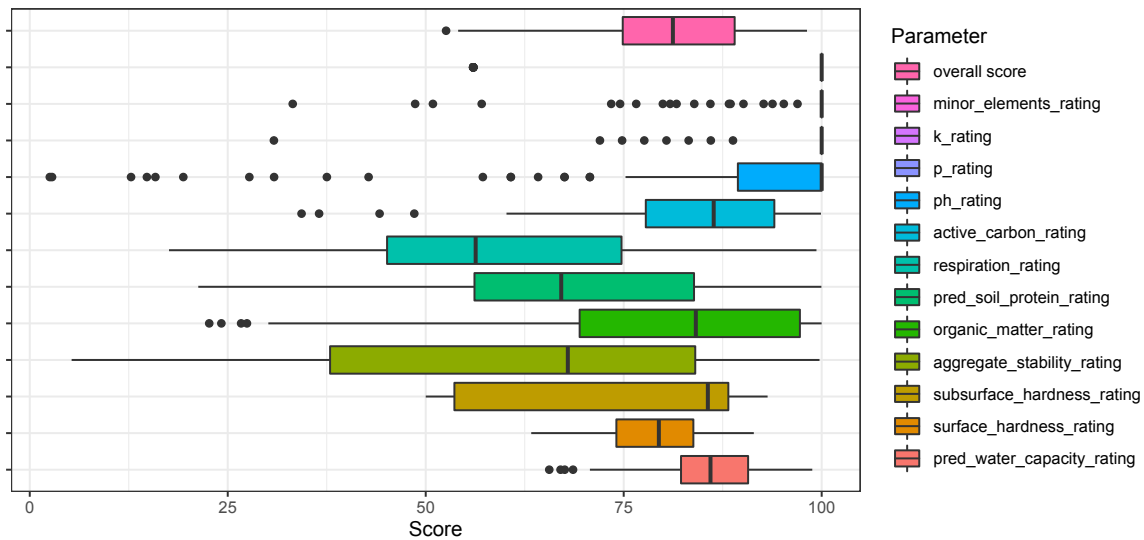| Parameter	Minimum	Q1	Median score	Mean score	Q3	Maximum
Available water capacity rating	65.60	82.24	85.96	85.61	90.71	98.81
Surface hardness rating	63.32	74.07	79.44	78.71	83.80	91.43
Subsurface hardness rating	50.00	53.62	85.63	74.27	88.21	93.17
Aggregate stability rating	5.29	37.92	67.94	62.10	84.03	99.73
Organic matter rating	22.66	69.44	84.11	78.47	97.25	99.99
Predicted soil protein rating	21.28	56.16	67.11	68.07	83.88	99.97
Respiration rating	17.59	45.12	56.31	58.78	74.73	99.34
Active carbon rating	34.32	77.79	86.36	83.93	94.02	99.91
pH rating	2.53	89.42	100.00	88.02	100.00	100.00
P rating	30.83	100.00	100.00	98.19	100.00	100.00
K rating	33.20	100.00	100.00	96.25	100.00	100.00
Minor elements rating	56.00	100.00	100.00	96.14	100.00	100.00
Overall score	52.57	74.88	81.21	81.53	89.01	98.15

Figure 30. Boxplot of scores for all parameters for corn fields.

CASH scores for all parameters for vegetable fields

Table 29. Descriptive statistics of scores for all parameters for vegetable fields.

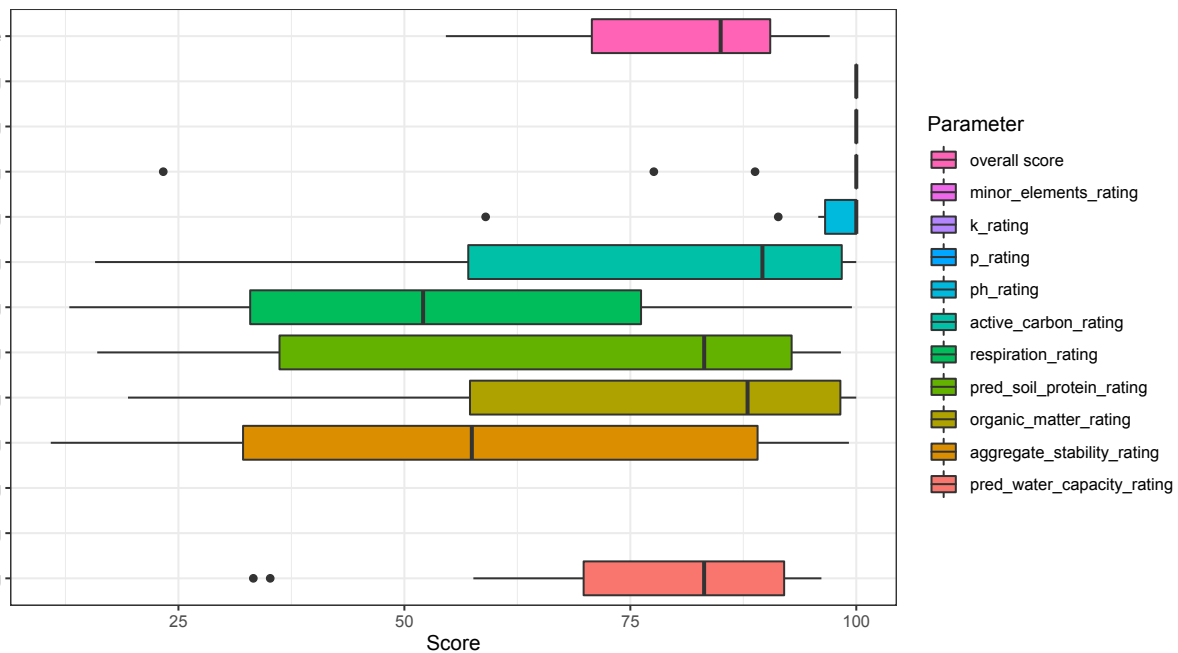| Parameter	Minimum	Q1	Median score	Mean score	Q3	Maximum
Available water capacity rating	33.29	69.83	83.16	78.33	92.02	96.14
Surface hardness rating	NA	NA	NA	NA	NA	NA
Subsurface hardness rating	NA	NA	NA	NA	NA	NA
Aggregate stability rating	10.88	32.15	57.46	58.27	89.08	99.18
Organic matter rating	19.42	57.26	87.97	74.25	98.24	100.00
Predicted soil protein rating	16.02	36.18	83.17	66.59	92.85	98.30
Respiration rating	12.93	32.94	52.07	54.95	76.19	99.52
Active carbon rating	15.78	57.07	89.61	77.35	98.39	100.00
pH rating	58.99	96.55	100.00	96.83	100.00	100.00
P rating	23.32	100.00	100.00	94.99	100.00	100.00
K rating	100.00	100.00	100.00	100.00	100.00	100.00
Minor elements rating	100.00	100.00	100.00	100.00	100.00	100.00
Overall score	54.59	70.74	84.99	80.16	90.48	97.06

Vegetable fields in 2021

Figure 31. Boxplot of scores for all parameters for vegetable fields.

CASH scores for all parameters for hay fields

Table 30. Descriptive statistics of scores for all parameters for hay fields.

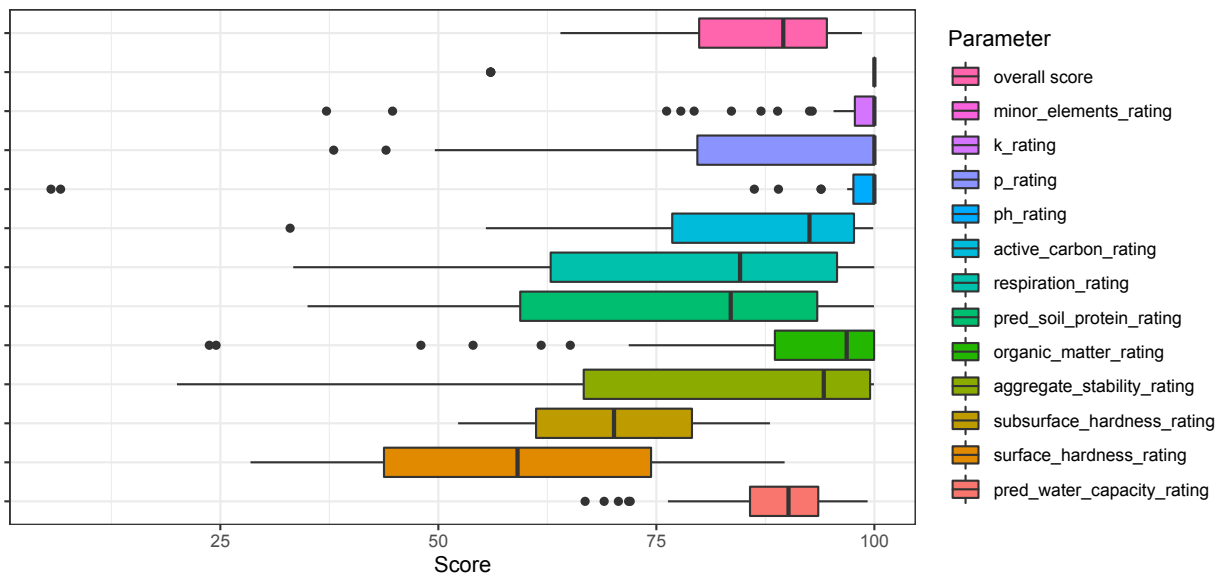| Parameter	Minimum	Q1	Median score	Mean score	Q3	Maximum
Available water capacity rating	66.83	85.74	90.15	88.14	93.57	99.22
Surface hardness rating	28.45	43.77	59.08	59.08	74.39	89.71
Subsurface hardness rating	52.27	61.20	70.14	70.14	79.08	88.02
Aggregate stability rating	20.03	66.67	94.20	81.28	99.51	99.95
Organic matter rating	23.74	88.59	96.82	88.40	99.97	100.00
Predicted soil protein rating	35.00	59.39	83.53	77.36	93.45	99.95
Respiration rating	33.36	62.88	84.60	79.19	95.72	99.99
Active carbon rating	33.00	76.82	92.56	86.02	97.66	99.86
pH rating	5.58	97.59	100.00	94.43	100.00	100.00
P rating	38.00	79.70	100.00	88.48	100.00	100.00
K rating	37.17	97.76	100.00	94.41	100.00	100.00
Minor elements rating	56.00	100.00	100.00	96.00	100.00	100.00
Overall score	64.00	79.91	89.55	87.16	94.55	98.58

Figure 32. Boxplot of scores for all parameters for hay fields.

CASH scores for all parameters for pasture fields

Table 31. Descriptive statistics of scores for all parameters for pasture fields.

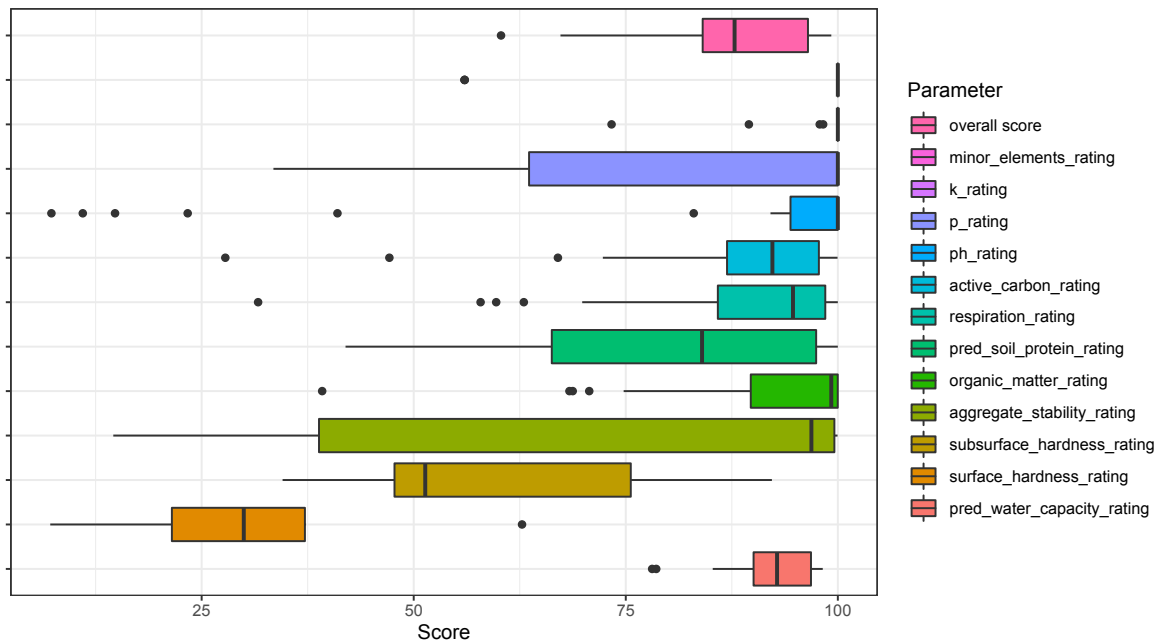| Parameter	Minimum	Q1	Median score	Mean score	Q3	Maximum
Available water capacity rating	78.11	90.07	92.84	92.47	96.83	98.22
Surface hardness rating	7.15	21.49	29.97	31.71	37.17	62.77
Subsurface hardness rating	34.54	47.73	51.36	60.29	75.59	92.23
Aggregate stability rating	14.58	38.84	96.88	74.18	99.59	99.97
Organic matter rating	39.21	89.74	99.23	91.86	99.99	100.00
Predicted soil protein rating	41.96	66.28	83.99	79.98	97.44	100.00
Respiration rating	31.66	85.85	94.71	88.98	98.52	100.00
Active carbon rating	27.79	86.94	92.29	88.48	97.76	99.97
pH rating	7.29	94.42	100.00	87.75	100.00	100.00
P rating	33.46	63.60	100.00	85.13	100.00	100.00
K rating	73.32	100.00	100.00	98.89	100.00	100.00
Minor elements rating	56.00	100.00	100.00	96.43	100.00	100.00
Overall score	60.29	84.06	87.83	87.54	96.48	99.23

Figure 33. Boxplot of scores for all parameters for pasture fields.

CASH scores by crop type

Table 32. Descriptive statistics of overall soil health scores by crop type.

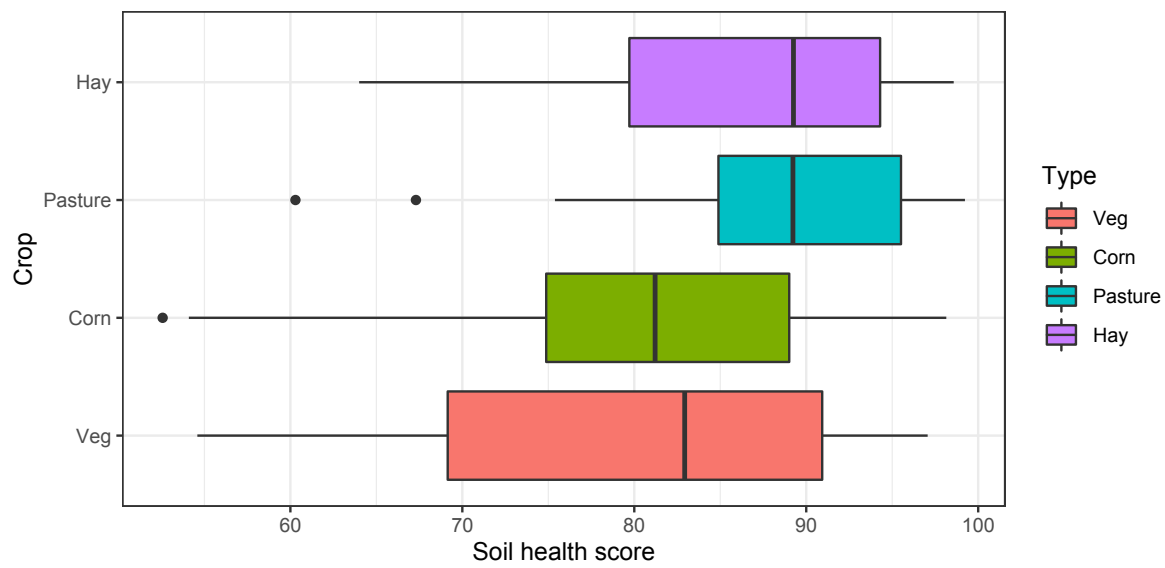| Type	n	Minimum	Q1	Median score	Mean score	Q3	Maximum	Standard Deviation
Vegetable	22	54.59	70.74	84.99	80.16	90.48	97.06	13.21
Field crops	4	83.04	85.96	90.27	89.88	94.19	95.94	5.94
Corn	114	52.57	74.88	81.21	81.53	89.01	98.15	9.08
Pasture	37	60.29	84.06	87.83	87.54	96.48	99.23	9.51
Hay	44	64.00	79.91	89.55	87.16	94.55	98.58	8.70

Figure 34. Boxplot of overall soil health scores by crop type.