CARBON
METRICS

Soils Report - 2022

Produced for:

Bancroft,
Boulsworth End Farm

This report includes the following information:

Soil Samples Results
Fertiliser and Lime Recommendations
Soil Organic Matter and Carbon Results
Soil VESS Score Tests Results
Soil Worm Counts Results
Soil Slake Tests Results

Soil Sample Results

Field Details	Soil pH	Index			Mg/l (Available)		
		P	K	Mg	P	K	Mg
Tom Grove Hey	4.4	0	1	2	5.2	71	69
Moorland 1	5.2	1	1	3	10.4	94	111
Moorland 2	5.0	0	1	3	6.8	62	122
Big Bells	5.4	0	0	2	4.4	48	57
Badger Lane	5.8	3	1	2	27.0	63	95
Hillside Opp	6.1	2	0	2	21.2	44	54
Mistress Hill M	5.8	2	3	3	17.8	257	108
Ridge Meadows 9	5.4	0	1	2	6.6	100	84
Ridge Meadows 10	5.7	2	2-	3	19.8	165	121
Ridge Meadows 20	5.7	0	1	2	6.0	78	91

Target indices for minerals within soil:

- Arable, Forage, Grassland and Potato Crops: P Index 2, K Index 2- (In rotations with autumn-sown crops, soils in good condition and annual phosphate applications, a high index 1 can be an adequate target).
- Vegetables and Bulbs: P Index 3, K Index 2+ (If vegetables are only grown occasionally as part of an arable rotation, it would be most economic to target index 2 for arable and forage crops).
- Fruit Vines and Hops: P Index 2, K Index 2, Mg Index 2
- A lime recommendation is usually for a 20cm depth of cultivated soil or a 15cm depth of grassland soil. Where soil is acidic below 20 cm and soils are ploughed for arable crops, a proportionately larger quantity of lime should be applied. Additionally, if more than 10 t/ha is needed, half should be deeply cultivated into the soil and ploughed down, with the remainder applied to the surface and worked in.

For nitrogen recommendations, it is advised to take N-Min tests in early spring (before any fertiliser application) for accurate representation of nitrogen in soil.

Phosphate, Potash and Magnesium Fertiliser and Lime Recommendations

Field	Crop	P_2O_5 (Kg/Ha)	K_2O (Kg/Ha)	MgO (Kg/Ha)	Lime (T/Ha)
Tom Grove	Grassland	n/a	n/a	n/a	n/a
Moorland 1	Grassland	n/a	n/a	n/a	n/a
Moorland 2	Grassland	n/a	n/a	n/a	n/a
Big Bells	Grassland	80	60	0	4.8
Badger Lane	Grassland	0	30	0	2.4
Hillside Opposite	Grassland	20	60	0	0
Mistress Hill Middle	Grassland	20	0	0	2.4
Ridge Meadows 9	Grassland	80	30	0	4.8
Ridge Meadows 10	Grassland	20	0	0	3.0
Ridge Meadows 20	Grassland	80	30	0	3.0

Key points and further recommendations

- These results are calculated using the RB209.
- n/a has been written for Tom Grove and Moorland 1&2, as these are rough grazing which is unlikely to have fertiliser or lime applied.
- The main benefits on this farm would arise from lime application, particularly on big bells and ridge meadows.
- Reduce soil compaction: Careful management and timing of cultivation will assist to reduce soil compaction. Reduce trafficking of soils and use of precision agriculture and agri-tech can reduce compaction from heavy machinery and high-risk cultivation practices. Compacted arable soils can require up to twice as much fertiliser to maintain crop yields.
- Maintain cover by protecting soils from erosion by ensuring complete ground cover in grasslands, retain crop residues, use cover crops and manage grazing pressures. Using deep rooted cover crops in the rotation can also assist in improving drainage and reducing sediment and nutrient loss by up to 80%.
- Address compaction issues. These can make a massive difference to net emissions. Use a spade to make regular inspections and address problem areas with appropriate cultivation. Both cultivation and roots can reduce soil compaction, with machinery being quicker acting, whilst roots are longer lasting.

Soil Organic Carbon Results

Field Name	*Soil Inorganic Carbon (%)*	*Total Carbon (%)*	*Total Nitrogen (%)*	*C:N Ratio*	*Organic Matter (%)*	*Soil Organic Carbon (%)*	*Active Carbon mg/kg*	*Active Carbon % of SOC*	*Organic Carbon Stock (t/ha)*
Tom Grove Hey	<0.1	6.7	0.4	17	11.6	6.7	1663	2.5	176
Moorland 1	0.2	38.8	1.38	28	66.6	38.7	1385	0.4	475
Moorland 2	<0.1	42.8	1.30	33	73.9	42.8	2718	0.6	630
Big Bells	<0.1	17.5	0.95	18	30.2	17.5	1620	0.9	331
Badger Lane	<0.1	6.0	0.54	11	10.3	6.0	1559	2.6	153
Hillside Opp	<0.1	7.6	0.55	14	13.1	7.6	1611	2.1	185
Mistress Hill M	<0.1	4.7	0.47	10	8.0	4.7	1402	3.0	120
Ridge Meadows 9	<0.1	7.6	0.57	13	13.1	7.6	1298	1.7	169
Ridge Meadows 10	<0.1	7.2	0.59	12	12.3	7.1	1446	2.0	157
Ridge Meadows 20	<0.1	9.6	0.65	15	16.5	9.6	1724	1.8	241

Key points and recommendations

- These carbon samples were taken to 30cm depth.
- As expected, from the farm practices and land management. There are some exceptional levels of organic matter on this farm. The UK average is between 2-5%, whilst some of the land here has over 70% organic matter. Protecting these pasturelands from organic matter loss is crucial for climate change prevention.

Glossary of terms

Organic Carbon Stock (t/ha) - Organic Carbon Stock gives a total organic carbon value in tonnes of carbon per hectare of land to the specified sampling depth. This calculation factors in the measured soil organic carbon %, stone content, sampling depth and bulk density.

Active Carbon mg/kg - Active or Labile Carbon is the portion of carbon which readily breaks down and provides an active source of nutrition to soil microbes. Changes in soil management such as cultivation methods or the use of cover crops, can be monitored with active carbon analysis as it is a precursor to long term build-up of organic matter.

Soil Organic Carbon % - Soil Organic Carbon is the carbon component of soil organic matter. It is a diverse group of carbon-based compounds originating from the decomposition of plant material, animal residues, soil fauna and biota. The level of SOC is influenced by environmental factors and management practises. It is a key measurement in monitoring changes in the levels of carbon stocks.

Organic Matter % - Soil Organic Matter is complex mixture of all organic material found in the soil including living components (plant roots, microorganisms) and dead components (leaf litter, humic substances). It increases the soils water holding capacity and provides a slow release source of energy for microorganisms which increases the cycling of nutrients within

the soil. This report uses the Van Bemmelen factor of 0.58, to convert Soil Organic Carbon to Organic Matter.

Total Nitrogen % - Nitrogen is the main driver of plant growth and is associated with soil organic matter. It is mobile in the environment and present in many different compounds some of which are available for uptake by plants. Total Nitrogen is the measure of all forms of nitrogen (organic and inorganic) in the dried sample.

Total Carbon % - Total Carbon is the measure of all carbon forms within the soil which are primarily organic or inorganic. Total carbon is different to Total Organic Carbon, which refers specifically to the organic carbon fraction.

C:N Ratio – The proportion of organic carbon relative to nitrogen (C:N ratio) gives an indication of the right balance for soil microbes to aid the release of nutrients. The optimum C:N ratio for nitrogen release in soil is between 10 and 12.

Inorganic Carbon % & Carbonate Classification - Soil Inorganic Carbon comprises carbonates and bicarbonates which are abundant in alkaline soils. The SIC forms a reservoir in the soil and the levels can be subject to change with biological and environmental factors that influence the precipitation of solid $CaCO_3$ or the emission of gaseous CO_2. The carbonate content is calculated from the Inorganic Carbon % which can then be classified as:

Soil Inorganic Carbon	<0.12%	0.12- 0.6%	0.6- 1.2%	1.2%- 4.8%	>4.8%
Carbonate	1%	5%	5- 10%	10- 40%	>40%
Classification	NC (Non calcareous)	SC (Slightly Calcareous)	MC(Moderately Calcareous)	VC (Very Calcareous)	EC (Extremely Calcareous)

Stone content (%) & Sampling depth - The amount of stone within the soil and the sampling depth are both factored into the Organic Carbon Stock value. Stone content will dilute the amount of carbon held within the soil. Bulk density kg/l - Bulk density is the weight of a soil for a given volume.

The Bulk Density of a soil gives a good indication of how well plant roots can grow and explore the soil for nutrients, and how easily air and water can move within the soil profile. The Bulk Density of the soil is used to calculate the Organic Carbon Stock.

Soil Health Tests: VESS Score, Worm Counts & Slake Tests

Field Name	VESS Score	Worm Count			Slake Test
		Epigeic	Endogeic	Anecic	
Tom Grove Hey	4	0	0	0	0
Moorland 1	4	0	0	0	0
Moorland 2	4	0	0	0	0
Big Bells	2	20	12	0	2.0
Badger Lane	2	7	1	1	1.0
Hillside Opp	3	5	1	0	2.0
Mistress Hill M	1	4	0	0	0.5
Ridge Meadows 9	3	4	0	0	1.0
Ridge Meadows 10	3	5	1	0	1.0
Ridge Meadows 20	3	4	0	0	0.5

Additional Notes

- Exceptional levels of worms were found in Big Bells, which correlated with a strong VESS score and also an exceptional Slake Test showing exceptional soil health.
- Very low worm counts on the moorland, expected due to wetness of land, these soil tests are not the best representation of moorland-type soils.

VESS Score: Explanation

VESS (Visual Evaluation of Soil Structure) is an assessment of soil structure allowing for comparisons between fields and farm practices, it is scored from 1-5 with 1 being the best.

- Score 1: Friable, Aggregates readily crumble with fingers, roots throughout the soil, highly porous.
- Score 2: Intact: Aggregates easy to break with one hand, a mixture of porous, rounded aggregates from 2mm-7cm, no clods present. Most aggregates are porous, roots throughout the soil.
- Score 3: Firm: Most aggregates break with one hand: a mixture of porous aggregates from 2mm-10cm; less than 30% are <1cm. Some non-angular, non-porous aggregates (clods) may be present). Macropores and cracks present and porosity and roots both within aggregates.
- Score 4: Compact: Requires considerable effort to break aggregates with one hand. Mostly large aggregates >10cm and sub-angular non-porous; horizontal/platy also possible, less than 30% are <7cm. Few macropores and cracks, all roots are clustered in macropores and around aggregates.
- Score 5: Very Compact: Difficult to break up, aggregates mostly large >10cm, very few <7cm, angular and non-porous with potentially anaerobic zones.

Worm Counts: Explanation

Earthworms are a great indicator or soil health, organic matter at soil ecology. There are three key types of earth worms: Epigeic, Endogeic and Anecic.

- Epigeic worms are litter-swelling, dark red-headed worms which are sensitive to tillage and increase in number with organic matter applications. They are key for carbon cycling and prey for native birds.
- Endogeic earthworms are the topsoil earthworms, they are pale and green and increase in number with organic matter management, they are important for soil aggregation and nutrient mobilisation for plants.
- Anecic earthworms are deep burrowing earthworms, they are sensitive to tillage and increase in number with organic matter management. They are important for deep burrows that improve aeration, water infiltration and root development.

This earthworm assessment used a soil pit (20cmx20cmx20cm), which was hand-sorted, and earthworm numbers and type recorded. The target earthworm population would be 16/hole with each of the three types of earthworms recorded.

Slake Test

A slake test is a strong indicator of soil biology, soil stability and aggregation. The test works by placing an aggregate of soil into water for 5 minutes and assessing the resulting aggregate. The scores are explained before which go from 0-2 with 2 being the best result. The higher the score, the more resistant the soil is to wind erosion, water erosion and capping.

- 0: Dissolves into single grains – lump collapses completely, as soil is too unstable to isolate aggregates.
- 0.5: Soil slumps into pyramid – lump collapses into a cone of <2mm grains, water is cloudy.
- 1: Breaks into angular pieces – the lump breaks up into larger angular pieces, indicating a loose, granular surface layer.
- 1.5: Stays mainly intact – lump edges crumble slightly but remains largely intact.
- 2: Lump intact – lump remains completely intact and the water is clear, indicating your soil is resistant to erosion.